FINAL REPORT for APN PROJECT
Project Reference: ARCP2010-08NSY-Freeman

Impact of Climate Change on Food Security and Biosecurity of Crop Production Systems in Small Pacific Nations

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State Government Victoria Department of Primary Industries

Impact of Climate Change on Food Security and Biosecurity of Crop Production Systems

Traditional giant swamp taro (pulaka) production in Tuvalu in pits. Production is now affected by salinity of the groundwater.

Breadfruit trees are a staple food in Kiribati but are dying of drought.

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Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

Climate change is impacting on food security and biosecurity in the Pacific region by degradation of food production areas (sea level rise, salinity, drought), devastation caused by extreme weather events (cyclones, flooding) and impacts on recovery time such as replacement of lost crop germplasm and the need to import food substitutes. The aim of this project was to identify the key impacts of climate change on the unique cropping systems in four small Pacific nations (Tonga, Vanuatu, Kiribati and Tuvalu). Information was collected by the development of a questionnaire which was completed by Senior Agricultural Administrators, Biosecurity/Quarantine scientists, agricultural research and extension officers and farmers. Personal interviews, field trips and information sessions were also held in each country. Key issues examined included:

1. Background country information (statistics, capability, etc).
2. Quarantine/Biosecurity Policy (regulatory framework supporting importation of food and planting materials and their effectiveness after natural disasters).
3. Quarantine/Biosecurity practice (local and regional expertise, pest and disease databases, processes for responding to biosecurity incursions, etc.).
4. Impacts of climate change on pests and diseases of crops (new incursions, changes in severity, etc).
5. Impacts of climate change on crop production (what type of events, what impacts, access to germplasm).
6. Country capacity and needs.

The data was used to develop country reports (containing a summary of the data collected, key findings, priorities for future research and training), which provide solid data to enable development of strategies/policies to minimise these risks and to identify future research and training priorities and opportunities. At the final workshop, regional priorities shared by Australia and the Pacific countries were identified.

Objectives

The main objectives of the project were:

1. To identify the key impacts of climate change on the unique cropping systems in four small Pacific nations (Tonga, Vanuatu, Kiribati and Tuvalu).
2. To produce a report for each country (containing a summary of the data collected, key findings, priorities for future research and training**)** which provides solid data to enable development of strategies/policies to minimise the risks associated with a changing climate.
3. To hold a workshop with appropriate experts to identify future research and training opportunities for the collaborating countries and regional partners (Australia, NZ).

Amount received and number years supported

The Grant awarded to this project was:
US$ 55,000 for Year 1.

Activity undertaken

1. A survey and questionnaire in four participating countries (Tonga, Vanuatu, Kiribati and Tuvalu), to identify the critical impacts of climate change on food security and biosecurity in their agricultural systems, data analysis, risks identified.
2. Workshop with invited experts from relevant organisations to prioritise food security/biosecurity risks and determine investment and research opportunities (FAO, SPC, ACIAR etc.).
3. Documentation of outcomes to provide country reports for policy and strategy development, report to APN, preliminary training and research concepts and data for investors.

Results

1. Climate change is impacting on food security due to the increased length and severity of droughts in all collaborating countries, causing reduced fruit set, reduced yield and quality of fruits and root crops, death of annual crops and in Kiribati and Tuvalu, death of the breadfruit and pandanus trees which are staple foods.

2. Climate change is impacting on food security by degradation of production areas caused by sea level rise, salinity due to storm surges and salination of the water table in the atoll countries, Kiribati and Tuvalu. These are the most serious impacts of climate change on food production due to yellowing, stunting, yield reduction and in some instances death of trees and crops.

3. Climate change is impacting on food security due to extreme weather events such as cyclones which cause major damage to crops, loss of crop germplasm and destruction of coastal vegetation in all collaborating countries except Kiribati, which has not experienced cyclones.

4. All countries are able to obtain some replacement crop germplasm of the major food crops as tissue cultures from the Centre for Pacific Crops and Trees (CePaCT), SPC, and from their own field collections and undertake multiplication of planting stocks.

5. Loss of traditional crops in Kiribati and Tuvalu due to extreme weather events (E.g. drought) and long-term climate change effects (E.g. salt water intrusion) is causing import substitutes (mainly rice) to replace traditional foods.

6. There are long delays in identifying suitable atoll crop replacement varieties (giant swamp taro, breadfruit trees) suitable for saline and drought conditions, due to the time required to collect germplasm from other atoll countries (E.g. Federated States of Micronesia), multiplication and screening of planting material at CePaCT and evaluation within the affected country.

7. There is a perception of increased pest and disease problems due to climate change in all collaborating countries due both to stresses making crops more vulnerable to endemic pests and diseases and incursions of new pests and diseases. All collaborating countries have experienced at least two new incursions of pests and diseases in the last five years and none have been eliminated and control is only being attempted for a few.

8. There is a lack of physical and human capacity for effectively delivering plant health services (biosecurity, crop protection, etc). Countries depend on regional organizations for identification of pests and diseases and for advice on follow-up action (eradication, management, etc.) due to a lack of trained staff and resources.

9. Although all collaborating countries have Quarantine Acts and Kiribati and Tuvalu have Biosecurity Acts before parliament, capacity and training to enact these laws and development of supporting regulations is often limited. For example, pest risk assessments associated with importation of foods and crop germplasm are normally undertaken by SPC.

10. The number of staff employed in crop production and crop protection respectively in the collaborating countries are very low: Tonga (17,7); Vanuatu (6,4); Kiribati (2,1); Tuvalu (2,2).

11. Countries recognise the value of developing regional networks between neighbouring and like countries in addition to dealing solely with a central organisation as a feasible, low cost and sustainable way of acquiring assistance to deal with the impacts of climate change.

Relevance to the APN Goals, Science Agenda and to Policy Processes?

This project relates to the APN themes of Climate and Ecosystems, Biodiversity and Land Use. Documentation of any increased risks in food production systems and increased risks from pests and diseases due to climate change will enable governments and agencies to prioritise responses and develop policies and practices to prepare for and manage these risks. With respect to Science, Policy and Institutional agendas this project has relevance in the following ways:

a. Science agenda: An APN priority is to generate and transfer knowledge on the physical and human dimensions of change in the Earth system with a focus on climate and ecosystems, biodiversity and land use. This scoping study engages scientists and policy makers in four Pacific countries, via targeted surveys and questionnaires, to conduct impact and risk assessments in their communities. Outcomes from the workshop identify high risk areas and encourage initiatives and country-based research and development activities to develop coping strategies and pathways to deal with climate change and associated extreme weather events. The need to strengthen regional biosecurity is a priority of both the Pacific nations and their Australian and New Zealand neighbours and new opportunities to provide on-line training and access remote diagnostics to scientists in remote island countries are identified.

b. Policy Agenda: This project has evolved out of a number of FAO consultancies in the Pacific, including The Development of National Medium Term Priority Framework (NMTPF) for all FAO-Pacific member countries (FAO 2009). The outcome of this study was to identify ways of strengthening policy, legal and regulatory frameworks for agriculture and fisheries, particularly in relation to vulnerability to the adverse impacts of climate change and sea level rise. This project links with FAO policy and development strategy expertise via Dr Taufatofua, who has worked extensively with FAO developing regional agricultural and sustainable development policies for Pacific nations. A number of the project collaborators are senior agricultural administrators involved in agricultural policy development. The information generated in this project has been used to develop country reports for use by senior administrators and policy makers to inform decision making.

c. Institutional Agenda: The five collaborating countries (Australia, Kiribati, Tonga, Tuvalu and Vanuatu) are all APN member countries and the four Pacific countries have senior country collaborators on the project and have made a commitment to involve a broad range of scientists and policy makers in the project activities. The project specifically addresses national global change priorities and is aimed at empowering local scientists and policy makers to develop strategies to deal with global change based on solid data. The project workshop and documented outcomes are aimed at providing information to the participating countries but also to a broader audience, including regional bodies such as SPC, FAO and APN. A broad range of experts will be invited to the workshop ensuring that outcomes can be fed into regional policy.

Self evaluation

The project was based around workshops in each of the four collaborating countries followed by a group workshop in Melbourne. We were able to conduct personal interviews with a wide range of people during the country visits, and particularly appreciated the time and openness of senior administrators in all countries. Questionnaires were also completed by a number of staff and these activities provided the basis for a consolidated country report for each collaborating country. The Melbourne workshop enabled the collaborators to review the information provided by their country and to provide additional information. A peer review process was then undertaken with data and key findings from each country discussed by the project team. These discussions lead to new ideas to address the key issues identified in the reports. Country specific issues were identified but the group meeting resulted in themes and approaches applicable to the whole group being identified and aimed at addressing the lack of capacity (staff numbers, budgets, etc) and capability (training, equipment, networks, etc) to deal with the impacts of climate change on their crop production systems. A number of experts on issues prioritized by the group gave presentations at the workshop and participated in discussions on collaborative future research and training options.

Potential for further work

Improved diagnostic services, access to expertise and information, and biosecurity-related training opportunities were regularly suggested as strategies to improve capacity and capability around biosecurity and food security in Pacific countries. The lack of sustainability of many project initiatives after project funding is finished was discussed at the project workshop and as a result the strategies developed for future work are based around low-cost options, some delivered via the internet.

Low cost sustainable strategies for future work, based on country priorities, are as follows:
1. Development of an informal or formal national biosecurity network within collaborating countries, incorporating current nodes, and addressing country and regional scientific and political agendas. If this network was beneficial at the local level it could easily be expanded to a national and regional level.
2. Internet-based diagnostics, including remote microscopy (E.g. CRNPB Remote Microscopy project; www.crcplantbiosecurity.com.au), pest and disease databases (E.g. SPC regional and country pestlists) and internet diagnostic enquiry services (E.g. Pestnet, PaDIL).
3. GPS/Database survey data collection methods to facilitate collection and maintenance of pest and disease records.
4. On-line training (internet) including Post Graduate Certificate, Diploma, Masters Degree in Biosecurity developed by CRCNPB and offered through Australian Universities.
5. Low-cost simple diagnostic assays in-country, including tissue blot immunoassay (TBIA) for virus identification and fixing of virus or DNA to membranes (nitrocellulose, FTA cards) for posting to a laboratory for diagnosis.
6. Biosecurity training to enable in-country assessment of risks in transfer of germplasm.

During our country workshops it was found that biosecurity risks were perceived to have increased with extreme climate events and that countries were ill equipped to undertake rapid identification of new pests and diseases and lacked scientific networks for seeking information and advice to ensure rapid response to incursions. A concept proposal entitled “Tools for assessing the impacts of climate change on biosecurity: Diagnostic capacity building pilot project in Tonga” was developed at the Tonga workshop and submitted to APN through the CaPABLE program. The proposed activity is a pilot program in the Pacific, addressing the biosecurity training needs in Tonga, as the first stage of extending Australian and New Zealand expertise to develop a regional biosecurity network. The project team has been invited to submit a full proposal for consideration by APN (CBA2011-SP17ataufa).

Publications

Freeman A, Taufatofua P, Rodoni B (2010) Impact of climate change on food security and biosecurity in small Pacific nations. Global Biosecurity 2010- safeguarding agriculture and the environment, Brisbane, Qld, 28 Feb-3 Mar, 2010.
Freeman A, Rodoni B, Taufatofua P (2011) Impact of climate change on food security and biosecurity in small Pacific nations. The 4th Asian conference on Plant Pathology, concurrent with The 18th Biennial Australasian Plant Pathology Society Conference. Darwin 26-29 April 2011.

References

Taufatofua, P (2009) National Medium Term Priority Framework for Pacific FAO member Countries (Report to FAO, SAP Document), FAO of the United Nations, Rome.

Acknowledgments

DPI-Victoria, Australia **;** CRC for National Plant Biosecurity, Australia **;** Museum of Victoria, Australia; Ministry of Agriculture, Forestry, Fisheries and Food, Tonga; Department of Agriculture, Research

and Development, Ministry of Agriculture, Vanuatu; Ministry of Environment, Land, Agriculture and Development, Kiribati**;** Ministry of Agriculture, Tuvalu.

TECHNICAL REPORT

Preface

The following report is based on the country reports we have developed from the research conducted in this project. We present (i) the consolidated data collected for each country by questionnaire and interviews (ii) a summary for each country consisting of key findings and priorities (iii) an overview of key findings for all collaborating countries, priorities for future research and training and a vision of sustainable outcomes.

Table of Contents

1.0 Introduction

The South Pacific nations are characterised by small populations, land areas and economies. The populations are often fragmented and spread over many small islands, creating problems of communication and the whole region is extremely isolated (Overton 2006, FAO 2009). The IPCC AR4 identifies small island states as being among the most vulnerable countries in the world to adverse impacts of climate change. It predicts temperature rises in the Pacific in line with world predictions, increased level of drought, sea level rise and increased cyclone intensity (IPCC 2007). Historical data on the impacts of natural disasters show that the cost of extreme events in the Pacific Island region was in excess of US $1 billion in the 1990s (Bettencourt and Warick, 2000). The implications of climate change for the Pacific are being responded to by organisations such as the Food and Agriculture Organization (FAO), the Secretariat of the Pacific Community (SPC), the Pacific Regional Environment Program (SPREP) and regional governments and all acknowledge that action to address climate change requires development partnership support (E.g. SPREP 2005).

Food security refers to the availability of food and one's access to it. Recent publications (e.g. FAO 2008, Barnett 2007) acknowledge the likely negative impacts of climate change on food security through degradation of production areas (sea level rise, salinity, drought), devastation caused by extreme weather events (cyclones, flooding, tsunamis) and impacts of recovery time such as loss of crop germplasm and the need to import food substitutes. Food crop genetic conservation work is being undertaken by the SPC Centre for Pacific Crops and Trees (CePaCT) with the strategic aim of maintaining the genetic diversity in the Pacific region (i.e. major crops from centres of diversity). This work is not focused on the cultural and food security needs of the small Pacific nations, particularly atoll countries, which depend on minor crops such as *Certosperma* (swamp taro) and pandanas. However, there is now some recognition of the importance these traditional crops have in maintaining human health and the serious health risks associated with cheap imported foods (Englberger and Lorens 2008). The role of genetic resource centres is genetic conservation and to provide small quantities of germplasm to countries. Recipient countries must develop their own strategies for multiplying the germplasm to provide crop planting material. This can be particularly challenging after natural disasters and often leads to food imports, which may occur without proper regard for biosecurity issues.

Plant biosecurity is defined as a set of measures designed to protect crops or a sub-group of crops from emergency plant pests at national, regional and individual farm levels (CRCNPB). The impacts of climate change on biosecurity are of great concern to Pacific countries as discussed at the recent regional meeting of Heads of Quarantine and Plant Protection held in Papua New Guinea (6th Pacific Plant Protection Organisation and 14th Regional Technical Meeting for Plant Protection 29/6–3/7 2009). It was acknowledged that a lack of physical and human capacity for effectively delivering plant health services remains a challenge for the Pacific region and that the region was now vulnerable to the extremes of the current global challenges of climate change, rising food prices, increased biosecurity risks and depletion of plant genetic resources.

The movement of pests and pathogens across the Pacific has been monitored over time by Australian and New Zealand biosecurity authorities. For example, historical data from New Zealand show that over the last 150 years new aphid species have arrived at the rate of one new species per year, most carried by wind, via the Pacific or on plant material (Teulon and Stufkens, 2002). Cyclones are recognised as a major pathway for movement of pests and pathogens. Increased extreme weather events are predicted to increase movement of pests and pathogens over long distances. Importation of food and crop planting materials after natural disasters is likely to be a path of entry for pests and pathogens. Changes in climate will also alter the geographic distribution of some pests and pathogens (Aurambout *et al.* 2006).

FAO (2008) has stressed the need for integrating climate change adaptation into national policies, strategies and programmes for agriculture in the Pacific and that these should be used to ensure farmers receive the best advice on crop production to reduce the risk of crop failure. Taufatofua (2009) identified assistance in dealing with adaptation/mitigation of adverse climate change impacts as a priority for FAO investment in Tonga, Vanuatu, Kiribati and Tuvalu as well as a number of other Pacific nations. The report highlights the major gap between international recognition of the likely impacts of climate change on food security in the Pacific and projects which will assist scientists to assess the risks and develop policies and strategies to reduce or respond to the key risks.

This project will identify the key impacts of climate change on the unique cropping systems in four small Pacific nations and provide solid data to enable development of strategies/policies to minimise these risks and identify training and research opportunities. Key issues which will be examined include:

- biosecurity impacts of climate change on food crops (including impacts on endemic pests and diseases and likelihood of incursions of exotic pests and diseases) and implications for international trade;
- impacts of rates of recovery from natural disasters on both food security and biosecurity;
- the maintenance of crop genetic resources and the availability of varieties adapted to future climates; and
- the need for assessing germplasm in collections or initiating breeding efforts.

2.0 Methodology

To collect and evaluate country specific data on the impacts of climate change on food security and biosecurity of crop production systems, a series of activities were undertaken and include:

1. The design of a questionnaire
2. Country visits by project participants to interview local scientists and biosecurity managers
3. A workshop of country participants to consolidate data
4. A desktop study to provide an overview of the impact of climate change on the South Pacific region.

1. Questionnaire design

The aim of the questionnaire was to identify the key impacts of climate change on food crop security and biosecurity in Tuvalu, Tonga, Kiribati and Vanuatu. The questionnaire was designed by Dr's Freeman, Taufatofua and Rodoni. Mrs Luseane Taufa (Tonga); Mr James Wasi, (Vanuatu), Mr Tianeti Beenna, (Kiribati) and Mr Itaia Lausaveve (Tuvalu) assisted in circulation of the questionnaire within their respective countries and coordinated the interviews with the research team, during the country visits.

The questionnaire comprised three sections:

- Part A - Part A contained higher level questions relating to the country and its agricultural systems (population, size, statistics, science capability and capacity). This information was completed by the country collaborator prior to the questionnaire being circulated to the country participants and is intended to be used as background information.
- Part B - Part B contained questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event and included questions around Quarantine/Biosecurity Policy in each country (section 1) and Quarantine/Biosecurity practice in each country (section 2).
- Part C - Part C contained questions relating to the experiences of the survey participants. The questions were aimed at determining the key impacts of climate change on food crop security and biosecurity in the participating country. The questions comprised 3 sections:

Section 1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

The questionnaire proforma that was circulated to country collaborators is provided in Appendix 5.

2. Country visits by project participants to interview local scientists and biosecurity managers
Country visits were divided into two trips. The first trip to Vanuatu and Kiribati was conducted by Dr's Freeman and Taufatofua from 9/5/2011 – 23/5/2011. The second trip to Tonga and Tuvalu was conducted by Dr's Freeman, Rodoni and Taufatofua from 24/7/2011 to 11/8/2011. The major objectives of the country visits were to hold meetings with country collaborators, senior administrators and regional scientists and discuss issues relating to climate change and plant biosecurity. Questionnaires were either completed while sitting with the country participant or the questionnaire was left with the country participant for completion.

The compiled questionnaires for each country are provided in Appendix 5 as described in the results section (Section 3) together with a country summary of each questionnaire.

3. Workshop with invited experts from relevant organisations to prioritise food security/ biosecurity risks and determine investment and research opportunities (FAO, SPC, ACIAR etc.).
The research team organised a workshop in Melbourne after all the completed questionnaires had been collated. The aim of this workshop was to analyse the data generated in the country surveys, identify major findings and key risk areas across the region, and make recommendations for future work and training opportunities.

Where appropriate, additional participants from local/regional organisations and scientists and policy-makers who have expertise in areas such as crop genetic resources, plant pathology, climate change, quarantine, biosecurity and trade, were asked to attend the workshop. The data generated from the questionnaire and workshop were collated and the recommendations focused on strategies that build on existing infrastructure and capacity within the region as well as building partnerships with relevant programs both from within and external to the Pacific region. A focus of the recommendations were targeted at ensuring a good connection between scientists, quarantine regulators and policy makers. These links will strengthen the biosecurity capacity in the Pacific region.

4. A desktop study to provide an overview of the impact of climate change on the South Pacific region.
Drs. Freeman and Rodoni conducted a desktop study, based on published climate data and predictions, to determine which factors are likely to increase biosecurity risks in the South Pacific.

3.0 Results & Discussion

3.1 Project survey consultations.

The people who contributed to the final consolidated Country Reports, either by interview, completion of the written questionnaire, participation in country training workshops or the final project workshop are listed in Table 1.

Table 1: A list of project participants that contributed to this project either by completing questionnaires or participating in project interviews and/or workshops.

Names	Position/Occupation
KIRIBATI	
To Murdoch	Deputy Secretary, Ministry of Environment, Lands, Agriculture and Development
Kaateti Toto	Senior Assistant Secretary, Agriculture Department
Betarim Rimon	Secretary, Office of the President
Rui Tabutoa	Assistant Secretary, Environment Department
Kinaai Kairo	Director of Agriculture
Tianeti Beenna	Deputy Director of Agriculture and Director of Research
Tearo Otiuea	Principal Agricultural Officer Quarantine, Agriculture Department
Ieete Timea	Acting Head Crop Investigation Improvement section
Taouea Titaake	Environment Impact Assessment Officer, Environment Department
Ribeta Abeta	Climate Change Planning Officer, Environment Department
Nakabuta Teuriaria	Farmer and Freelance Agricultural Consultant
Etera Teangana	Farmer and former Speaker of Parliament
VANUATU	
James Wasi	Director of Research and Extension, Department of Agriculture, Research and Development (DARD)
Ruben Bakeo Markward	Director, DARD
Marie Melteras	Director, Vanuatu Agriculture Research and Training Centre (VARTC)
Bai George	Head of Quarantine, DARD
Francis Quarani	Quarantine Officer, DARD
Francois Japiot	Extension Officer, DARD
Dr Vincent Lebot	Senior Scientist, EU World Aroid Diversity program
Antoine Ravo.	Provincial Agriculture Officer for Shefa Province, DARD
Peter Iesul	Farming Systems Officer, DARD
Peter Kaoh	Extension Officer with Vanuatu Farm Support Association
Oneal Dalesa	Senior Farming Systems Officer Santo Island, DARD
Charles Rogers	General Manager , Vanuatu Farm Support Association
Jim Batty	Managing Director, South Pacific Sandalwood Limited
Cornelia Wyllie	Managing Director , Vanuatu Direct Farm Fresh Produce
TONGA	
Sione Foliaki	Head of Research, MAFFF
Luseane Taufa	Senior Plant Pathologist, MAFFF
Kamilo ‘Ali	FAO NPC-FSSLP
Salesi Kaitu’u	Extension Officer, MAFFF
Petelo ‘Anitoni	Technical Officer (Agronomy) MAFFF
Siutoni Tupou	Entomologist, MAFFF
Malina Siale	Agricultural Officer (Entomology), MAFFF
Minoru Nishi	Commercial Farmer/Exporter

Takaniko Ruabete	Pathologist/Nematologist, SPC Suva, Fiji
Fereti Atu	Entomologist, SPC Suva, Fiji
Dr Viliami Manu	Acting CEO, MAFFF
Taniela Hoponoa	Head of Quarantine, MAFFF
Losaline Ma'asi	Head of Extension, MAFFF
Siale 'Ilolahia	Project Officer, Tonga Civil Society
Kalati Hafoka	FAO Projects Officer
Manaia Halafihi	OIC, MAFFF Vava'u
Taniela Foliaki	Extension Officer, MAFFF Vava'u
Tevita Sinipata	Market Manager, MAFFF Vava'u
TUVALU	
Itaia Lausaveve	Director of Agriculture
Sam Panapa	Head of Quarantine
Akinesi Sianoa	Senior Agricultural Extension and Information Officer
Faavae Lutelu	Quarantine Officer
Iosia Siose	Extension Officer
Peleti Pole	Livestock Officer
Timoteo Panapa	Agricultural Officer
Fialua Mouise	Extension (FAO Banana Project)
Tavau Teii	NPC FAO FSSLP
Evolini Mami	Counterpart – Taiwan Technical Mission Vegetable Program
Yeong-Lang Yang	Team Leader – Taiwan Technical Mission
Annie Homasi	Manager Tuvalu Association of NGOs (TANGO)
OTHERS	
Dr Gary Kong	Project Leader Remote Microscopy Project, CRC for National Plant Biosecurity
Dr Ken Walker	Project Leader PaDIL, Museum of Victoria
Shane King	Quarantine Operations Manager, Vic DPI
Dr Mohammed Aftab	Plant Virologist, Vic DPI
Jane Moran	Program Leader, CRCNPB
Dr Jo Luck	Principal Scientist Climate Change/Microbiology, Vic DPI
Dr Graham Jackson	PestNet Moderator
Dr Wilco Liebregts	PestNet Moderator

3.2 Country Reports

Each country report consists of:
(1) A Project Summary, which contains a brief summary of the country data and Key findings.
(2) A Consolidated Country Questionnaire, which provides a single country response to each of the questions, based on a compilation of the individual questionnaires undertaken by country scientists, interviews and a final review by the country collaborator.
(3) The individual questionnaires are provided in Appendix 5.

The country report together with a summary of the overall project findings and priorities for future work which were developed with the country collaborators at the final workshop will be provided to each country. The individual country questionnaires for each country (provided in Appendix 5) have been included as an appendix.

3.2.1 Tonga Country Report

1. Tonga Summary Report

Part A: Background information.

1. Tonga - Background Information

Land area (km^2): 747	Sea area/EEZ (km^2): 700,000
Population (No.): 101,134 (2006)	Annual population growth (%): 0.4
Density (inhabitants/km2): 135	Rural population (% of total population): 57 % (2006)
GDP (US$ million): 178.504 (2004)	GDP per capita: US$1,781 (2004)
GDP Real Growth (ave. 1996-2006) : 2.5 % per annum	Primary Sector GDP (% of total GDP): 23.2 % (2004)
Trade Balance: -US$106,149,650 (exports as a % of imports): 5.6 % (2007)	Food as percent of total imports: 14 %
Budget allocation agriculture/forest/fisheries (2007): less than 2 %	Human Development Index (2004): 0.815 position 55 out of 177 countries

Sources: FAO NMTPF 2009

2. Of the 15,738 total households in Tonga, 70% are agriculturally active in the country (Agri census 2001).
3. The average farm size is 2.7ha and 73% of farmers own their own land while 27% either lease or co-share land.
4. Ninety percent of farmers are subsistence farmers and less than 10% of the farms are commercial operations. The dominant farming system is mixed relay intercrop system with a small amount of mono-crops at the commercial scale.
5. The main food crops are cassava, taro (Colocasia and Xanthosoma), yam, sweet potato, Alocasia, breadfruit, bananas and vegetables.
6. Currently, there are no adverse effects of CC on the major food crops. However it is the opinion of the Tongan participants of this project that climate change is likely to have substantial and widespread impacts on areas around the coast. Among these damages that

started to show are losses of coastal infrastructure and coastal erosion resulting from cyclones and sea level rise. CC could also cause more intense cyclones and droughts resulting in crop failures.

7. There were traditional reserve food crops including wild spp of yam, olynesian arrow root, wild alocasia and some underutilized indigenous greens that were identified as a source of food during time of food shortages. However with increasing availability of imported food stuff, those reserve food crops become less important.
8. The agricultural science/extension capacity in Tonga is listed in Table 2.

Table 2. Country capability: Human resources in the Ministry of Agriculture (MAFFF)

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	6	10	1			17
Crop Protection		4	2		1	7
Extension		9	2	1		12
Quarantine	5	14	2			21
Policy	4	9	7	1	2	23
Food and agro-processing		2	1			3
Women in development	9	4		1		14
Forestry	12	11	4	1		28
Fisheries	22	14	6	4	1	47
Livestock	2	8	2	1		13
Outer islands	25	20	4	1		50
Total	85	105	31	10	4	**235**

Part B: Recovery of food crops and agricultural systems following a severe climatic event

1: Quarantine/ biosecurity policy

Tonga has the "Plant Quarantine Act 1998" which is enforced and provides legal powers for quarantine agencies to protect agriculture and native flora and fauna in Tonga. Pest risk analyses (PRAs) are routinely conducted on imported plant products and plant material is confiscated at the border if this material is deemed to be a risk.

A national Disease management committee does exist and is used after a climate event or national disaster. A part of the charter of this committee is to complete an immediate assessment of the food requirements of the region during the recovery period and quarantine issues are taken into consideration when deciding on where to import food stuff from.

After the tsunami in 2009 country "systems" did support the recovery effort, but there were some communication issues between the jurisdictions that hampered the rate of progress.

2: Quarantine/ biosecurity practice

Tonga MAFFF is heavily reliant on the Plant Protection Division of the Secretariat of the Pacific Communities (SPC) to conduct pest and disease diagnoses and this service is provided on request from Tongan crop protection staff. This process can be expensive and can also be restricted by quotas of samples to be processed. Tongan Crop Protection staff can also access on-line diagnostic services such as "Pestnet" but this has the disadvantage of being a completely open system.

Eleven high risk pests were identified as threats to root crops and vegetables and the survey participants listed three pest and disease incursions over the last 5 years.

Part C: The key impacts of climate change on food crop security and biosecurity

1: General information

The major crop of importance culturally was yam, but the major food source was cassava with the highest consumption followed by taro and sweet potato. Export crops listed included squash watermelon, vanilla, kava and root crops. Fifteen major pests were directly correlated to crops grown and included fungi, insects and nematodes. Drought was cited as the trigger for recent outbreaks. Strong winds were also identified as the means for disease and spread of *Erwinia papayea* in pawpaw.

2: Experiences with crop production and climatic events

Cyclones (physical damage) and drought (prolonged effect) were identified as the major weather events in Tonga. Salinity was also an issue in some outer islands.

3: Capacity building: Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

Tonga MAFFF depends heavily on access to expertise in the SPC, New Zealand and Australia. Several survey respondents identified a lack of biosecurity expertise (e.g. pest and disease diagnostics capability) within Tonga as an issue and recognized that training in plant biosecurity was required, as well as basic equipment and facilities.

Key findings – Tonga

1. The Tongan MAFFF has no proper contingency plan to assist recovery from an extreme CC event. There is some infrastructure and systems in place but with the lack of trained staff, these systems and processes are hard to operate smoothly when needed.
2. Unreliable diagnostic support and networking including a general lack of surveillance skills.
3. Increased exotic pest introductions with 11 exotics and 3 incursions in the last 5 years.
4. Cyclones and prolonged drought reduced yields and had a negative impact on food security.
5. Limited basic resources and networking capability (people) in Tonga.

2. Tonga – Consolidated Country Questionnaire (November 2011):

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)
NB. The individual responses by participants are provided in Appendix 5.

Part A: Background information on Tonga: Provided in the Summary

Part B: Recovery of food crops and agricultural systems following a severe climatic event

Section 1:
Quarantine/biosecurity policy

1. There is no national contingency plan to assist in recovery from an extreme climatic event. In such events, the Government, NGOs and donor partners will contribute resources to meet food needs based on assessments made. The National Disaster Management Committee takes charge. MAFFF will monitor and report on the annual food distribution and crop production through annual surveys and market analysis. The analysis projects the likely level of food production lost due to the CC event and the management plan for cropping areas is determined based on this information.
2. There is a need to import staple foods such as root crops and fruits, a risk assessment of the source country is undertaken.
3. The preferred supply countries in the Pacific region to minimize the biosecurity risks when importing staple foods are Australia and New Zealand and any other countries that have existing bilateral quarantine agreement with Tonga.
4. There are quarantine regulations around the importation of foods and planting materials– The Plant Quarantine Act, 1988 (Revised version).
5. These regulations are maintained during food emergencies.
6. Risk assessment of the planting material must be undertaken prior to getting an import permit from the National Plant Protection Officer and the Tonga Quarantine requirements stated on Import Permit must be met.
7. The preferred supply countries of planting material in the Pacific region to minimize the biosecurity risks when importing germplasm is the regional Centre for Pacific Crops and Trees (CePaCT) at SPC, Fiji, but other countries may be permitted by taking a Pest Risk Analysis for the specific plant species.
8. There are quarantine regulations around the importation of planting material/germplasm (Plant regulations 1995).
9. The regulations regarding importation of planting material/germplasm are maintained during disaster recovery periods.
10. Quarantine restrictions on the large scale movement of planting material/germplasm or food aid are maintained following a disaster, especially if countries have diseases and insect pests that are not in Tonga.
11. There is a back-up source of some local, preferred varieties of staple crops at SPC-CePaCT. E.g Tongan *Colocasia, Xanthosoma* and sweet potato cultivars. Tonga is in the process of ratifying the International Treaty on Plant Genetic Resources for Agriculture and Food (PGRFA) which would give the advantage of access to and benefit-sharing with other germplasm collections.

Section 2: Quarantine/ biosecurity practice

1. The SPC regional pest and disease list is used in Tonga as well as the Tongan country database and other databases such as CABI Crop Pest Compendium.
2. Tonga has its own pest and disease list which is maintained and updated as part of the SPC regional pestlist database.
3. The country pest list is used routinely by Quarantine officers who have a copy of the database. It can also be used by other staff who usually have to access it at SPC via the internet.
4. The highest risk exotic pest and disease threats to the main food crops in Tonga that were listed in the questionnaire were :
   - *i.* Taro leaf blight *(phytophtora colocaisae)*
   - *ii.* *Viral diseases of yam*
   - *iii.* *Alomae and bobone virus* diseases on taro
   - *iv.* Taro beetle
   - *v.* African snail
   - *vi.* Fruitfly species that are not yet present in Tonga
   - *vii.* *Huanglongbing citrus* disease
   - *viii.* Bacterial diseases of banana
   - *ix.* Papaya ring spot virus
   - *x.* Phytoplasma lethal yellowing of coconut

5. The research division of MAFFF has basic diagnostic facilities to identify new insect pests and diseases. There is only one pathologist and one entomologist with support staff in MAFFF. Preliminary identification of some new pests and diseases is possible, with identification always confirmed by two other recognized institutes. Other samples are sent to SPC for forwarding to international centres such as CABI (at a high cost but paid for by SPC). Certain diagnostic resources, in particular virus diagnostic agents, are often expensive and there are budget limitations which restrict capacity to undertake diagnostics.

6. When unable to identify a pest or disease, SPC is contacted and appropriate images, reports, samples etc for diagnosis. In certain cases, other Plant Protection professions in the region are contacted and certain cases are posted in the PestNet if broader dialogue on the identified pest and/or disease problem is required.

7. One quarantine interception of a new pest or disease of food crops that have occurred in the last 5 years was recorded:
   - *i.* *Erwinia papayae* on papaya

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?
   - *i.* Silver Leaf White fly *(Bemisia argentifolii)*
   - *ii.* Erythrina gall wasp *(Quadrastichus erythrinae)*
   - *iii.* Papaya canker *(Erwinia spp.)*

Part C: The key impacts of climate change on food crop security and biosecurity.

Section 1: General information

1. What are the major crops grown in your area? Please rank in order of importance below:
   i. yam
   ii. cassava
   iii. taro
   iv. sweet potato
   v. vegetables
   vi. coconut
   vii. banana
   viii. other crops (Eg export crops- watermelon, squash, vanilla)

2. What are the major pests and diseases of these crops? Please rank in order of importance below:
   i. Yam Anthracnose
   ii. Sweet Potato Scab
   iii. Sweet potato weevil
   iv. Nematodes
   v. Mites
   vi. Powdery and downy mildew
   vii. Viruses of banana and cucurbits and others
   viii. Fruitflies
   ix. Rose beetle
   x. Leafhoppers
   xi. Armyworms
   xii. Taro hawkmoths
   xiii. Mealybugs
   xiv. Rhino beetles and stick insects of coconut
   xv. Gummy stem blight

3. No serious outbreaks or increases in any of these endemic pests/diseases have been observed due to changes in climate. However, silver white fly outbreaks have increased due to drought.

4. Table 3 lists the new pests/diseases that were listed in the questionnaires that have been found in Tonga in the last 5 years which have impacted on food crop production:

Table 3. New pests and diseases recorded in Tonga in the last 5 years

Name of Pests/Diseases	Actions taken				
	Survey	**Control**	**Elimination**	**Ignore**	**Comments**
Silver leaf whitefly	yes	Chemical & Biocontrol	no		Needs more training on IPM for successful pre-harvest control.
Erythrina gall wasp	No	Nil	no		Needs survey, research & control
Papaya canker (*Erwinia sp.*)	Delimiting survey schedule for end of Nov, 2011	Nil	no		Incursion of *Erwinia* spp. Recorded in August, 2009. No emergency response plan in place. It takes two years before a delimiting survey to be conducted.

Section 2: Experiences with crop production and climatic events

1. All respondents experienced the effect of severe climatic events (cyclone, tsunami, rising sea level, salinity, drought, increased temperature, extreme rain events, etc) on crop production and food availability in Tonga.

2. The impacts of the following CC events were reported as affecting food supply and crop production:
   - The impact of cyclones damages all food crops.
   - Cyclones reduce crop yields and delays in fruiting and maturity expectations.
   - Cyclones causing sea water inundation of coastal farmland killing food crops .
   - Increase damage from salt spray for crops near coastal areas.

3. All respondents experienced the impact of a drought on agricultural systems that affect food supply and crop production as follows:
   - Drought has a serious impact on vegetables, causing shortages in vegetable production and supply.
   - Root crops persist, so drought is not as bad as a cyclone unless if it is of long duration. The most recent serious drought was in 2010 and seriously impacted on all crop production.
   - Shortage of planting materials for recovery planting at the onset of rains is also a serious consequence.

4. No respondents have experienced any impacts of flooding on agricultural systems that affect food supply and crop production.

5. Rising sea water levels have had limited impact on agricultural systems that affect food supply and crop production as follows:
   - Loss of arable land due to salt intrusion from the rising seawater has occurred at Kanokupolu village in eastern Tongatapu.

6. Other climatic events that have impacted on food security in Tonga include:
   - Tsunami in 2009 hit Niuatoputapu and Niuafo'ou and inundated villages and destroyed crops and trees.
   - Rainfall pattern and intensity have greatly changed across the Tongan kingdom and extreme rainfall events have significant negative impacts on fruit tree flowering due to physical damage and more serious disease levels, leading to low and no harvest.

Section 3: Capacity building: Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

1. Tonga has access to the following sources of germplasm/planting material:
   - The SPC-Centre for Pacific Crops and Trees (CePaCT) in collaboration.
   - Field collection of rootcrops, bananas and fruit crops at Vaini Research Station.

2. In Tonga, it is the responsibility of MAFFF Plant Pathology Team at Vaini Research Station to multiply germplasm of food crops by tissue culture, seed or cuttings.

3. Tonga does not have adequate resources for diagnostics and recognition of new pests and diseases due to low departmental budget and a loss of diagnostic skills.

4. Tonga has access to regional diagnostic expertise at SPC and through personal networks. The Quarantine Department recently received training and microscopes for the establishment of a Remote Microscopy Diagnostic Unit. Remote diagnostics is currently limited to access to the SPC regional Pestlist database.

5. There is adequate internet access in Tonga.

6. Tonga is linked to the following regional food security and biosecurity CC projects:
   - FAO Food Security and Sustainable Livelihood program (FSSLP)
   - PGRFA

7. Currently, future impacts of CC are unclear but training is required to deal with increased biosecurity incursions. There may be a need to develop crop varieties adapted to CC but due to closure of breeding programs, skilled breeders are no longer available. Extension staff will require training to deal with new issues with farmers adapting to CC.

8. Tongan scientists involved in quarantine/biosecurity, would benefit from networking/training opportunities with Australian/NZ biosecurity agencies.
   - Quarantine staff have just completed four Pest & Disease Diagnostic training courses from NZ MAFFF Biosecurity, which included Remote Microscopy Diagnostic training with Australian Experts. This type of training would also be beneficial for MAFFF Research staff, who are often involved in surveying and identifying new pest and disease incursions within Tonga.
   - Opportunities to develop informal and formal regional biosecurity networks would be beneficial to all involved.
   - This is important as Tonga trades mostly with Australia and New Zealand and these two countries both have very strict quarantine requirements.

End of Questionnaire

People consulted in Tonga

Names	**Position/Occupation**
TONGA	
Sione Foliaki	Head of Research, MAFFF
Luseane Taufa	Senior Plant Pathologist, MAFFF
Kamilo ‘Ali	FAO NPC-FSSLP
Salesi Kaitu’u	Extension Officer, MAFFF
Petelo ‘Anitoni	Technical Officer (Agronomy) MAFFF
Siutoni Tupou	Entomologist, MAFFF
Malina Siale	Agricultural Officer (Entomology), MAFFF
Minoru Nishi	Commercial Farmer/Exporter
Takaniko Ruabete	Pathologist/Nematologist, SPC Suva, Fiji
Fereti Atu	Entomologist, SPC Suva, Fiji
Dr Viliami Manu	Acting CEO, MAFFF
Taniela Hoponoa	Head of Quarantine, MAFFF
Losaline Ma’asi	Head of Extension, MAFFF
Siale ‘Ilolahia	Project Officer, Tonga Civil Society
Kalati Hafoka	FAO Projects Officer
Manaia Halafihi	OIC, MAFFF Vava’u
Taniela Foliaki	Extension Officer, MAFFF Vava’u
Tevita Sinipata	Market Manager, MAFFF Vava’u

3.2.2 Vanuatu Country Report

1. Vanuatu Summary Report

Part A: Background information on the collaborating country

1. Vanuatu background data.

Land area (km^2): 12,18	Sea area/EEZ (km^2): 680,000
Population (No.): 217,000 (2005)	Annual population growth (%): 2.6
Density (inhabitants/km2): 16 (2005 estimate)	Rural population (% of total population): 76%
GDP (US$ million): 368.9 (2005)	GDP per capita (US$): 1,700 (2005)
GDP Real Growth (ave.1996-2006): 2.5 % per annum	Primary Sector GDP (% of total GDP): 14.7 % (2006)
Trade Balance –US$75 million (exports as % of imports): 14.8% (2007)	Food & Live Animals as % of total imports: 17.2% (2006)
Budget allocation agriculture (2007): VT 405 million (US$ 4 m) % of Total Budget 3.4 %	Human Development Index 0.674 (2008): position 120 out of 177 countries

Sources: FAO NMTPF 2009

2. There are 38,870 households engaged in Agricultural activities (2007 Ag census) with an average of 5 people per household.
3. The average farm size is less than 1 ha.
4. The main farming systems are relay intercropping, mixed systems (cattle under coconuts, cocoa under coconuts etc), monocropping such as kava and agro forestry where food crops are inter planted with leguminous trees.
5. The main food crops in order of importance are yam, taro, banana, rice, cassava, bele, sweet potato, kava, fruit trees and vegetables.
6. Major impacts of CC on the major food crops are rotting in taro, cassava and bele as result of excessive ground water especially on low laying areas, crop loss due to drought and cyclones.
7. The special/reserve food crop eaten only during times of food shortages are some varieties of wild alocasia and some forest foods.
8. The agricultural science/extension capacity in Vanuatu is provided in Table 3.

Table 3. Country capability: Human resources in the Ministry of Agriculture

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	2	1	1	1	1	6
Crop Protection		2	2	0	0	4
Extension	20	10	5	3	0	38
Quarantine	10	5	3	1	0	19
Livestock	4	2	1	1		8
Policy				1		1
Total	36	20	12	7	1	76

Part B: Recovery of food crops and agricultural systems following a severe climatic event

1: Quarantine/ biosecurity policy

There is a National Disaster Management Office (NDMO) to coordinate and assist in recovery from extreme climatic events. In such events, the NDMO, relevant Government Ministries, NGOs and donor partners, based on assessments made, will contribute services and resources to meet needs including shelter and food needs. There are quarantine regulations around the importation of staple foods and planting material/germplasm. These regulations are maintained during food emergencies and disaster recovery periods. If germplasm or fresh foods are to be imported, a risk assessment of the source country is conducted. There are country specific quarantine restrictions on the large scale movement of planting material/germplasm and food aid following a disaster, especially from some Asian countries such as Indonesia and China. There are back-up sources of the local, preferred varieties of staple crops in tissue culture at CePaCT, SPC, Fiji and at field collections in Vila and Santo.

2: Quarantine/ biosecurity practices

Currently Vanuatu does not possess adequate diagnostic facilities to identify pests and diseases. However, it has a good regional network and links with regional institutions such as SPC, Landcare and MAF in New Zealand, CSRIO and the Allan Fletcher Research Station in Australia and when an in-country identification cannot be completed, specimens are sent to these organisations for identification. Vanuatu uses the SPC regional pest list database and also has its own pest list database which is mainly used by Quarantine officers who have been trained in its use.

The highest risk exotic pest and disease threats to the main food crops in Vanuatu are Taro leaf blight *(Phytophtora colocaisae)*, Queensland fruit fly *(Bactrocera tryionii)*, Bunchy top virus of banana, Melon fly and Papaya mealy bug *(Paracoccus marginatus)*. New pests and diseases found in food crops in the last five years (2007-2011) are Spiralling White fly *(Aleurodecus disperses)*, Banana leaf rust and Erythrina gall wasp *(Quadrastichus erythrinae)*.

Part C: The key impacts of climate change on food crop security and biosecurity.

1: General information

The major food crops grown are yam, taro, banana, rice, cassava, bele, sweet potato, kava, fruit trees and vegetables. The major pests and diseases of these crops are Yam Anthracnose, Sweet potato weevil, Sweet potato Scab *(Elsinoe batatas)*, Taro beetle (*Papuana spp*), Black Sigatoka Disease, Root fungus (*Phytophtora*), Fruit Piecing moth, Fruit Fly, Stem borer of bele and Giant African snail. Climate change increased severity and incidence for some pests and diseases, eg. Anthracnose and fungal root pathogens are particularly bad during periods of high rainfall. The impacts of sweet potato weevil and taro beetle are worse with prolonged dry periods.

2: Experiences with crop production and climatic events

All respondents experienced the effects of severe climatic events (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability. The impact of cyclones is immediate and the damage of food crops drastically reduces food supply. Cyclones also cause sea water inundation and salt water spray of coastal farmland, killing food crops. Drought initially causes loss of seedlings and newly planted crops, and water stress in crops are more prone to some pests and diseases that can greatly reducing yields. Droughts may also cause death of long-term crops such as fruit trees and can lead to a shortage of planting materials for recovery planting at the onset of rains. Crop losses due to flooding or salt water inundation of coastal land during storm surges have also been reported along low lying areas.

3: Capacity building and preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

Out of a total of 76 staff employed in the Ministry of Agriculture, only six work in crop production and four in crop protection. There is capacity to multiply tissue culture and field propagation of germplasm when required, although there may be constraints in terms of meeting big demands over a short period of time.

There is not an adequate capability nor resources for diagnostics and recognition of new pests and diseases in Vanuatu and support is much needed in this area. Vanuatu has access to regional diagnostic expertise and remote diagnostic services with SPC and PestNet through the internet and internet access is adequate to utilize these services. Vanuatu has linkages to the SPC/GIZ project and the NARI EU-ARD regional CC projects.

1. Key findings – Vanuatu

1. There is not an adequate capability or resources for diagnostics to enable recognition of new pests and diseases in the country. Support in both staff training and purchase of basic equipment is much needed in this area
2. Vanuatu uses the SPC regional pest list database and also has its own pest list database which is mainly used by Quarantine officers who have been trained in its use. There is a need for training of Extension officers on use of the pest list database.
3. There are high risk exotic pest and disease threats to the main food crops that are established in neighboring countries.
4. Vanuatu is prone to severe climatic events such as cyclone, flood, salinity, drought and increased temperature and their impacts on crop production and food availability can be

significant. Project participants from Vanuatu indicated that preparedness for recovery from such events should be a high national priority.

2. Vanuatu Survey Questionnaire: Consolidated Report November 2011

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Part A: Background information on Vanuatu: provided in the Summary
Part B: Recovery of food crops and agricultural systems following a severe climatic event

Section 1: Quarantine/biosecurity policy

1. There is no national contingency plan to assist in recovery from an extreme climatic event. In such events, the Govt, NGOs and donor partners will contribute resources to meet food needs based on assessments made.
2. When there is a need to import staple foods such as root crops and fruits, a risk assessment of the source country is undertaken.
3. There are no preferred supply countries for importing staple foods.
4. There are quarantine regulations around the importation of staple foods.
5. The regulations regarding importation of staple foods are maintained during food emergencies.
6. If planting material/germplasm are to be imported, a risk assessment of the source country is conducted.
7. There are no preferred supply countries in the Pacific region for importing planting materials/germplasm.
8. There are quarantine regulations around the importation of planting material/germplasm.
9. The regulations regarding importation of planting material/germplasm are maintained during disaster recovery periods.
10. There are country specific quarantine restrictions on the large scale movement of planting material/germplasm and food aid following a disaster, especially from some Asian countries such as Indonesia and China.
11. There are back-up sources of local, preferred varieties of staple crops in tissue culture at SPC Suva and at sites in Vila and Santo.

Section 2: Quarantine/ biosecurity practice

1. Vanuatu uses the SPC regional pest and disease pest lists.
2. Vanuatu has its own pest list in its own pest list database.
3. The country pest list is used by Quarantine officers. It can also be used by extension staff however training on the use of this data base is needed for extension officers.
4. The highest risk exotic pest and disease threats to the main food crops in Vanuatu are:
   - Taro leaf blight *(Phytophtora colocaisae)*
   - Queensland fruit fly *(Bactrocera tryionii)*
   - Bunchy top virus of banana
   - Melon fly
   - Papaya mealy bug *(Paracoccus marginatus)*

5. Currently Vanuatu does not possess adequate diagnostic facilities to identify pests and diseases. Equipments such as compound microscopes and other laboratory apparatus are needed to conduct good analysis of pests and diseases. However, Vanuatu has a good

regional network and links with regional institutions such as SPC, Landcare and MAF in New Zealand, CSRIO and Allan Fletcher Research station in Australia.

6. When unable to identify a pest or disease, Vanuatu sends the specimens for identification either to SPC, MAF New Zealand, Landcare Research Station in New Zealand or CSIRO, Australia.
7. During the past 5 years no new pests and diseases have been intercepted on the border; only fresh produce have been confiscated from incoming passengers.
8. The new pests and diseases found in food crops in the last 5 years are:
   - Spiralling White fly *(Aleurodecus disperses)*
   - Erythrina gall wasp *(Quadrastichus erythrinae)*
   - Banana leaf rust

Part C: Key impacts of climate change on food crop security and biosecurity in Vanuatu

Section 1: General information

1. The major crops grown:
   1. Yam
   2. Bele
   3. Taro
   4. Bananas
   5. Sweet potato
   6. Cassava
   7. Kava
   8. Fruit trees
   9. Vegetables

2. The major pests and diseases of these crops:
   1 Yam Anthracnose
   2 Sweet potato weevil
   3 Sweet potato Scab *(Elsinoe batatas)*
   4 Taro beetle (*Papuana spp*)
   5 Black Sigatoka Disease
   6 Root fungus (*Phytophtora*)
   7 Fruit Piecing moth
   8 Fruit Fly
   9 Stem borer of bele
   10. Giant African snail

3. Climate change increased severity and incidence for some pests and diseases in Vanuatu E.g. Anthracnose is particularly bad during periods of excessive rainfall. This is also true for root fungus. The taro beetle on the other hand does not like wet soil and tends to be more prevalent in drier weather. The sweet potato weevil attacks are bad with prolonged dry periods.

4. A list of the new pests and diseases that have arrived in the last 5 years in Vanuatu, as recorded by the country participants and which have impacted on food crop production is provided in table 5.

Table 5. The new pests and diseases that have established in the last 5 years and which have impacted on food crop production.

Name of Pests/Diseases	Actions taken				
	Survey	Control	Elimination	Ignore	Comments
Banana leaf rust	x				VQIS has given control advice
Red fire Ants	x				Spread from the Solomon Islands as far south as the Banks Islands of Vanuatu
Spiralling White fly *(Aleurodecus disperses)*					
Erythrina gall wasp *(Quadrastichus erythrinae)*					

Section 2: Experiences with crop production and climatic events

1. All respondents experienced the effects of severe climatic events (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in Vanuatu. Increased damage from salt spray for food gardens near coastal areas has also occurred. Coastal erosion has occurred due to strong winds causing large sea waves that move further in-land. Cyclones damage crops and reduce production. Drought causes drying off of crops, increased pest and disease and yield loss due to lack of water.

2. All respondents experienced the impacts of a cyclone on agricultural systems that affect food supply and crop production as follows:
   - The impact of cyclone damage on food crops is significant and drastically reduces food supply.
   - Cyclones causing sea water inundation of coastal farmland killing food crops.
   - Increase damage from salt spray for gardens near coastal areas was reported.
   - Farmer families live on salvaged crops for about 2 weeks after a bad cyclone but after that they will look elsewhere for food supply.
   - It is noted that root crops, if managed properly prior to a cyclone season will suffer less damage. For example, removing the excessive branches of cassava will help keep the plant from falling over in a cyclone.
   - After a cyclone, farmers would plant quick producing crops like corn and sweet potato and leafy vegetables.

3. All respondents experienced the impact of a drought on agricultural systems that affect food supply and crop production as follows:
   - The impact of drought is particularly bad for cattle farmers who mostly rely on rain water to sustain their livestock. Large numbers of cattle have died during prolonged dry weather on North Malekula and Santo in the past.
   - Seedlings and newly planted crops are affected as leaves dried up, crops are more prone to diseases and yields greatly reduced.
   - Shortage of planting materials for recovery planting at the onset of rains is also a serious consequence.
   - Small islands are also hit badly during drought periods because of limited water resources. In most cases the Government intervenes with food aid.

- Currently there is little scope for the Agriculture Department to assist in drought situations unless they develop appropriate technology (new varieties, different agronomic practices).

4. Sixty percent of respondents had no experience with flooding and the remaining respondants observed that:
   - Apart from physical damage caused by water, plants rot and eventually die due to exposure to excess water.
   - Land slide caused by flooding often causes damage to crops and crop lands.
   - Physical damage to infrastructure such as roads and bridges affects transportation and communication including to local markets.
   - Less fresh food supply in the local market.

5. Thirty-three percent of respondents had no experience with rising sea water level on agriculture while sixty seven percent had. Impacts of sea level riseinclude:
   - Most food crops are not adapted to salt conditions (E.g. dryland taro, yams, cassava and vegetables) and they dry up under saline condition prior to full maturity of the crop.
   - Rising sea water causes sea water inundation of farms that are close to the sea, killing plants.
   - Most seawater intrusion is caused by strong winds (storm surges), with waves coming further inland and damaging crops (physically and increased soil salinity).
   - Salt spray on crops causes leaves to yellow and dry up.

6. Impacts of other climatic events on food security in Vanuatu include:
   - Although not related to climate change, volcanic ash has affected some parts of the country in the past. Volcanic ash burns crops and facilitates rotting. It contaminates water systems and affects livestock. It displaces whole communities which brings on a whole set of social issues that the government has to deal with. The Department of Agriculture had supported farmers with new planting materials where communities were relocated to new sites.
   - Acid rain derived from volcano ash caused problems on the growth of vegetables, fruit trees and other cash crops like kava.

Section 3: Capacity building and preparedness for dealing with impacts of CC on crop production systems

1. Vanuatu has sources of germplasm/planting material as follows:
   - The national field collection of elite varieties of most agricultural crops including food crops, fruits, and cash crops is based in Tagabe Research Station and the Vanuatu Agriculture Research and Training Center (VARTC) at Santo.Tissue cultures from the SPC Centre for Pacific Crops and Trees (CePaCT), Fiji can also be requested.
2. There is capacity to multiply germplasm, although there may be constraints in terms of meeting big demands in a short space of time.
3. There are not adequate resources for diagnostics and recognition of new pests and diseases in Vanuatu and support is much needed in this area.
4. Vanuatu has access to regional diagnostic expertise and remote diagnostic services with SPC and PestNet through the internet.
5. There is adequate internet access.
6. Vanuatu has linkages to the following regional CC projects:
   - The SPC/GIZ project and the EU-ARD project with NARI being undertaken.

- Generation and adaptation of improved agricultural technologies to mitigate climate change-imposed risks to food production within vulnerable smallholder farming communities in Western Pacific countries (VARTC is associate)

7. There is training needs to deal with CC (crop production under changing climate, plant pest and disease diagnostics, CC impact minimization).

8. Networking and training in quarantine/biosecurity with Australian/NZ biosecurity agencies will help because in these developed countries biosecurity is well developed, and we can learn from them to tackle pest and disease control challenges in our country.

End of Questionnaire

People consulted in Vanuatu

Names	Position/Occupation
VANUATU	
James Wasi	Director of Research and Extension, Department of Agriculture, Research and Development (DARD)
Ruben Bakeo Markward	Director, DARD
Marie Melteras	Director, Vanuatu Agriculture Research and Training Centre, VARTC
Bai George	Head of Quarantine, DARD
Francis Quarani	Quarantine Officer, DARD
Francois Japiot	Extension Officer, DARD
Dr Vincent Lebot	Senior Scientist, EU World Aroid Diversity program
Antoine Ravo.	Provincial Agriculture Officer for Shefa Province (DARD)
Peter Iesul	Farming Systems Officer, DARD)
Mr Peter Kaoh	Extension Officer with Vanuatu Farm Support Association
Mr Oneal Dalesa	Senior Farming Systems Officer Santo Island, DARD
Charles Rogers	General Manager , Vanuatu Farm Support Association
Jim Batty	Managing Director, South Pacific Sandalwood Limited
Cornelia Wyllie	Managing Director , Vanuatu Direct Farm Fresh Produce

3.2.3 Kiribati Country Report

1. Kiribati Summary Report:

Part A: Background information on Kiribati

1. Kiribati background data

Land area (km^2): 810	Sea area/EEZ (million km^2): 3.6
Population (No.): 92,533 (2005 census)	Annual population growth (%): 2.5
Average Density (inhabitants/km^2):127	Rural population (% of total population): 54
GDP (A$ million): 81.91 (2006): US$61.43	GDP per capita (A$): 870 (2006): US$653
GDP Real Growth (ave.2000-2006): 0.04%per annum	Primary Sector GDP (% of total GDP): 3.2% (2006)
Trade Balance – US$56,887,000 (Exports as % of imports) 9.9 % (2006)	Food & live Animals as a % of total imports 30.1 % (2005)
Budget Expenditure Ag & Fisheries(2006) A$ 1.83 m % of Total Budget Expenditure 2.3 %	Human Development Index : N/A

Sources: FAO NMTPF 2009

2. More than 80% of the population are farmers; in terms of household or home gardening closed to 30% have at least a small backyard garden.

3. Coconut plantations range from 1- 3 ha while crops averages 0.4 ha per family and home gardens averages about 80 sq m.

4. The main farming system is mixed cropping where all types of food crops are planted together. Mono-crops of coconut and giant swamp taro do occur.

5. The main food crops are: coconut, breadfruit, pandanus, giant swamp taro, banana, fig, pawpaw, pumpkin, sweet potato and cassava.

6. Major food crops affected by CC are: coconut, breadfruit, pandanus and giant swamp taro with greatly reduced yield due to prolonged drought.

7. Special reserve food eaten only during times of food shortages is organizati arrow root.

8. The agricultural science/extension capacity in Kiribati is presented in Table 6.

Table 6. Country capability: Human resources in the Department of Agriculture

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	3	1	2	2		8
Crop Research	3			1		4
Extension	16	1	1			18
Quarantine	6		1	1		8
Policy				2		2
Livestock	4		2			6
Total	32	2	6	6		46

Part B: Recovery of food crops and agricultural systems following a severe climatic event

1: Quarantine/ biosecurity policy

A quarantine biosecurity policy does exist and was introduced into parliament in 2011 and needs to be ratified by government and enforced by relevant departments. It is envisaged that this Act will bring quarantine policy in Kiribati closer in line with other countries in the region. A national security Task force involving relevant ministries (Commerce, Agriculture and Fisheries) is also formed after an extreme weather event. A key function is to identify food needs and import material accordingly. Quality and cost parameters are included in these considerations.

Kiribati agriculture staff would like to do PRAs for new sources of food (rice and flour) from south east Asia but lack resources to conduct these audits properly. The absence of a relevant PRA did result recently in a shipload of rice to be held on the docks. A change in trading partners for importing foodstuff into Kiribati is due mainly to costs and supply.

It was noted that germplasm backup for breadfruit is needed as Kiribati has lost some cultivars during the recent drought. SPC is currently screening cultivars for salt tolerance in anticipation that these traits will be required for adaption to future climate scenarios in countries like Kiribati. A germplasm repository for pandanus and fig trees is also required as these plants cannot be introduced into tissue culture and are currently not held at the SPC facility in Fiji.

2: Quarantine/ biosecurity practice

Pest lists for Kiribati do exist at SPC and in Kiribati. It is likely that these lists are one and the same thing as Kiribati is dependent on the SPC for pest and disease identification. The current strategy for a pest and disease diagnosis is to send anything perceived as “new” or “unusual” to SPC for diagnosis. If identified as new by SPC, the SPC staff will travel to Kiribati and conduct surveys just for that pest.

Kiribati has recorded one new pest incursion (Coconut Scale) in the last 5 years and this pest is currently restricted to several outer islands.

There is no capability in Kiribati for pest and disease diagnostics. This is due primarily to a lack of people skills and equipment. Internet and communication facilities are not a limitation.

Part C: The key impacts of climate change on food crop security and biosecurity.

1: General information

Ten major crops including coconut and giant swamp taro were identified as important to Kiribati. The major pests included rats and taro beetle (on some islands only). Kiribati has its own germplasm collection of pandanus, breadfruit and coconut. The country recently lost its field germplasm collection of sweet potato, banana and taro, however this germplasm is safely held in tissue culture at SPC.

2: Experiences with crop production and climatic events

Climate Change and related weather events were identified as increasing the severity and impact of many of the major pests and diseases. The most significant CC event is drought and results in reduced water availability and quality (salinity). Kiribati has never been exposed to cyclones but King tides are an increasingly serious issue to contend with. Vegetable growers also comment that the vegetables require more water to grow successfully due to increased temperatures.

Kiribati does have a Climate Change technical committee. A major focus of this committee is to provide information to the public about the impact of climate change and to increase communication on this topic within the country and local community. This network will then aide in the dissemination of strategies that can be used to reduce the impacts of climate change and help maintain sustainable levels of crop production. This committee operates across all sectors of the community including human health.

Kiribati would like a germplasm network directly between other atoll countries, particularly for pandanus and breadfruit. This requirement is purely for food security purposes.

3: Capacity building and preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

The Kiribati Department of Agriculture has close relationship with the Land Resources Division (LRD) of SPC on which it depends heavily for pest and disease diagnostic capability. As CC is expected to increase incidents of as well severity of pest and disease impacts on food production, training as well as basic equipments and resources for pest and disease diagnostic and management are needed. CC adaptable germplasm will become more important, thus screening and evaluation of materials of interest to Kiribati from other countries such as those hold by CePaCT is seen as areas needing capacity and capability improvements within the Department of Agriculture.

Key findings – Kiribati

1. Climate Change is associated with the prolonged drought in Kiribati and this climatic event is impacting on food security as the taro pits are drying out and the giant swamp taro is dying.

2. The threat of CC on genetic materials, particularly pandanus and giant swamp taro is of concern is a result of increased soil salinity and poor water quality due to sea level rise and sea water intrusion.

3. The biosecurity capacity in Kiribati is not adequate and is due to a lack of skills within the Dept of Agriculture and a lack of infrastructure.

4. A change in food suppliers (linked to dependence on importing food) has resulted in change in quality and reliability of imported food. This has identified the difficulties in conducting meaningful PRAs in Kiribati on imported plant material from new regions. For example, It is currently difficult to know where to source information to conduct PRA. There is a lack of skills within Kiribati to conduct pest and disease diagnoses and the Dept of Ag relies heavily on SPC at the moment.

2. Kiribati Survey Questionnaire: Consolidated Report November 2011

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Part A: Background information on Kiribati: provided in the Summary

Part B: Recovery of food crops and agricultural systems following a severe climatic event

Section 1: Quarantine/biosecurity policy

1. The Government has contingency plans with respect to food availability and crop production to assist in recovery from an extreme climatic event. The National Food Security Task Force, chaired by the office of the President. Implementation of the work is lead by the Ministry of Environment, Lands and Agricultural Development through the Department of Agriculture
2. A risk assessment of the source country is undertaken when there is a need to import staple foods such as root crops and fruits into Kiribati.
3. There are preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods and these countries must meet Kiribati own guidelines.
4. There are quarantine regulations around the importation of foods – the Biosecurity Bill.
5. These regulations are maintained even during food emergencies.
6. A risk assessment of the source country is undertaken if planting material/germplasm is imported, and usually only tissue culture plantlets are allowed to be imported into Kiribati.
7. There are preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm.
8. There are quarantine regulations around the importation of planting material/germplasm.
9. These regulations are maintained even during disaster recovery periods.
10. There are quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster from Asian countries.
11. Kiribati has access to a back-up source of its local, preferred varieties of staple crops germplasm with the SPC Centre for Pacific Crops and Trees (CePaCT).

Section 2: Quarantine/ biosecurity practice

1. Kiribati uses the SPC regional pest and disease list.
2. There is a Kiribati country pest and disease list. It is not clear if the Kiribati country pest list is different and more extensive than the SPC regional pest list.
3. The country pest and disease list is available and used by extension staff.

4. The highest risk exotic pest and disease threats to the main food crops in Kiribati are:
   - Taro beetle
   - Fruit fly
   - Spiraling white fly
   - Coconut scale
   - Breadfruit Rot disease (phytophtora)

5. The Department of Agriculture does not have adequate diagnostic facilities or trained staff to be able to identify a new/unknown pest or disease.

6. When unable to diagnose a pest or disease, Kiribati requests SPC and CSIRO for assistance.

7. No quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years.

8. Only one biosecurity incursion of Coconut scale insect has occurred in food crops in the last 5 years.

Part C: The key impacts of climate change on food crop security and biosecurity in Kiribati

Section 1: General information

1. The major crops grown in your area? Please rank in order of importance below:
   i. Coconut
   ii. Giant swamp taro
   iii. Breadfruit
   iv. Pandanus
   v. Fig tree
   vi. Banana
   vii. Pawpaw
   viii. Pumpkin
   ix. sweet potato
   x. vegetables

2. The major pests and diseases of these crops:
   - rats
   - taro beetle
   - coconut scale
   - mealy bug
   - spiraling white fly
   - fruit fly
   - wood louse
   - nematodes

3. All respondents states that seriousness of any of pests/diseases has increased due to changes in climate. Eg, rat damage on coconut, papaya, pumpkin, banana and sweet potato has been reported.

4. New pests/diseases which have arrived in Kiribat in the last 5 years are as follows:

Name of Pests/Diseases	Actions taken				
	Survey	**Control**	**Elimination**	**Ignore**	**Comments**
Coconut scale	Yes	Under investigation			Dealing with overseas partners to develop the best approach
Red ant, beetle, moth					

Section 2: Experiences with crop production and climatic events

1. All respondents experienced the effect of severe climatic events (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in Kiribati. Prolonged drought has caused the reduction in quantity and quality of coconut fruit and breadfruit. Salt water intrusion is the most common climatic factor that affects the growth and production of food crops. Salinity reduces fruiting in trees as well as early fruit drop. Increased damage from salt spray for gardens near coastal areas and coastal erosion from strong wind causing large sea waves that move further in-land has occurred.

2. No cyclone ever hit Kiribati.

3. The respondents listed the following impacts of a drought on agricultural systems that affect food supply and crop production:
   - Drought period affects the quality of food crops such as coconuts, breadfruits. It is experienced that traditional foods tend to be very hard to find during drought periods.
   - Prolong drought caused the fruit from trees, in particular coconut trees, to prematurely fall and trees became senile and to bare very few fruits.
   - Prolonged drought affects quality of well water which is the main source for domestic use.
   - Seedlings and newly planted crops are affected as leaves dried up.
   - Crops are more prone to diseases and yields greatly reduced.

4. Kiribati does not experience flooding except sea water flooding during periods of king tides.

5. All respondents experienced rising sea water level on agriculture. Impacts of sea level rise are as follows:
   - Breadfruit trees and banana have been negatively affected by a rise in sea water levels.
   - Some babai pits have been lost in outer islands due to sea water inundation and intrusion due to sea level rise.
   - Tends to cause death and stunted growth of crops at close proximity to coastal areas, this includes coconut, breadfruit and pandanus trees.
   - Soil becomes infertile with the increasing salinity from salt water intrusion.

6. Other climatic events that impact food security in Kiribati:
    - Change in rain pattern and intensity affects crop growth.
    - Increased temperature caused death of some plants
    - Concern was expressed by the respondents that Introduced new pests may be more adaptable to the altered climatic conditions and fear that their impacts would be more disastrous.

Section 3: Capacity building: Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

1. Sources of germplasm/planting material that are available are:
    - The SPC CePaCT.
    - Purchase from farmers
    - Purchase commercial seeds from Taiwanese technical Mission Farm, FSP Supply, Agriculture Dept.

2. Department of Agriculture is able to multiply germplasm.

3. The Department of Agriculture has limited expertise for the diagnosis and recognition of pests and diseases and there is also not adequate technical and financial resources to support these activities.

4. There is limited access to regional diagnostic expertise and remote diagnostic services via the internet mainly because of the poor internet connection, and also inability of staff to use this technology to either send or download relevant information.

5. There is internet access; however it is problematic at times including having no access for up to a month.

6. Kiribati has linkage to the following regional CC projects:
    - Coping with Climate Change in the Pacific Island Region (CCCPIR)
    - SPC and SPREP programs

7. There is a need for training to deal with impacts of CC on crop production, such as producing CC adapted crops and the ability to make sound diagnoses of certain situations enhancing adaptability and minimize impacts.

8. Kiribati will benefit from networking/training opportunities on quarantine/biosecurity with Australian/NZ biosecurity agencies and develop networks.

End of Questionnaire

People consulted in Kiribati

Names	Position/Occupation
KIRIBATI	
To Murdoch	Deputy Secretary, Ministry of Environment, Lands, Agriculture and Development
Kaateti Toto	Senior Assistant Secretary, Agriculture Department
Betarim Rimon	Secretary, Office of the President
Rui Tabutoa	Assistant Secretary, Environment Department
Kinaai Kairo	Director of Agriculture
Tianeti Beenna	Deputy Director of Agriculture and Director of Research
Tearo Otiuea	Principal Agricultural Officer Quarantine, Agriculture Department
Ieete Timea	Acting Head Crop Investigation Improvement section
Taouea Titaake	Environment Impact Assessment Officer, Environment Department
Ribeta Abeta	Climate Change Planning Officer, Environment Department
Nakabuta Teuriaria	Farmer and Free lance Agricultural Consultant
Etera Teangana	Farmer and former Speaker of Parliament

3.2.4.Tuvalu Country Report

1. Tuvalu Summary Report:

Part A: Background information

1. Tuvalu background data

Land area (km^2): 26	Sea area/EEZ (million km^2): 900,000
Population: 9,561 (2002 census)	Annual population growth (%): 0.51 (1991-2002)
Average density (inhabitants/km^2): 378	Rural (outer island) population: 58%
GDP (A$ million): 27.49 (2002) US$18 million	GDP per capita (A$): 2,872 (2002) US$1,889
GDP Real Growth (ave.2003-2007): 2.6 % per annum	Primary sector GDP (% of total GDP): 16.6 % (2002)
Trade Balance – US$11,071,006 (Exports as % of imports) 0.47 % (2005)	Food & live Animals as a % of total imports 25 % (2007)
Budget Expenditure Agriculture & Fisheries(2006) N/A	Human Development Index Available in 2011 national Budget

Sources: FAO NMTPF 2009

2. About 60% of the population lives in rural islands and about 33% of them are active subsistence farmers.

3. The average farm size is less than 0.2 ha.

4. The main farming systems are: Giant swamp taro - pit cultivation (communal plots) which can include banana and taro (Colocasia sp.), Vegetable home gardening, coconut and toddy production, household pigs and poultry farming, village production of breadfruits, bananas and pandanus, traditional agroforestry and commercial production of eggs and vegetables.

5. The main food crops in Tuvalu are: coconuts, giant swamp taro, breadfruits, bananas, pandanus, pawpaw, vegetables, taro, wild fig and sweet potato.

6. The major impacts of CC on the major food crops include: incursion of saltwater and floods during heavy rains and prolonged dry weather kills giant swamp taro, crops are killed during long dry weather and flooding and coastal erosion from king tides.

7. The special/reserve food crops eaten during times of food shortages are: giant swamp taro, alocasia and wild figs.

8. The agricultural science/extension capacity in Tuvalu

Table 7. Country capability: Human resources in the Department of Agriculture

Sections in Ministry	Number with qualifications					
	Certificate	Diploma	Bachelor	Masters	PhD	Total
Crop Production		2				2
Crop Protection		1	1			2
Extension		2	1			3
Quarantine			1			1
Policy		1				1
Others		1	1			2
Total		**7**	**4**			**11**

Part B: Recovery of food crops and agricultural systems following a severe climatic event

Section 1 & 2: Quarantine/ biosecurity policy and practice

A Quarantine Policy does exist in Tuvalu but is widely considered to be old and needs renewing. A Biosecurity Bill is being written and will be enacted in the next 2 years. This bill covers plant, animal and marine agriculture and native environments.

It was generally considered that there were several barriers to overcome to provide responsive but safe quarantine measures in response to a climatic event or disaster. There is a requirement for a quick response to disasters particularly in identifying suppliers of germplasm/planting material in advance.

An example that is unfolding at present is the requirement for Tuvalu to import 500 – 1000 propagules of Giant Swamp taro planting material due to the effects of the current drought and the requirement to replenish taro pits in the country. Tuvalu has identified the Federated States of Micronesia (FSM) as a likely source of planting material. The problem they have is that they are not sure:

- what the biosecurity risks will be in importing planting "setts" or suckers from FSM.
- what protocols to practice to safely import this planting material.
- how the FSM giant swamp taro will grow in Tuvalu.

These gaps in knowledge would be the type of pre-emptive biosecurity activities that Tuvalu should have conducted 3 – 4 years ago before this current drought.

Tuvalu relies heavily on the skills and expertise of SPC to conduct and complete pest and disease diagnoses. However this arrangement has not always operated smoothly. SPC did collect some samples from Tuvalu a few years ago and have not returned any results or specimens back to Tuvalu. The SPC list for plant viruses as published by Davis et al (2010) only reports 2 viruses in Tuvalu and both these viruses are obtuse viruses not from the main food crops. This seems to be incomplete.

Part C: The key impacts of climate change on food crop security and biosecurity.

Section 1: General information

Drought, salt water intrusion via spring tides (full moon), king tides (once yearly) and storm surges are the weather events that are changing as a result of climate change and are having the biggest impact on cropping systems in Tuvalu, particularly perennial crops. Tree crops are dying due to lack of water and salt toxicity and coast line erosion is resulting in trees falling into the lagoon.

Section 2: Experiences with crop production and climatic events

The recovery efforts from the current drought in Tuvalu, the worst in living memory, as indicated above, will involve addressing the shortage of safe and well adapted planting material for Giant Swamp Taro and the potential biosecurity risks that will be taken on receival of propagative setts and suckers from FSM (see comments above).

A change in farming practices that have occurred in Tuvalu to counteract the effect of salt water intrusion is composting to increase the health of tree plants/crops. The survival of fruit trees such as banana and papaya has been improved by composting around the base of these plants.

Section 3: Capacity building: Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

There are limited skills in country pest and disease identification in Tuvalu and as mentioned earlier they rely heavily on SPC for these skills. As such Tuvalu has limited pest and disease lists and the inability to conduct their own diagnoses centres around staff skills and basic equipment.

The current issue of importing Giant swamp taro suckers from FSM requires an immediate PRA to be completed. However at the moment Tuvalu could only conduct a draft PRA and would depend on an outside organization (e.g. SPC) to complete the PRA. This situation is compounded by incomplete pest and disease lists in both Tuvalu and FSM.

Key findings from project

1. Lack of diagnostic capability within country is a significant problem. There is a reliance on SPC to do diagnostics and this can be a long way between drinks – see earlier comments
2. Regional networking and sharing needs to be improved
3. Regional resources are declining e.g. SPC survey not reporting results back.
4. Climate change events on food security
5. Community neglect of supply of traditional food crops (Pulaka) is a concern as this capability is more vulnerable to being lost, as production is lower and therefore it is harder to recover. This is driven by a community change in production (i.e. the consumption of more imported foodstuff such as rice).

2. Tuvalu Survey Questionnaire: Consolidated Report November 2011

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Part A: Background information on Tuvalu: provided in the Summary

Part B: Recovery of food crops and agricultural systems following a severe climatic event

Section 1:
Quarantine/biosecurity policy

1. There is no contingency plan within Tuvalu with respect to food availability and crop production, to assist in recovery from extreme climatic events. However, there is a National Disaster Management Committee where its role is to develop plans for emergency response and recovery. SPC has already assisted the department in developing its Emergency Response Plan but requires further review to accommodate extreme climatic events.

2. Tuvalu's food security will continue to rely on food imports including staple foods such as root crops and fruits because the local production of these food commodities remains too low given the increasing demand. This is why the Tuvalu government has supported the Tuvalu – Rotuma Trade arrangement that SPC has assisted with since the beginning of 2011. So far only cassava, taro and sweet potatoes from Rotuma are allowed to be imported into Tuvalu under this arrangement. Two shipments have already taken place so far and this will undoubtedly increase into the foreseeable future.

A PRA was conducted for each of the root crops prior to their importation. Plans are under way to conduct PRA for non-fruit fly prone fruits and other vegetables from Rotuma.

3. Tuvalu will continue to allow vegetable and fruits from New Zealand, Australia and Fiji which have been Tuvalu's traditional trading partners in fruits and vegetables and root crops.

4. The quarantine regulations related to the importation of foods are guided by the Plants Act which does control importation of fresh fruits. The animal importation act controls the importation of live animals while the Food Safety Act covers the processed and stored foods and food handling practices.

5. These quarantine regulations are not fully addressed during food emergencies and so the regulations would need to be reviewed for further improvement.

6. A risk assessment of a source country regarding the importation of planting material/germplasm into Tuvalu is conducted. Tuvalu has been receiving planting material from Fiji through the SPC – CePACT arrangement to undertake risk assessments of this planting material under local conditions. A Material Transfer

Agreement is signed between both Tuvalu and the exporting country. Tuvalu is aware that what SPC sends to Tuvalu is not necessarily materials from Fiji but from other countries as well as within and beyond the region. But since the germplasm is being distributed by SPC, the planting material would have undertaken Risk Assessment. The Tuvalu experience with the Rotuma arrangement is that all the plant species that can be imported into Tuvalu has been risk assessed and the facilities at Rotuma have been audited. This strategy will be the basis for any other new food crops that are to be imported into Tuvalu from any other country in the region and beyond in the near future.

7. The preferred supply countries are from within the Pacific region so as to minimize the biosecurity risks when importing planting materials/germplasm. To some extent, specifically from countries where the cultivation of Giant swamp taro (Cyrtosperma chamissonis) is commonly practiced, because of the current need to access more salt tolerant pulaka varieties for inclusion in the Tuvalu adaptation program. The countries that we are interested to export their Giant Swamp taro (pulaka) to Tuvalu are Kiribati and FSM. to date the CePACT has also collected few known varieties from Kiribati and Fiji and FSM. This germplasm is still being cultured in the CePACT as tissue cultures and are yet to be released for Tuvalu until they have been virus indexed.

8. Tuvalu has quarantine regulations around the importation of planting material/germplasm that is old and needs reviewing to enable the importation of different germplasm from new countries. The Biosecurity Bill will address many of these issues but is yet to be tabled to Parliament. This bill is more suited to the current practices and needs in Tuvalu.

9. During disaster recovery periods maintenance of current regulations do not seem to be addressed. It is hoped that the new Biosecurity Bill will improve and guide decision making during disaster recovery periods.

10. There are no specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster. Normally Tuvalu may seek SPC Plant Protection and Biosecurity Advising Units for their advice.

11. Tuvalu uses CePACT (SPC) as a source of preferred varieties of staple crops if available. Tuvalu has begun collecting some of their traditional crops including the giant swamp taro (cultivar te ikataoi), and other root crops and bananas.

Section 2:
Quarantine/ biosecurity practice

1. All respondents use the SPC regional pest and disease list.

2. Tuvalu has a country pest and disease list although its incomplete and a more thorough survey need to be conducted

3. The country pest and disease list could be made available but needs to be improved in content, and translated to local language not only for extension but for local farmers awareness.

4. The highest risk exotic pest and disease threats to the main food crops in Tuvalu are:
    i. Taro beetle
    ii. Coconut Rhino beetle
    iii. Fruit flies
    iv. Coconut scale insects
    v. Mealy bugs are badly affecting tomatoes, cucumbers and capsicums in home gardens.

5. There is a not sufficient resources/staff/regional network to be able to identify a new/unknown pest or disease, thus rely on SPC's assistance.

6. When Tuvalu is unable to identify a pest or disease, it is referred to SPC – LRD.

7. Quarantine interceptions of new pests and diseases of food crops that occurred in the last 5 years were:
    i. A fruit fly spp. still contained on Niulakita
    ii. A caterpillar that devastated foliage of the Cartappa Tree on Funafuti
    iii. Coconut scale insect.
    iv. More recently in 2011, a caterpillar attack on the kanava trees on Nanumea Island. Working closely with SPC to control. Kanava is not a food crop but is an important shoreline coastal protection tree because of its strong root system

8. The biosecurity incursion of a new pest or disease that have been detected in food crops in the last 5 years was:
    i. Bactrocera xanthodes- found in one island only

Part C: The key impacts of climate change on food crop security and biosecurity

Section 1: General information

1. The major crops grown in Tuvalu:
    - Coconut
    - Pulaka
    - Breadfruits
    - Bananas
    - Taro colocassia
    - Vegetables and pawpaws
    - Panadanus
2. What are the major pests and diseases of these crops? Please rank in order of importance below:
    - Coconut scale insect
    - Rats

- Fruit flies
- Mealy bugs
- Ants

3. The seriousness of these pests/diseases has increased due to changes in climate
   - Corm rot in pulaka and taro due to increase salinity of underground water lense especially during the king tide period.
   - Increase in population of mealy bug during prolonged drought periods.

4. New pests/diseases arrive in Tuvalu in the last 5 years which have impacted on food crop production are listed in Table 9.:

Table 9: New pests and diseases that have been detected in Tuvalu in the last 5 years.

Code	Name of Pests/Diseases	Actions taken				
		Survey	Control	Elim	Ignore	Comments
IL	Fruit flies	x	x			Trapping continue
	Coconut scales	x				Bio-control continues to be monitored and strict movement of plant materials

Section 2: Experiences with crop production and climatic events

1. The effect of climatic factors that were identified by the respondents was an increase in salt water intrusion and increased prolonged drought that has resulted in the killing of food plants.

2. The experience with the impact of a cyclone on agricultural systems that affect food supply and crop production include increased wave activity that came overland and impacted the pulaka pit on Nukulaelae island in 2005 damaging more than an acre of pulaka crops. This event also caused direct physical damage to crops and fruit trees.

3. The experience with the impact of a drought on agricultural systems that affect food supply and crop production include:
   - The Nanumaga Drought in 2006 killed about two acres of pulaka because of the prolonged drought.
   - Low production of fruit trees and vegetable production.

4. The experience with the impact of flooding on agricultural systems that affect food supply and crop production. Flooding here refers to salt water flooding.
   - In 2007, the kingtide flooded the Funafuti pulaka pits with saltwater and the local community sought government assistance. However the problem was minimal due to subsequent continuous heavy rains that washed away the accumulated salt in the pulaka pit from the saltwater incursion from this particular king tide.
   - The flood impacts from spring tides and king tides also frequently damages home gardens in lower lying areas on the capital island of Funafuti.

5. The experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production. This is the most important issue affecting food supply and crop production:
   - Yellowing of coconut trees and in higher trees and bushes in low lying areas of all islands in the interior.
   - Pulaka pits that are dug right down to the water lens have more obvious impacts in the yellowing of crop plants and in some instances the plants rot and can die.

6. Other climatic events that impact food security in your country in Tuvalu:
   - Coastal erosion from tidal impacts/waves that caused many trees including coconut and pandanus on the coastline to fall.

Section 3: Capacity building – Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

1. The sources of germplasm/planting material available in Tuvalu are:
   - Cuttings, corms/tubers and shoots of traditional food crops including sweet potatoes, and cassava
   - Vegetables seedlings from the Taiwan Mission.
   - The department import vegetable seeds from NZ

2. The department of Agriculture has been propagating breadfruit variety from the Niutao variety during the DSAP project and distributed to other islands who were interested in this low fruiting breadfruit. The department recently has not been very active recently in this for other traditional food crops because of the lack of funds. However it has the capability given its allocation of land leases including a pulaka pit that is available to conduct these activities.

3. There is neither capability nor adequate resources for diagnostics and recognition of new pests and diseases.

4. Tuvalu's access to regional diagnostic expertise and remote diagnostic services via the internet is limited. There is access to SPC technical personnel but does not have access to remote diagnostic service via the internet. The department has tried to use Pestnet but the response had been slow. Sending photos of pests and describing their impacts and sending them to SPC has been most effective with prompt results from SPC

5. Tuvalu has adequate internet access, but always experience daily cuts and slow internet speed due to heavy internet use. The problem of the government internet system is that it has a small bandwith that is congested at most times. Telcom operates an ISP with faster connection but the charges are too high and not affordable by departmental staff (AuD 500.00 per month).

6. Tuvalu is linked to the following regional CC projects:

- The Environment GEF funded National Adaptation Plan of Action (Salt tolerant crop varieties) – 3 more years
- Sustainable Land Management (EU) Pulaka pit terracing farming system 1.5 years.
- Food Security & Sustainable Livelihood Program (FSSLP) of the FAO addressing; food production, fisheries, added value foods, health, trade and climate change

7. Training needs of Tuvalu to deal with CC includes:
   - Composting, agronomy, improved farming systems, biosecurity, identification of pests, pest control; IPM.
   - Pest forecasting software through environmental changes, sustainable agriculture practices on atolls.

Networking/training opportunities with Australian/NZ biosecurity agencies in quarantine/biosecurity, would be most useful, to expose biosecurity staff to learning advanced methods and experience from these countries would undoubtedly improve the knowledge and capabilities of departmental staff to carry out their responsibilities.

End of Questionnaire
People consulted

Names	**Position/Occupation**
TUVALU	
Itaia Lausaveve	Director of Agriculture
Sam Panapa	Head of Quarantine
Akinesi Sianoa	Senior Agricultural Extension and Information Officer
Faavae Lutelu	Quarantine Officer
Iosia Siose	Extension Officer
Peleti Pole	Livestock Officer
Timoteo Panapa	Agricultural Officer
Fialua Mouise	Extension (FAO Banana Project)
Tavau Teii	NPC FAO FSSLP
Evolini Mami	Counterpart – Taiwan Technical Mission Vegetable Program
Yeong-Lang Yang	Team Leader – Taiwan Technical Mission
Annie Homasi	Manager Tuvalu Association of NGOs (TANGO)

3.3 Key Country Findings (prepared by collaborators from country reports)

Tonga key findings (Ms Luseane Taufa):

1. Ministry of Agriculture has no proper contingency plan to assist recovery from an extreme CC event. There are some infrastructure and systems in place but with a lack of trained staff, are hard to implement and operate smoothly.
2. Tonga has unreliable diagnostic support and networking including a general lack of surveillance skills.
3. There is evidence of an Increase in exotic pest introductions with 11 exotics and 3 incursions in the last 5 years.
4. Cyclones and prolonged drought has reduced yields and is affecting food security.
5. There is a limiting and declining basic resources and networking capability (people) in Tonga.

Vanuatu key findings (Mr James Wasi):

1. There is not an adequate capability and resource for diagnostics and recognition of new pests and diseases in the country.
2. Vanuatu uses the SPC regional pest list database and also has its own pest list database which is mainly used by Quarantine officers who have been trained in its use. There is a need for training of extension officers on use of pest list database.
3. Vanuatu recognizes that there are high risk exotic pest and disease that are established in neighbouring countries and threatens the main food crops of the country.
4. Vanuatu is prone to a range of severe climatic events (cyclone, flood, salinity, drought, increased temperature etc) and their impacts on crop production and food availability. Preparedness for recovery from such events should be a high national priority.

Kiribati key findings (Mr Tianeti Beenna)

1. Climate Change is impacting on food security with prolonged droughts drying the taro pits and causing the giant swamp taro to die.
2. The threat of CC on genetic materials, particularly pandanus and giant swamp taro is of concern is a result of increased soil salinity and poor water quality due to sea level rise and sea water intrusion.
3. The Biosecurity capacity in Kiribati is not adequate and is due to a lack of skills of Dept of Agriculture staff and a lack of infrastructure.
4. A change in food suppliers (linked to dependence on importing food) has resulted in change in quality and reliability of imported food. This has identified the difficulties in conducting meaningful PRAs in Kiribati on plant material imported from new regions. It is also difficult to know where to source information to conduct PRA. There is a lack of skills within Kiribati to do this and they rely heavily on SPC.

Tuvalu key findings (Mr Itaia Lausaveve):

1. There is a lack of diagnostic capability within Tuvalu and this is a significant problem. There is a reliance on SPC to do diagnostics and this can be a very slow process to get diagnostic results back to the country.
2. Regional biosecurity and diagnostic networking and sharing needs to be improved. Regional resources are declining e.g. SPC survey not reporting results back.
3. Climate change events such as prolonged droughts and saltwater inundation into Pulaka (taro) pits reduced productivity of this system with significant consequences on food security. As a result, communities tend to neglect this traditional food crop and rely more on imported food such as rice.
4. There is a need to find germplasm (possibly from Micronesia) of atoll crops (giant swamp taro, pandanus, breadfruit trees) which are adapted to saline conditions.

3.4 Summary of results (overall key findings)

1. Climate change is impacting on food security due to the increased length and severity of droughts in all collaborating countries, causing reduced fruit set, reduced yield and quality of fruits and root crops, death of annual crops and in Kiribati and Tuvalu, death of the breadfruit and pandanus trees which are staple foods.

2. Climate change is impacting on food security by degradation of production areas caused by sea level rise, salinity due to storm surges and salination of the water table in the atoll countries, Kiribati and Tuvalu. These are the most serious impacts of climate change on food production and cause yellowing, stunting and dying of affected crops and trees.

3. Climate change is impacting on food security due to extreme weather events such as cyclones which cause major damage to crops, loss of crop germplasm and destruction of coastal vegetation in all collaborating countries except Kiribati, which has not experienced cyclones.

4. Loss of traditional crops in Kiribati and Tuvalu due to extreme weather events (E.g. drought) and long-term climate change effects (E.g. salt water intrusion) is causing import substitutes (mainly rice) to replace traditional foods.

5. All countries are able to obtain some replacement crop germplasm as tissue cultures from the Centre for Pacific Crops and Trees (CePaCT), SPC, and from their own field collections. Each country can undertake multiplication of planting stocks.

6. There are long delays in identifying suitable atoll crop replacement varieties (giant swamp taro, breadfruit trees) suitable for saline and drought conditions, due to the time required to collect germplasm from other atoll countries (E.g. Federated States of Micronesia), and multiplication and screening at CePaCT.

7. Climate change events do impact on the incidence of pests and diseases, for example, changes in rain intensity and seasonality have negative impacts on fruiting of certain fruit trees such as mangoes. Increased droughts favour the breeding and activities of taro beetles that feeds on taro.

8. There are increased pest and disease problems due to climate change in all collaborating countries due both to stresses making crops more vulnerable to endemic pests and diseases and incursions of new pests and diseases. All collaborating countries have experienced at least two new incursions of pests and diseases in the last five years and none have been eliminated and control is only being attempted for a few.

9. The highest ranking exotic pest and disease threats for the four countries were similar with taro beetle, taro blight, Queensland fruit fly, coconut scale insects being listed most frequently. The lists contained insects, fungi, bacteria, viruses and phytoplasmas, indicating the range of skills required for biosecurity and incursion management.

10. There is a lack of physical and human capacity for effectively delivering plant health services (biosecurity, crop protection, etc). Countries depend on regional organizations for identification of pests and diseases and for advice on follow-up action (eradication, management, etc.) due to lack of trained staff and resources.

11. The number of staff employed in crop production and crop protection respectively in the collaborating countries are very low: Tonga (17,7); Vanuatu (6,4); Kiribati (2,1); Tuvalu (2,2).

12. Although all collaborating countries have Quarantine Acts and Kiribati and Tuvalu have Biosecurity Acts before parliament, capacity and training to enact these laws and development of supporting regulations are often limited E.g. pest risk assessments (PRAs) associated with importation of foods and crop germplasm are normally undertaken by SPC. Countries lack skills in conducting effective (PRAs) as well as setting adequate risk levels in each country.

13. Contingency plans are in place in all countries to deal with disasters associated with climate change events, although some of the plans need serious review.

14. Countries recognise the value of developing regional networks between like countries in addition to dealing solely with a central organisation as a feasible, low cost and sustainable way of acquiring assistance to deal with the impacts of climate change.

3.5 Climatic Factors that are likely to increase biosecurity risks in the South Pacific, with specific reference to Kiribati, Tonga, Tuvalu and Vanuatu.

Introduction:

The South Pacific nations are characterised by small populations, land areas and economies and are often fragmented and spread over many small islands (Overton 2006). The IPCC AR4 identifies small island states as being among the most vulnerable countries in the world to adverse impacts of climate change. It predicts temperature rises in the Pacific in line with world predictions, increased level of drought, sea level rise and increased cyclone intensity (IPCC 2007). These changes are in turn likely to drive changes in the agricultural land use by Pacific Island people such as coastal erosion and inundation, coral bleaching and saline contamination which will result in declining agricultural production (Mortreux and Barnett, 2007).

Food security refers to the availability of sufficient, safe and nutritious food at all times to all people (FAO, 2002). This definition comprises four key dimensions of food supplies: availability, stability, access and utilisation (Schmidhuber and Tubiella 2007). Recent publications (e.g. FAO 2008, Barnett 2007) acknowledge the likely negative impacts of climate change on food security through degradation of production areas (sea level rise, salinity, drought), devastation caused by extreme weather events (cyclones, flooding, tsunamis) and impacts of recovery time such as loss of crop germplasm and the need to import food substitutes. Despite some regions benefiting from climate change through increased crop production, the majority of quantitative assessments show that climate change will adversely affect food security and will increase the dependency of developing countries on imported food (Schmidhuber and Tubiella, 2007).

Some of the direct impacts of climate change include:

Rising ocean temperatures: Increased ocean temperatures cause a variety of impacts. These include sea-level rise and incidents of coral bleaching which stress coral reef ecosystems. New research by the Pacific Climate Change Science Program (PCCSP) scientists shows average sea surface temperatures have increased by 0.7°C from 1950 to 2000 across the tropical Pacific.

Continuous rise in sea levels: Analysis of global tide gauge data shows that the rate of sea-level rise increased in the late 19th and early 20th century, with a global-average rate of about 1.7 mm/yr over the 20th century. The rate of rise measured by satellite altimeters since 1993 has been about 3.2 mm/yr. Tide gauge data indicate a slightly smaller rate of rise over the same period but it is still increasing at an annual rate.

Historical data on the impacts of natural disasters show that the cost of extreme events in the Pacific Island region was in excess of US $1 billion in the 1990s (Bettencourt and Warick, 2000). Climate change is predicted to have a progressively negative effect on the yield of field crops (Luck et al. 2011). The major climate change factors that are likely to influence pest and disease severity are increased atmospheric CO_2, heavy and unseasonal rains, increased humidity, drought, cyclones and warmer winter temperatures (Luck et al., 2011). Over the last 250 years atmospheric CO_2 concentrations have increased from 280 p.p.m (1750) to 368 p.p.m. in 2000 (Watson, 2000) and during the 20th century the global temperature has increased by 0.74°C and is projected to increase 3-4°C this century under the "A2" scenario (Pachauri and Reisinger, 2007). It is likely that this "A2" scenario will be accompanied with a more variable climate and more extreme weather related events (Chakraborty and Newton, 2011).

In spite of the many advances in crop production and the detailed analyses of the impact of climate change on these systems there are only a few reports on the affect of these climatic factors on spreading invasive plants, diseases and pests (Dehnen-Schmutz et al. 2010). In 2005 Hurricane Wilma spread *Xanthomonas citri* subsp *citri* through citrus orchards in Florida and this resulted in the

establishment of this pathogen in the Florida region (Gottwald and Irey, 2007). Significantly, the wind and driving rain assisted the colonisation of the pathogen on the host plants and is a similar scenario to the establishment of bacterial crown rot of papaya in the Kingdom of Tonga (Fullerton et al. 2011). Severe storm events clearly have the potential to aide the spread and establishment of pest and diseases in new areas.

The prevalence of *Potato leafroll virus* (PLRV) in Canada is predicted to increase in future climates in Canada due to increased populations of aphid vectors as a result of warmer winter temperatures (Boland et al. 2004). Climate change is also predicted to make the Australian horticultural industry more vulnerable to the Queensland fruit fly (*Bactrocera tryani*) (Sutherst et al. 2000).

Changing climatic conditions can alter the geographic area in which a plant pest or pathogen can survive and can result in the emergence of previously unrecorded pests and diseases within an agricultural system (Rosenzweig et al., 2001). For example a poleward shift in the distribution of southern death syndrome of soybean, caused by *Fusarium solani* f. sp. *glycines*, is being observed in to the northern states of the USA (Roy et al. 1997). In the South Pacific, Tuelon and Stufkens (2002) reviewed the introduction of aphid species into New Zealand and reported the introduction of over 100 aphid species into the region over the last 100 years. The authors sight two main pathways for introduction:

1. as passengers on plants and produce
2. by wind. Aphids have been detected in air traps which provide evidence that the aphids have been blown across the Tasman Sea from Australia other neighbouring land masses such as the South Pacific Islands.

Increased extreme weather events are predicted to increase movement of pests and pathogens over long distances. Changes in climate will alter the geographic distribution of some pests and pathogens. For example, the silver leafed whitefly and *Thrips palmi* (Luck et al. 2011). Another major biosecurity risk is the importation of substitute foods following a natural disaster.

There is recognition by Pacific regional governments that climate change will impact on food security and biosecurity in the Pacific region. Climate change poses increased risks through degradation of food production areas (sea level rise, salinity, drought), devastation caused by extreme weather events (cyclones, flooding) and impacts of recovery time such as replacement of lost crop germplasm and the need to import food substitutes (PCCSP, 2010).

For example, horticultural exports from Central and South America have increased significantly in the last decade and this will increase the likelihood that known and unknown pathogens from these regions will be introduced to and become established in regions that are importing the plant produce (Hodgetts et al. 2009). There is evidence from the CABI Abstracts and from pest and disease databases such as PROMED (www.promed.org) that the first reports of plant pathogens in most regions that import plant products have been steadily increasing over the last two decades (Dehnen-Schmutz et al. 2010). It is therefore important that countries and regional jurisdictions adopt a pro-active strategy to identify safe places from which to import plant products that minimise the chances of introducing pests and diseases into their country or region. A balance is required between the immediate need to import food and plant products to prevent famine and malnutrition, the environmental impacts of importing this plant material and the enhanced risks to plant health due to increased trade (Rossman, 2008).

Predicted climate change patterns in Kiribati, Tonga, Tuvalu and Vanuatu

Much of the information presented in the country assessments below has originated from a recent report published by the Australian government tiled "Climate Change in the Pacific: Scientific Assessment and New Research". This report is a peer-reviewed scientific assessment of the climate

of the western Pacific region (www.pacificclimatechangescience.org). Interviews conducted with South Pacific countries as part of the Australian government funded project called The Pacific Climate Change Science Program (PCCSP) identified a number of observations that impact directly on the lives of south Pacific people and include:

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

Following is a brief summary of some of the observed and predicted climatic factors that are expected and which may impact on the biosecurity of crop production in these four small South Pacific nations.

Kiribati:
Kiribati has a hot, humid tropical climate, with air temperatures very closely related to the sea surface temperature of the surrounding oceans. High year-to-year variability in rainfall is mostly due to the impact of the El Nino-Southern Oscillation. With respect to climate change, warming trends are evident in both annual and seasonal mean air temperatures at Tarawa for the period 1950–2009 with the mean temperature rising 0.19 °C/decade during this period. In contrast the mean annual rainfall trend is increasing at a rate of 41.92 mm/decade (PCCSP-Kiribati, 2011). The sea-level rises near Kiribati that have been measured by satellite altimeters since 1993 ranges from 1–4 mm per year. Storm surges and high sea levels associated with low pressure systems and distant tropical cyclones have severely damaged coastal homes in recent years. Droughts, usually associated with La Nina events, are occasionally very severe in Kiribati.

It is predicted that over the remainder of the 21st century there is a high probability of surface air and sea-surface temperature will continue to increase as will the intensity and frequency of days of extreme heat. The annual and seasonal rainfall in Kiribati is also projected to increase (high confidence) along with the frequency of days of extreme rainfall. Significantly the incidence of drought is projected to decrease for this atoll country (PCCSP, Nov 2011). Ocean acidification and mean sea level rises is highly likely to continue.

Sea level is expected to continue to rise in Kiribati and by 2030, under a medium emissions scenario, this rise is projected to be in the range of 5–14 cm and up to 10-29 cm by 2055. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. Projections for all emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future in Kiribati. By 2030, under a high emissions scenario, this increase in temperature is projected to be in the range of 0.3 –1.3°C and by 2090 this increase could be as high as 3°C.

Tonga:
The climate in Tonga is characterised by two distinct seasons – a warm wet season from November to April and a cooler dry season from May to October. Nearly two-thirds of Tonga's rainfall falls in the wet season from November to April. The rainfall is affected by the South Pacific Convergence Zone, which is most intense during the wet season. Rainfall in Tonga has high variability from year-to-year due mainly to the El Nino/Southern Oscillation and the seasons are influenced by El Nino and La Nina weather events. El Nino events tend to bring cooler dry seasons and drier wet seasons than normal, while La Nina events usually bring wetter than normal conditions.

Seasonal variations in air temperature has been recorded in Tonga and this is due mainly to the close proximity of Tonga to the sub-tropics. Part of the seasonal change is driven by the sea surface temperature of the oceans surrounding the islands. Warming trends are evident in both annual and seasonal mean air temperatures at Nuku'alofa for the period 1950–2009, with the strongest trends in the wet season. Records show that the maximum temperatures in Tonga have increased at a rate of 0.1 °C per decade which is consistent with global pattern of warming. Data collected since 1950 indicate that the Tongan annual rainfall is decreasing with substantial variation in rainfall from year to year observed. Satellite data indicate the sea level has risen 6 mm per year near Tonga since 1993 and is larger than the global average of 2.8 – 3.6 mm per year.

Over the course of the 21st century under a medium emissions scenario the annual average air temperature is expected to increase by 0.2 – 1.2 °C by 2030 and from 0.7 – 1.9°C by 2055 with a significant increase in the number of very hot days. The annual rainfall is projected to stay the same but there is expected to be an increase in wet season rainfall and a corresponding decrease in dry season rainfall. There will be an increase in frequency of extreme rainfall days and there will be little change in the incidence of drought. Tropical cyclone numbers are projected to decline in the south-east Pacific Ocean basin, including Tonga, but there is likely to be an increase in intensity of the cyclones with stronger winds and more intense rainfall events. Mean sea-level rise is projected to continue with an increase of 4-16 cm by 2030 under a medium emissions scenario and by 10 – 31 cm by 2055.

Tuvalu:

Like Tonga, Tuvalu has two distinct seasons; the wet season from November to April
and a dry season from May to October. This seasonal cycle is driven by the strength of the South Pacific Convergence Zone, which is strongest during the wet season. The West Pacific Monsoon can also bring high rainfall to Tuvalu during the wet season. Tuvalu's climate also varies considerably from year to year due to the El Nino-Southern Oscillation. El Nino events tend to bring wetter, warmer conditions than normal and is likely due to the warmer ocean temperatures around Tuvalu in these years, while La Nina events usually bring drier, cooler than normal conditions.

Air temperatures in Tuvalu are relatively constant throughout the year and are closely related to sea surface temperatures. Warming trends are evident in both annual and seasonal mean air temperatures with maximum temperatures increasing at a rate of 0.21°C per decade between 1950 and 2009. These temperature increases are consistent with the global pattern of warming. Average annual rainfall has remained mostly unchanged since 1950 although significant variation in rainfall between years has been observed. This high year-to-year variability in rainfall is mostly due to the impact of the El Nino-Southern Oscillation.

The sea-level rise near Tuvalu measured by satellite altimeters since 1993 is about 5 mm per year and this is greater than the global average of 2.8–3.6 mm per year. Spring tides and tropical cyclones are among the main extreme events that affect Tuvalu. On average Tuvalu experiences eight tropical cyclones per decade, with most occurring between November and April. The high inter-annual variability in tropical cyclone numbers makes it difficult to identify any long-term trends in frequency. As well as high winds and rainfall, tropical cyclones also cause storm surges and swells. The resulting flooding causes agricultural losses, particularly of taro crops and damage to buildings and roads along the coast.

Future climate predictions for Tuvalu indicate that the surface air temperature will continue to increase. Under a medium emissions scenario the increase in temperature is projected to be in the range of 0.4 –1.2°C by 2030 and by 1.0 –2.0°C by 2055. These increases will be accompanied with an increase in the number of hot days and warm nights, and a decline in cooler weather. The Annual and seasonal mean rainfall is projected to increase over the course of the 21st century with the

intensity and frequency of days of extreme rainfall are projected to increase. Despite Tuvalu currently experienced a severe drought, the incidence of drought is projected to decrease. Tropical cyclone numbers are projected to decline in the south-east Pacific Ocean basin. In the Tuvalu region, projections tend to show a decrease in the frequency of tropical cyclones by the late 21st century and an increase in the proportion of the more intense storms.

Sea level rise is expected to continue with a projected 5-14 cm increase under a medium emissions scenario by 2030 and 10-29 cm by 2055. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. The impacts of sea level rise on this atoll country will be significant.

Vanuatu:
Vanuatu has a marked wet season from November to April. Vanuatu's rainfall is strongly influenced by the position and strength of the South Pacific Convergence Zone. During summer the South Pacific Convergence Zone intensifies and moves further south, bringing the higher rainfall of the wet season. Temperatures in the warmest months in Vanuatu (January - February) are about 4ºC higher than those in the coolest months (July-August). Rainfall in Vanuatu varies greatly from year-to-year due mainly to the influence of the El Nino-Southern Oscillation and the South Pacific Convergence Zone. In Vanuatu El Nino events tend to bring drier conditions as well as a late start to the wet season and cooler than normal dry seasons. The opposite occurs during La Niña events.

Warming trends are evident in both annual and seasonal mean air temperatures for the capital, Port Vila, for the period 1950–2009 and is increasing at a rate of approximately 0.17°C per decade. Data since 1950 for Port Vila show a decreasing trend in wet season rainfall, but there are no clear trends in annual and dry season rainfall over the same time period. Sea level rises in Vanuatu are similar to Tuvalu and have increased by about 6 mm per year since 1993. This is larger than the global average of 2.8–3.6 mm per year. On average Vanuatu experiences 23 tropical cyclones per decade, with most occurring in January and February. The high inter-annual variability in tropical cyclone numbers makes it difficult to identify any long-term trends in frequency.

Temperatures will continue to increase with predictions of a 0.3–1.1°C increase by 2030 under a medium emissions scenario and up to 0.8 –2.0°C by 2055. The Increases in average temperatures will also result in a rise in the number of hot days and warm nights and a decline in cooler weather. Although overall rainfall levels will not change significantly there will be a change in rainfall patterns with a decrease in dry season rainfall and an increase in wet season rainfall and will include an increase in intensity and frequency of days of extreme rainfall. There is little projected change in the incidence of drought. Due to the projected decline of cyclone numbers in the south-west Pacific Ocean basin the impact of cyclones for Vanuatu is likely to decrease but, the intensity of a cyclone event is likely to increase. Sea level is expected to continue to rise in Vanuatu with a 1-16 cm increase by 2030 under a medium emissions scenario and a 8–31 cm increase by 2055.

Conclusion:
Climate impacts almost all aspects of life in the south Pacific and understanding possible future climatic scenarios and the associated biosecurity risks that naturally emerge over the coming years will enable people and governments to plan ahead and adapt to change. Some of the impacts from these climate change events were not always bad and in some instances (e.g. higher temperatures) were reported as increasing the yields of some crops. For example in Vanuatu, coconut trees are bearing more fruit. However, the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC, 2007) found significant research gaps which needed to be filled to better inform climate change adaptation and resilience building in small island States.

There is much data that needs to be generated to better understand the affects of pests and diseases on agricultural systems due to climate change. It is widely reported that increasing CO_2 concentrations will increase crop biomass (Ainsworth and Long, 2005), but the impact of altered climatic conditions (e.g. extreme weather events such as cyclones, floods and prolonged droughts) and the potential impacts of plant pest and diseases, which currently is poorly understood, is likely to minimise or reverse any benefits from the CO_2 fertilisation effect (Chakraborty and Newton, 2011). Water is a key limiting factor for plant growth. There is no overall trend in the amount rainfall will change as a result of climate change, however there is clear evidence that rain distribution patterns are changing in intensity and seasonally (Barnett et al. 2006).

It is likely the four small South Pacific countries will need to adapt to one or several significant climatic factors such as rising sea water levels, more intense cyclones and associated storm surges, changing rainfall patterns and in some countries (i.e. Kiribati) more prolonged droughts.

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4.0 Conclusions

4.1 Objectives of the project

1. To identify the critical impacts of climate change on food security and biosecurity in the unique agricultural systems of the four participating countries (Tonga, Vanuatu, Kiribati and Tuvalu) by undertaking a questionnaire and survey.
2. To engage with agricultural leaders and scientists from the participating countries and invited experts from relevant organisations at a workshop, to prioritise food security/biosecurity risks and identify strategies to prepare for or mitigate impacts, and frame a biosecurity policy to protect agriculture in these countries.
3. To determine investment, research and training opportunities for regional scientists (FAO, SPC, ACIAR, Australian CRC for National Plant Biosecurity (CRCNPB), etc.).
4. To provide documentation of outcomes for policy and strategy development, report to APN, preliminary training and research concepts and data for investors (FAO, etc.).
5. To link to country participants to regional biosecurity expertise (Australian and NZ biosecurity agencies, CRCNPB etc), to identify opportunities to strengthen regional biosecurity.
6. If possible, data collected will be used to prepare a scientific publication.

4.2 Discussion

The impacts of climate change on the four collaborating countries varied from the short term effects of weather events such as cyclones to the long term effects of salinity on crop production areas. Although the impacts varied from country to country, there was a general sense of an inability to prepare for or respond to many of the impacts of climate change being experienced or expected in the future. Lack of human capacity, infrastructure, small economies and geographical isolation make these issues particularly challenging.

The impacts of climate change on food security generally related to loss of crop germplasm, either due to weather events such as cyclones or drought or due to the long term and increasing problems of salinity. These problems are much greater in the small atoll countries of Kiribati and Tuvalu which have unique food crops such as giant swamp taro and pandanus. Giant swamp taro is grown in deep pits which are dug to the level of the water table. Production is being severely impacted by ground water salinity due to rising seawater level. Panadanus and breadfruit trees in Kiribati and Tuvalu have died in recent years due to a prolonged drought. Breadfruit trees take up to seven years to fruit, so this loss has a serious impact on food security.

SPC operates the Centre for Pacific Crops and Trees (CePaCT) and collects germplasm of all main food crops and maintains them in tissue culture in Fiji. The material is virus-indexed before being supplied to countries for multiplication and assessment. For crops such as the giant swamp taro, which is a staple in the atoll countries, the tissue culture multiplication process is slow as it is a monocot and the viruses of this crop are largely unknown and as such, CePaCT does not hold a significant collection of Giant Swamp Taro germplasm. The methods for screening germplasm for CC adaptation (salinity tolerance, drought tolerance, etc) have not yet been developed. After extreme drought and salt inundation problems, Tuvalu is under pressure to acquire and assess giant swamp taro as soon as possible and is considering direct importation of planting material from the Federated States of Micronesia (FSM). The pest and disease status of giant swamp taro in both Tuvalu and FSM is unknown making a PRA for assessing the risk of importation from FSM to Tuvalu ineffective. Education is needed on simple pre-emptive biosecurity measures that would reduce the risk of direct country to country germplasm transfers. For example, in this instance, Tuvalu should assess the disease status of plants in FSM, review anecdotal evidence of previous pest and disease occurrences, identify a nursery site for in country evaluation of FSM germplasm in Tuvalu that is restricted to one island and maintain accurate records of sources of material for future reference in the event of a pest or disease outbreak, etc.

There is quarantine legislation (Acts) in all four countries. In Kiribati and Tuvalu, new biosecurity bills have been prepared but not yet passed by parliament. The ability to enact the requirements under this legislation is limited due to a lack of human resources and reliable information sources. The pest list databases for each country are incomplete and are not regularly updated and this prevents good decision making. The Pest Risk Assessments (PRAs) cannot be effectively conducted without good baseline country data for both the exporting and importing countries. There is also a lack of skills within countries to undertake these assessments (PRAs) and thus heavily reliant on SPC. If risk assessments were conducted in country, the lack of available data would become obvious and perhaps something would be done about it. However, due to the "outsourcing" of these activities to SPC, the importance of the country's pest and disease status is lost. It is also difficult for countries to make their own decisions about the risks around importing food and planting material when the PRA is done by SPC.

All collaborating countries have inadequate resources for plant pest and disease diagnostics, particularly for new pests and diseases in imported material or cargo (quarantine) and exotic pest and disease incursions (biosecurity). This is due not only to the small number of people working in crop protection, the level of their training, but also to the lack of laboratories and equipment and small operating budgets. In some countries there is some capability in diagnosing pests and fungal diseases but no capability to diagnose viruses and pathogens particularly important in vegetatively propagated crops such as rootcrops. There is limited in-country ability to undertake regular pest and disease surveys. As such, these are usually undertaken jointly with the SPC Crop Protection Service. The focus is usually on identifying unknown (or unrecognised) pests and disease and only a small number of samples can be submitted for diagnoses (sent to a third party via SPC). There are no country records of the samples collected and their pest/disease status, which is usually the basis for providing pest and disease management advice to farmers. The focus seems to be more on adding new pests and diseases to the regional and country pest list databases which are directed more towards trade rather than on crop protection. Assistance in diagnosing pests and diseases is provided by SPC and Pestnet. The starting point for both these services is usually sending of images for diagnosis, followed by provision of advice on what to do by the service provider. If specimens are needed for diagnosis, they are normally sent through SPC to a third party (CABI, England; CSIRO, Australia; MAF Biosecurity NZ, etc). Following a request for assistance from SPC, samples are collected then SPC provide the necessary paperwork and pay for the diagnosis. These diagnoses may take up to eight weeks or even months in some cases. Good diagnostic capability underpins the regulatory decision making and biosecurity risk mitigation and the loss of this capability in the four countries interviewed in this project needs to be addressed.

Some nodes of a regional diagnostic network exist such as Pestnet, SPC Plant Protection Service and SPC Pacific pest list Database and country pest list databases. However, there is limited diagnostic capacity in these organisations. The SPC databases are lacking information for the small atoll countries and are not always up to date. Pestnet provides an excellent service identifying pests and diseases mostly from images and descriptions. Dr Grahame Jackson, Moderator of Pestnet, states that most of the pest and diseases that come for diagnosis are well known in the region (although, rarely, new ones do occur), but there are: a) new approaches to control and b) a need for a constant reminder about what to do. Pestnet produces fact sheets on the management of pests and diseases which are available on their website (http://www.pestnet.org/) SPC Crop Protection Service maintain the Pacific pest list database and the country pest list databases which are subsidiaries of the main database. SPC also adds to the pest list any survey information and pest and disease specimen identifications. There is no capacity in countries for large scale diagnostics to be undertaken or for payment of a third party to undertake them. There is limited ability to capture survey and diagnostic sample data electronically (in a database) to build up a picture of incidence of

pests and diseases over time. This baseline data is needed to enable overlay of climate/weather data to interpret changes in pest and disease incidence in relation to climate change.

There is no formal linkage between the Pacific countries and the quarantine/ biosecurity/ plant diagnostics services in Australia. MAF Biosecurity NZ on the other hand has linkages with a number of Pacific countries, focused on improving the diagnostic skills of quarantine officers. There is considerable interest in Australia in developing a regional biosecurity network. This includes Australian initiatives such as PaDIL, the CRCNPB Remote Microscopy Project, the new National Plant Diagnostics Network being developed by SPHDS, ABIN, etc, as well as existing regional services.

As Grahame Jackson stated while discussing regional plant biosecurity issues in the South Pacific: "We also need to ensure that (Pacific) countries know what is happening in Pacific rim countries and likely to come their way. I don't think that countries monitor this. One that's obvious is the increase of troops to Guam. We know from years of experience what that is likely to mean in terms of new pests and disease introductions. The Pacific has far more to fear from countries around than vice versa!"

4.3 Conclusions

1. Impacts of climate change on food security and biosecurity are evident in the collaborating countries, with impacts greatest in the atoll countries, Kiribati and Tuvalu.
2. Countries are unable to deal with these impacts without assistance from the international community.
3. The country reports prepared will be used by the senior agricultural administrators to facilitate biosecurity discussion and assist in development of biosecurity policy and frameworks.
4. There is a need to develop a regional biosecurity/ diagnostic network to support Pacific countries and their regional organizations.
5. There is an urgent need to identify germplasm of unique atoll crops with adaptation to salinity and drought.
6. Future collaborations are supported by all parties and are actively being developed with a focus on low-cost sustainable initiatives and regional co-operation.

5.0 Future Directions

5.1 Potential for further work

Improved diagnostic services, access to expertise and information and training opportunities in plant biosecurity were regularly suggested by country participants as strategies to improve capacity and capability around biosecurity and food security in Pacific countries. The lack of sustainability of many project initiatives after project funding is finished was discussed at the project workshop and has resulted in strategies developed below for future work that are based around low-cost options, some delivered via the internet.

Low cost sustainable strategies for future work, based on country priorities, are as follows:
1. Initiate the development of informal or formal biosecurity networks, incorporating current nodes, and addressing country and regional scientific and political agendas.

2. Development of an internet-based diagnostics capability using remote microscopy (E.g. CRNPB Remote Microscopy project) that is linked with existing pest and disease databases (E.g. SPC regional and country pest lists) and internet diagnostic enquiry services (E.g. Pestnet, PaDIL, etc).

3. Introduction of GPS/Database survey data collection methods to facilitate collection and maintenance of pest and disease records to support surveys and surveillance activities.

4. Training in low-cost simple diagnostic assays in-country, including tissue blot immunoassay (TBIA) for virus identification and fixing of virus or DNA to membranes (nitrocellulose, FTA cards) for posting to a laboratory for diagnosis.

5. Provision of on-line training (internet) including Post Graduate Certificate, Diploma, Masters Degree in Biosecurity developed by CRCNPB and offered through Australian Universities.

6. Biosecurity training, particularly in the area of pest risk analyses, to enable in-country assessment of risks in transfer of germplasm.

5.2 Other priorities

1. Food security- germplasm adapted to climate change conditions is particularly important/urgent for the unique food crops of the atoll countries. The collection, screening and distribution of regional germplasm are conducted by CePaCT (SPC) and are beyond the scope of this project.

5.3 New project submissions

During our country workshops this year, it was found that biosecurity risks were perceived to have increased with extreme climate events and that countries were ill equipped to undertake rapid identification of new pests and diseases and lacked scientific networks for seeking information and advice to ensure rapid response to incursions. A concept proposal entitled "Tools for assessing the impacts of climate change on biosecurity: Diagnostic capacity building pilot project in Tonga" was developed at the Tonga workshop and submitted to APN through the CaPABLE program. The proposed activity is a pilot program in the Pacific, addressing the biosecurity training needs in Tonga, as the first stage of extending Australian and New Zealand expertise to develop a regional biosecurity network. The team were then invited to submit a full proposal for consideration (CBA2011-SP17ataufa).

In November 2011, the Australian federal government announced a $30 million investment to continue funding for the Cooperative Research Centre for National Plant Biosecurity for a further 6 years. This research program provides an opportunity to seek training programs in plant biosecurity and development of potential research linkages with Australian researchers on plant biosecurity issues. The impacts of climate change and extreme weather events on biosecurity are one of the main themes of the new CRCNPB. The CRCNPB (www.crcnpb.com.au) has also been very active in promoting and establishing a Remote Microscope Diagnostics (RMD) capability in south East asia and this regional biosecurity theme is likely to continue in the next phase of the CRCNPB research program.

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Appendices

Appendix 1 Project Workshops

Workshop 1: Kiribati and Vanuatu 9-23 May 2011 (Workshop report)

OBJECTIVES OF TRAVEL

To conduct two workshops in Kiribati and Vanuatu, respectively, as part of a one year regional biosecurity/food security project funded by the Asia Pacific Network for Global Change Research entitled "Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations", with the aim of identifying which climate change factors will affect in-country biosecurity/food security and what impact these might have on regional biosecurity in the Pacific, Australia and New Zealand.

SYNOPSIS OF KEY OUTCOME(S) ACHIEVED

Both Kiribati and Vanuatu identified development of a regional biosecurity network and access to remote diagnostics as their top priority in dealing with impacts of climate change on crop production, biosecurity and food security.

EXTENT TO WHICH OBJECTIVES WERE ACHIEVED

A questionnaire based on FAO procedures and accepted biosecurity risk assessment practice was developed by the project leadership team to determine impacts of climate change on food security and biosecurity in the collaborating countries. The country collaborators in each country arranged meetings, workshops and field trips with a range of people in the agricultural sector whose views we sought (senior administrators, quarantine officers, agricultural officers, farmers etc) and the questionnaire was completed by a number of these contacts. In both Kiribati and Vanuatu, the overwhelming response to the visit was that the top priority for collaboration was the development of a regional biosecurity network and access to remote diagnostics. This priority aligns with DPI-Victoria priorities and the goals of the National Plant Biosecurity Strategy (Plant Health Australia 2010). The tools required to develop a regional biosecurity network have been developed by the Australian PaDIL project funded through the CRC National Plant Biosecurity and our project will facilitate the roll out of these tools to the Pacific region.

Preliminary analysis of the country data was undertaken during the visit, risks identified, and discussions held with senior collaborators to assist in the planning for a regional workshop in October aimed at developing strategies and policies to manage climate change impacts.

TRIP DETAILS AND KEY OBSERVATIONS

In Kiribati and Vanuatu, meetings were held with the following key senior administrators and agricultural officers as well as visits to agricultural businesses and farms:

Names	Position/Occupation
KIRIBATI	
To Murdoch	Deputy Secretary, Ministry of Environment, Lands, Agriculture and Development
Kaateti Toto	Senior Assistant Secretary, Agriculture Department
Betarim Rimon	Secretary, Office of the President
Rui Tabutoa	Assistant Secretary, Environment Department
Kinaai Kairo	Director of Agriculture
Tianeti Beenna	Deputy Director of Agriculture and Director of Research

Tearo Otiuea	Principal Agricultural Officer Quarantine, Agriculture Department
Ieete Timea	Acting Head Crop Investigation Improvement section
Taouea Titaake	Environment Impact Assessment Officer, Environment Department
Ribeta Abeta	Climate Change Planning Officer, Environment Department
Nakabuta Teuriaria	Farmer and Freelance Agricultural Consultant
Etera Teangana	Farmer and former Speaker of Parliament
VANUATU	
James Wasi	Director of Research and Extension, Department of Agriculture, Research and Development (DARD)
Ruben Bakeo Markward	Director, DARD
Marie Melteras	Director, Vanuatu Agriculture Research and Training Centre (VARTC)
Bai George	Head of Quarantine, DARD
Francis Quarani	Quarantine Officer, DARD
Francois Japiot	Extension Officer, DARD
Dr Vincent Lebot	Senior Scientist, EU World Aroid Diversity program
Antoine Ravo.	Provincial Agriculture Officer for Shefa Province, DARD
Peter Iesul	Farming Systems Officer, DARD
Peter Kaoh	Extension Officer with Vanuatu Farm Support Association
Oneal Dalesa	Senior Farming Systems Officer Santo Island, DARD
Charles Rogers	General Manager , Vanuatu Farm Support Association
Jim Batty	Managing Director, South Pacific Sandalwood Limited

ITINERARY:

Date	Travel and Meeting Activities	Day #
Mon. 9 May 2011	Depart from Melb (9.30 am) to Nadi, Fiji (4.30 pm). Meet Dr Taufatofua, Agricultural Policy Scientist and leader of Pacific collaborators.	1
Tues. 10 May 2011	Depart from Nadi (12.10 pm) to Tarawa, Kiribati (3.10 pm) Meet Mr Tianeti Beenna, Director of Research, Ministry of Environment, Land, Agriculture and Development, Kiribati	2
Wed. 11 May 2011	Day 1 Workshop Meeting with collaborator, Mr Tianeti Beenna, Director of Research, Ministry of Environment, Land, Agriculture and Development, Kiribati, and senior administrators. Discussions on country capability/capacity, policy framework, management of previous natural disasters, emergency response plans, management of incursions (case studies).	3
Thur. 12 May 2011	Day 2 Workshop with Senior Quarantine Administration (on quarantine policy, risk assessments following disasters,	4

	international transfer of germplasm and food) and quarantine officers (on quarantine operations, access to diagnostic services, management of pest incursions, border quarantine etc.)	
Fri. 13 May 2011	Day 3 Workshop with Dept, of Agriculture staff- interviews and completion of questionnaire by staff, discussion of issues in questionnaire.	5
Sat. 14 May 2011	Day 4 Workshop Preliminary analysis of data including written questionnaires from staff on outer islands. Discusions on data with Mr Wasi and senior staff.	6
Sun. 15 May 2011	Further analysis of data, formulation of follow-up questions, data needed.	7
Mon. 16 May 2011	Depart from Kirribati (8.00 am) to Nadi (11.05 am).	8
Tues. 17 May 2011	Depart Nadi (8.30 am) to Port Vila, Vanuatu (9.10 am). Day 1 Workshop Meeting with collaborator, Mr James Wasi, Director of Extension, Department of Agriculture, Research and Development, Ministry of Agriculture, Vanuatu and senior administrators. Discussions on country capability/capacity, policy framework, management of previous natural disasters, emergency response plans, management of incursions (case studies).	9
Wed. 18 May 2011	Day 2 Workshop with Senior Quarantine Administration (on quarantine policy, risk assessments following disasters, international transfer of germplasm and food) and quarantine officers (on quarantine operations, access to diagnostic services, management of pest incursions, border quarantine etc.)	10
Thur. 19 May 2011	Day 3 Workshop with Dept, of Agriculture staff- interviews and completion of questionnaire by staff, discussion of issues in questionnaire.	11
Fri. 20 May 2011	Day 4 Workshop Preliminary analysis of data including written questionnaires from staff on outer islands. Discussions on data with Mr Wasi and senior staff.	12
Sat. 21 May 2011	Day 5 Further analysis of data, formulation of follow-up questions, data needed.	13
Sun. 22 May 2011	Flexible- currently no schedule (Sunday)	14
Mon. 23 May 2011	Depart from Port Vila (12 noon) to Melb (1.35 pm).	15

KEY OBSERVATIONS WERE AS FOLLOWS:

The number of trained staff and budgets in the Agriculture Departments in Kiribati and Vanuatu are small and staff have very limited access to international scientists and networks. Although Kiribati has much greater limitations than Vanuatu, which has an expanding economy, the responses we received to the project were the same in both countries. The need for international collaboration to rapidly identify new pests and diseases in shipping containers (quarantine import) and in the field (biosecurity incursions) was the top priority. In Kiribati, the fragile nature of the atolls, where the only fresh water is held in a lens below the land surface, has meant that agricultural pesticides and fertilizers can not be used at all. This makes responses to pest and disease incursions difficult and rapid response provides the only chance of eradication.

The lack of capacity to respond to climate change threats in the Pacific has been identified previously and linkages with Australia and New Zealand are needed to enable these countries to respond to such threats. The linking of Pacific scientists to Australian expertise and the use of remote microscopy, images and diagnostics networks for identifying new pest and disease threats is also a new approach which can provide Australia with an early warning system of potential incursions of

exotic pests and pathogens which historically have been found to “hop” across the Pacific to Australia and New Zealand. There a number of pests present in the Pacific islands which are considered a major threat to Australia, such as one of the species of giant snail which occurs in Vanuatu. On this trip, both Kiribati and Vanuatu provided lists of the exotic pests and diseases which are of most threat to their crop production. A number of these are endemic to Australia, such as the Queensland fruit fly and banana bunchy top virus, and there is concern about their potential movement to the Pacific islands. Therefore, the development of a regional biosecurity network was seen as beneficial to all countries, with the added benefit of developing eradication or control strategies in countries where pests occur and using this information when an incursion occurs in a new country.

ACTION PLAN

A second trip is planned to the other countries collaborating on this project, Tonga and Tuvalu, and it will involve collecting information on impacts of climate change on crop food security and biosecurity in the same manner as that collected from Kiribati and Vanuatu. The prioritization of the development of a regional biosecurity network by Kiribati and Vanuatu collaborators has enabled us to develop some training modules on biosecurity networking, remote microscopy and diagnostics, which will be delivered during the Tonga/Tuvalu trip to determine the level of interest and competencies of scientists in these countries.

A preliminary analysis of data from all four countries will be conducted to identify climate change risks and determine country priorities to deal with these impacts, which will inform the planning of a regional workshop in Fiji in October that aims to develop strategies and policies to manage climate change impacts.

Workshop 2: Tonga and Tuvalu 24 July- 11 August 2011 (Workshop report)

OBJECTIVES OF TRAVEL

To conduct workshops in Tonga and Tuvalu, respectively, as part of a one year regional biosecurity/food security project funded by the Asia Pacific Network for Global Change Research (APN) entitled "Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations", with the aim of identifying which climate change factors will affect in-country biosecurity/food security and what impact these might have on regional biosecurity in the Pacific, Australia and New Zealand.

SYNOPSIS OF KEY OUTCOME(S) ACHIEVED

Both Tonga and Tuvalu identified development of a regional biosecurity network, access to training in simple diagnostic tools and use of remote diagnostics (Eg. microscopy) as their top priorities in dealing with impacts of climate change on crop production, biosecurity and food security. The information was used to plan the final project workshop in November and to develop and submit a one year training project to APN.

EXTENT TO WHICH OBJECTIVES WERE ACHIEVED

A questionnaire based on FAO procedures and accepted biosecurity risk assessment practice was developed by the project leadership team to determine impacts of climate change on food security and biosecurity in the collaborating countries. The country collaborators in each country arranged meetings, workshops and field trips with a range of people in the agricultural sector whose views we sought (senior administrators, quarantine officers, agricultural officers, farmers etc) and the questionnaire was completed by a number of these contacts. In both Tonga and Tuvalu, the overwhelming response to the visit was that the top priority for collaboration was the development of a regional biosecurity network and access to remote diagnostics and training in the use of simple diagnostic tools. This priority aligns with DPI- Victoria priorities and the goals of the National Plant Biosecurity Strategy (Plant Health Australia 2010).

The tools required to develop a regional biosecurity network are available and include remote microscopy, image library and other tools developed by the Australian PaDIL project funded through the CRC National Plant Biosecurity and biosecurity/quarantine/diagnostic skills in DPI. Our project will facilitate the roll out of some these tools to the Pacific region.

Preliminary analysis of the country data was undertaken during the visit, risks identified, and discussions held with senior collaborators to assist in the planning for a regional workshop in October aimed at developing strategies and policies to manage climate change impacts.

TRIP DETAILS AND KEY OBSERVATIONS

In Tonga, meetings/workshops were held with the following key MAFFF senior staff, Agricultural Officers, farmers and Secretariat for the Pacific Community (SPC) pathologist and entomologist:

Names	Position/Occupation
TONGA	
Sione Foliaki	Head of Research MAFFF
Luseane Taufa	Senior Plant Pathologist MAFFF
Kamilo 'Ali	FAO NPC-FSSLP
Salesi Kaitu'u	Extension Officer MAFFF
Petelo 'Anitoni	Technical Officer (Agronomy) MAFFF
Siutoni Tupou	Entomologist MAFFF
Malina Siale	Agricultural Officer (Entomology) MAFFF
Minoru Nishi	Commercial Farmer/Exporter
Takaniko Ruabete	Pathologist/Nematologist SPC Suva, Fiji

Fereti Atu	Entomologist SPC Suva, Fiji
Dr Viliami Manu	Acting CEO MAFFF
Taniela Hoponoa	Head of Quarantine MAFFF
Losaline Ma'asi	Head of Extension MAFFF
Siale 'Ilolahia	Project Officer, Tonga Civil Society
Kalati Hafoka	FAO Projects Officer
Manaia Halafihi	OIC MAFFF Vava'u
Taniela Foliaki	Extension Officer MAFFF Vava'u
Tevita Sinipata	Market Manager Vava'u

In Tuvalu, meetings/workshops were held with the following Department of Agriculture, FAO,and NGO staff:

Names	Position/Occupation
TUVALU	
Itaia Lausaveve	Director of Agriculture
Sam Panapa	Head of Quarantine
Akinesi Sianoa	Senior Agricultural Extension and Information Officer
Faavae Lutelu	Quarantine Officer
Iosia Siose	Extension Officer
Peleti Pole	Livestock Officer
Timoteo Panapa	Agricultural Officer
Fialua Mouise	Extension (FAO Banana Project)
Tavau Teii	National Programme Coordinator FAO Food Security and Sustainable Livelihoods Programme (NPC-FSSLP)
Evolini Mami	Counterpart – Taiwan Technical Mission Vegetable Program
Yeong-Lang Yang	Team Leader - Taiwan Technical Mission
Annie Homasi	Manager Tuvalu Association of NGOs (TANGO)

ITINERARY:

Date	Travel and Meeting Activities	Day #
Sun. 24 July 2011	Depart from Melb (2325).	1
Mon. 25 July 2011	Arrive Nadi 0605. Depart Nadi (1140) to Tonga (arrive 1545). Meet Dr Taufatofua, Agricultural Policy Scientist and leader of Pacific collaborators.	2
Tues. 26 July 2011	Day 1 Meetings with MAFFF senior administrators. Discussions on country capability/capacity, policy framework, management of previous natural disasters, emergency response plans, management of incursions (case studies).	3
Wed. 27 July 2011	Day 2 Travel to Vava'u, meet Country Collaborator, Mrs Lusaene Taufa, MAFFF regional staff and Secretariat for the Pacific Community (SPC) pathologist and entomologist and participate in regional pest and disease survey.	4
Thur. 28 July 2011	Day 3 Workshop with MAFFF and SPC staff- interviews and completion of questionnaire by staff, discussion of issues in questionnaire and assessment of biosecurity networking and	5

	diagnostic training interest by staff.	
Fri. 29 July 2011	Day 4 Return to Tongatapu. Introductory Biosecurity and Diagnostics workshop.	6
Sat. 30 July 2011	Collection of questionnaires. Complete APN project proposal and submit to APN.	7
Sun. 31 July 2011	Preliminary analysis of data including written questionnaires from staff on outer islands.	8
Mon. 1 August 2011	Discussions on data with Ms Taufa and senior staff. Further analysis of data, formulation of follow-up questions, data needed and collection of questionnaires. Depart Tonga (1630) to Suva (arrive 1715).	9
Tues. 2 August 2011	Depart Suva 0800 to Tuvalu (arrive 1140). Meet with collaborator, Mrs Akinesi Sianoa, Senior Agricultural Extension and Information Officer and Mr Sam Panapas, Head of Biosecurity and Quarantine and senior administrators. Discussions on country capability/capacity, policy framework, management of previous natural disasters, emergency response plans, management of incursions (case studies).	10
Wed. 3 August 2011	Day 2 Biosecurity and Diagnostics Workshop.	11
Thur. 4 August 2011	Day 3 Workshop with Dept, of Agriculture staff - interviews and completion of questionnaire by staff, discussion of issues in questionnaire. Visit to Taiwanese Technical Mission vegetable project.	12
Fri. 5 August 2011	Day 4 On request by the Prime Minister of Tuvalu, undertook island survey with the Head of Biosecurity and Quarantine to determine impacts of climate change and pests and disease on island trees.	13
Sat. 6 August 2011	Field trip – impacts of climate change on small atoll vegetation and agriculture.	14
Sun. 7 August 2011	Preliminary analysis of data including written questionnaires from staff on outer islands.	15
Mon. August 2011	Planning of October Fiji workshop programme Further analysis of data, formulation of follow-up questions, data needed, collection of questionnaires.	16
Tues. 9 August 2011	Discussions on data with Mr Itaia Lausaveve, Director of Agriculture. Depart Tuvalu (1225) to Nadi (arrive 1600).	17
Wed.10 August 2011	Make bookings and arrangements for November workshop in Nadi.	18
Thur. 11 August 2011	Depart Nadi (0900) to Melb (arrive 1535).	19

KEY OBSERVATIONS WERE AS FOLLOWS:

Tonga has well trained pathologists and entomologists but an extremely small operating budget in the Research Division of MAFFF and although there is a functional pathology laboratory, staff have little access to international training and networking. Staff were extremely enthusiastic about opportunities for training and access to overseas expertise. In Tuvalu, there are no pathology or entomology laboratories although there are quarantine and extension staff who require these services. The responses we received to the project were the same in both Tonga and Tuvalu. The need for international collaboration to rapidly identify new pests and diseases in shipping containers (quarantine import) and in the field (biosecurity incursions) was the top priority. In both countries there was interest in pathology/quarantine staff receiving training in the tissue blot immunoassay (TBIA) technique to enable simple plant virus diagnostics to be carried out within the country. Simple

hand-held digital microscopes with image capture were demonstrated in both countries during the workshops and there was great interest in purchasing these and using them for assisting in the diagnosis of fungal and insect pathogens.

The lack of capacity to respond to climate change threats in the Pacific has been identified previously and linkages with Australia and New Zealand are needed to enable these countries to respond to such threats. The linking of Pacific scientists to Australian expertise and the use of remote microscopy, images and diagnostics networks for identifying new pest and disease threats is also a new approach which can provide Australia with an early warning system of potential incursions of exotic pests and pathogens which historically have been found to "hop" across the Pacific to Australia and New Zealand. Tonga and Tuvalu provided lists of the exotic pests and diseases which are of most threat to their crop production. A number of these are endemic to Australia, such as the Queensland fruit fly and there is concern about their potential movement to the Pacific islands. Therefore, the development of a regional biosecurity network was seen as beneficial to all countries, with the added benefit of developing eradication or control strategies in countries where pests occur and using this information when an incursion occurs in a new country. Currently most exotic pests and pathogens are sent to SPC in Fiji and then sent by them to experts around the world for identification. SPC also undertake regional pest and disease surveys and manage the South Pacific pest and disease database for the 22 member countries. Any discussions around the development of a regional diagnostic/biosecurity network must include SPC.

ACTION PLAN

Final analysis of data from all four countries will be conducted to identify climate change risks and determine country priorities to deal with these impacts, which will inform the planning of a regional workshop in Fiji in November that aims to develop strategies and policies to manage climate change impacts.

As the two key observations to date are interest in access to a range of pest and disease diagnostic tools and the potential development of a regional biosecurity network, advice from key experts will be sought and possibly invitations extended to attend the Fiji workshop.

Workshop 3 Melbourne 31 October- 4 November 2011

Melbourne Workshop Program
Wednesday – Friday 2-4 November 2011
DPI- Victoria, Knoxfield (Syndicate rooms 1 and 2)

Attendees:
Dr Angela Freeman (Australia, Project leader)
Dr Pita Taufatofua (Tonga, Project Leadership Team)
Dr Brendan Rodoni (Australia, Project Leadership Team)
Ms Luseane Taufa (Tonga, Country collaborator)
Mr Tianeti Ioane (Kiribati, Country collaborator)
Mr Itaia Lausaveve (Tuvalu, Country collaborator)

Thursday Guest Speakers:
Dr Gary Kong (CRC for National Plant Biosecurity)
Dr Ken Walker (Museum Victoria)
Mr Shane King (Vic-DPI Quarantine Operations Manager)
Dr Mohammed Aftab (Vic-DPI Plant Virologist)
Dr Linda Zheng (Vic-DPI Molecular Virologist)

Friday Invitees:
Ms Jane Moran (CRCNPB Program Leader Biosecurity, Chairperson of the Sub-Committee for Plant Diagnostics Standards (SPHDS) of the Australian Plant Health Committee)
Dr Jo Luck (Principal Scientist Climate Change (Microbiology), Biosciences Research Division, Vic DPI)

Workshop Program
Day 1 (Wednesday 2/11/2011): Analysing data

9.00 AM Workshop opening (Drs Freeman and Taufatofua)
- Project introduction
- Goals
- Expected outcomes
- Regional Context
- Where to from here?

10.00 AM Morning Tea

10.30 AM Activity 1: Country questionnaires
Tonga country review and summary (Ms Luseane Taufa)

12.00 noon Lunch

1.00 PM Activity 1: Country questionnaires
Vanuatu country review and summary (Dr Pita Taufatofua)

2.45 PM Afternoon Tea

3.15 PM General discussion of key findings

5.00 PM Close

Day 2 (Thursday 3/11/2011): Remote Pest and Disease diagnostics

9.00 AM
Simple survey technologies and data capture in the field (GPS and database) demonstration (Mr Shane King)
Simple low cost, low technology virus diagnostics: Tissue blot immunoassay (TBIA) demonstration (Dr Mohammed Aftab)
Nucleic acid capture and storage using FTA cards demonstration Dr (Linda Zheng)

10.00 AM Morning Tea

10.30 AM Remote Microscopy Diagnostics presentation (Dr Gary Kong)

12.30 PM Lunch

1.30 PM Pest and Disease databases (PADIL) presentation (Dr Ken Walker)

3.00 PM Afternoon Tea

3.30 PM Activity 1: Country questionnaires
- Tuvalu country review and summary (Mr Itaia Lausaveve)
- Kiribati country review and summary (Mr Tianeti Beenna)

53.0 PM Close

Day 3 (Friday 4/11/2011): Future opportunities
Friday 9.00 AM – 5.00 PM

9.00 AM Summary of Days 1 and 2 (Group activity)
- Identify trends
- Identify gaps

10.00 AM Morning Tea

10.30 AM Biosecurity Networks – what is involved?

10.30 AM The Australian National Plant Diagnostic Network (Ms Jane Moran)

11.30 AM Opportunities for "value adding" to existing regional diagnostic networks in the South Pacific

12 noon Brainstorming session

1.00 PM - Lunch

1.30- 5.00 PM - Workshop Final Session;
- Final report – requirements for completion
- Training Opportunities
-where too from here/next steps

5.00 PM Workshop Close.

Appendix 2. Funding sources outside the APN: details of the contributions from the project leader's institution and from other collaborating countries and institutions (monetary and in-kind contributions).

DPI-Victoria
In Kind: Salaries: 10% FTE Dr Freeman ($19,000), Dr Rodoni ($19,000); 5% FTE Dr Luck ($9,500) Total $47,500. Overheads and administrative support: $47,500.

CRC for National Plant Biosecurity
In kind: Attendance at workshop Ms Jane Moran, Biosecurity Program Leader, Dr Gary Kong, Project Leader, Remote Microscopy Project ($1,000 expenses).

Museum of Victoria
In Kind: Attendance at workshop Dr Ken Walker, Project Leader, Pest and Disease Image Library (PaDIL) Project.

Collaborative countries (Tonga, Vanuatu, Kiribati, Tuvalu)
In Kind Salaries 10% FTE: Mrs Luseane Taufa, Mr James Wasi, Mr Tianeti Beenna, Mr Itaia Lausaveve: $40,000. Administrative support and overheads: $20,000.

Appendix 3. List of young scientists.

Young Scientist name/country	Role/Addresss
Tonga	
Kamilo 'Ali	FAO NPC-FSSLP, MAFFF, Tonga
Siutoni Tupou	Entomologist, MAFFF Tonga
Malina Siale	Agricultural Officer (Entomology), MAFFF Tonga
Tuvalu	
Evolini Mami	Counterpart – Taiwan Technical Mission Vegetable Program

Statement from the young scientists: All the young scientists were interested in developing stronger networks with overseas colleagues to assist them in dealing with impacts of climate change, but also more generally to enable them to develop their careers, collaborate outside their country and to learn new techniques. They were all interested in the opportunities the internet provides for remote collaboration and communication and the ability to use such techniques as remote microscopy.

Appendix 4. Glossary of terms

ACIAR Australian Centre for International Agricultural research
CePaCT Centre for Pacific Crops and Trees
CRCNPB Co-operative research Centre for National Plant Biosecurity
FAO Food and Agriculture Organization
PaDIL Pest and Disease Image Library
PRAs Pest Risk Assessments
SPC Secretariat of the Pacific Community
SPREP Pacific Regional Environment Program

Appendix 5. Questionnaire proforma and compiled Country Questionnaires.
A copy of the questionnaire proforma sent to participants is provided. The compiled questionnaires contain the actual responses of all the people who completed the written questionnaires. NB. These compiled questionnaires, along with interview responses, were used by the leadership team and country collaborators to produce the Consolidated Country Reports which contain a single statement for each question.

1. Questionnaire Proforma

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Introduction to the project:
This small one year project was developed to assist scientists in Tonga, Vanuatu, Kiribati and Tuvalu deal with the impacts of climate change on crop production. The aim is to determine what the priority issues are in each country and then explore possible solutions or methods for addressing these issues. The priorities will be identified through a questionnaire and country visits followed by a workshop. Linkages and networks will be developed and training and new project opportunities will be explored and developed. A summary of the project documentation is attached.

Questionnaire:
Following is a survey/questionnaire to identify the critical impacts of climate change (cc) on food security and biosecurity in the agricultural systems of four South Pacific countries (Tonga, Vanuatu, Kiribati and Tuvalu)

Our strategy:
The questionnaire is in 3 parts:
Part A: to be completed by the Country Collaborator prior to the Participants questionnaire.
Part A contains higher level questions relating to the country (statistics, capability, etc). The completed Part A country information will be supplied to the participants as background information, with their questionnaire.

Part B: to be completed by Country Collaborators/Biosecurity/ Policy Officials prior to the Participants questionnaire.
Part B contains questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event. The questions comprise 2 sections: Section1- Quarantine/Biosecurity Policy; Section 2- Quarantine/Biosecurity practice. The completed Part B information will be provided to the participants as background information, with their questionnaire.

Part C: To be completed by the country participants.
Part C contains questions relating to the experiences of the agricultural staff members selected by their Country Collaborator to participate in the survey (this should include the Country Collaborator, senior officials and science and extension staff). The questions are aimed at determining the key impacts of climate change on food crop security and

biosecurity in the participating country. The questions comprise 3 sections: Section1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

Planning/ time frame:

1. Draft questionnaire prepared by Project Leaders, Drs Taufatofua, Freeman and Rodoni. Mar 10 2011
2. Questionnaire sent to Country Collaborators. Mar 15 2011
3. The questionnaire may be answered by a number of procedures: Country Collaborator sitting with participants and assisting completion, questionnaire sent by Country Collaborator to participant, Project Leaders meet with Country Collaborator and selected participants and conduct interviews. Questionnaire returned to Dr Taufatofua. Mar 30 2011.
4. Preliminary analysis of the results will be undertaken in country to enable discussion with the Country Collaborators. Apr 30 2011.
5. Vanuatu and Kiribati country survey (Taufatofua, Freeman, Rodoni). May 10-24 2011.
6. Analysis. Jun 2011.
7. Tonga and Tuvalu country survey (Taufatofua, Freeman, Rodoni). Jul 7-22 2011.
8. Analysis Aug 2011.
9. Survey/questionnaire results then discussed by Dr Taufatofua with Country Collaborators to enable plans for Fiji meeting to be developed. Aug- Sep 2011.
10. Fiji workshop after identifying key country priorities. Oct 3-7

Part A: Country Collaborators:
Background information on the collaborating country

***Note*: Climate change (cc) for the purpose of this questionnaire is define by its related impacts such as – sea level rise, salt water intrusion, new pests and diseases, increase/decrease pest and diseases, shift pattern of and quantity of rainfall, changes in temperature, change in pattern and severity of extreme weather events etc.**

1. What human resources are available in your country to support the agriculture sector? Please update the table below :

(Insert respective revised country summary table – at end of this doc.)

2. How many farmers are there?
3. What is the average farm size?
4. What are the main farming systems? Add extra numbers if required.
    i. .
    ii. .
    iii. .
5. What are the main food crops in your country? (list in descending order of importance)
    ii. .
    iii. .
    iv. .
    v. .
    vi. .
    vii. .
6. Which of the major food crops have been affected by cc and how?

7. Are there special/reserve food crops eaten only during times of food shortages? Please list
    i. .
    ii. .
    iii. .

8. What is the agricultural science/extension capacity in your country? (number of staff/educational level). Fill table 2 below.

Table 2. Country capability: Human resources in Agriculture Sector

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production						
Crop Protection						
Extension						
Quarantine						
Policy						
Others						
Total						

Part B: Country Collaborators/Biosecurity/ Policy Officials:

Recovery of food crops and agricultural systems following a climatic event

Section 1:

Quarantine/biosecurity policy

1. With respect to food availability and crop production, are you aware of any contingency plans within your country to assist in recovery from an extreme climatic event? – Pls explain.

2. If there is a need to import **staple foods** such as root crops and fruits, is a risk assessment of the source country undertaken?

3. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods?

4. Do you have quarantine regulations around the importation of foods?

5. If so, are these regulations maintained during food emergencies?

6. If you had to import **planting material/germplasm** into your country, is a risk assessment of the source country undertaken?

7. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm??

8. Do you have quarantine regulations around the importation of planting material/germplasm?

9. If so, are these regulations maintained during disaster recovery periods?

10. Are there country specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster?

11. Do you have access to a back-up source of your local, preferred varieties of your staple crops? E.g. other islands in your country, regional germplasm centre, etc.

Section 2:

Quarantine/ biosecurity practice

1. Do you use the SPC regional pest and disease list?

2. Do you have a country pest and disease list?

3. If so, is the country pest and disease list available and used by extension staff?

4. What are the highest risk exotic pest and disease threats to the main food crops in your country?

5. Do you have sufficient resources/staff/regional networks to be able to identify a new/unknown pest or disease?

6. What do you do when you are unable to identify a pest or disease?

7. What quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years?

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?

Part C: Participants survey:

What are the key impacts of climate change on food crop security and biosecurity in your country?

Section 1: General information

Participant name:

Position held:

Main areas of responsibility/duties:

Address:

1. What are the major crops grown in your area? Please rank in order of importance below:

1. .
2. .
3. .
4. .
5. .
6. .

2. What are the major pests and diseases of these crops? Please rank in order of importance below:

1. .
2. .
3. .
4. .
5. .
6. .

3. Do you think the seriousness of any of these pests/diseases has increased due to changes in climate (e.g. rise in water table, changes in rainfall etc)? Please explain.

4. Have you seen any new pests/diseases arrive in your country in the last 5 years which have impacted on food crop production? Please explain; and what actions were taken (i.e. survey, controls, elimination, etc)

Name of Pests/Diseases	Actions taken				
	Survey	Control	Elimination	Ignore	Comments

Section 2: Experiences with crop production and climatic events

1. Have you experienced the effect of climatic factors (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in your area? **Yes/No** If yes please answer the more specific questions below

2. Have you had any experience with the impact of a cyclone on agricultural systems that affect food supply and crop production? **Yes/No**
   If yes, please provide details of the impacts.

3. Have you had any experience with the impact of a drought on agricultural systems that affect food supply and crop production? **Yes/No**
   If yes, please provide details.

4. Have you had any experience with the impact of flooding on agricultural systems that affect food supply and crop production? **Yes/No**
   If yes, please provide details.

5. Have you had any experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production? **Yes/No**
   If yes, please provide details.

6. Are there any other climatic events that you believe impact on food security in your country? **Yes/No**
   If yes, please provide details.

Section 3: Capacity building:

Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

(Yes, no, N/A- please elaborate on questions relevant to your job)

1. What sources of germplasm/planting material do you have access to?

2. Are you able to multiply germplasm?

3. Do you have adequate resources for diagnostics and recognition of new pests and diseases?

4. Do you have access to regional diagnostic expertise and remote diagnostic services via the internet?

5. Do you have adequate internet access?

6. Which regional CC projects do you have linkages to?

7. Do you have training needs to deal with CC? (crop production under changing climate, diagnostics, CC impact minimization,)

8. If you are involved in quarantine/biosecurity, would you benefit from networking/training opportunities with Australian/NZ biosecurity agencies? Pls explain.

Country summary to be revised and insert Part A, question 1.

Vanuatu - Country summary

Land Area (km^2): 12,189	Sea Area/EEZ (km^2): 680,000
Population (No.): 217,000 (2005)	Annual Growth (%): 2.6
Density (inhabitants/km2): 16 (2005 estimate)	Rural Population (% of total population): 76%
GDP (US$ million): 368.9 (2005)	GDP per capita (US$): 1,700 (2005)
GDP Real Growth (ave.1996-2006): 2.5 % per annum	Primary Sector GDP (% of total GDP): 14.7 % (2006)
Trade Balance –US$75 million (exports as % of imports): 14.8% (2007)	Food & Live Animals as % of total imports: 17.2% (2006)
Budget allocation agriculture (2007): VT 405 million (US$ 4 m) % of Total Budget 3.4 %	Human Development Index 0.674 (2008): position 120 out of 177 countries

Sources: FAO NMTPF 2009

Kiribati – Country summary

Land Area (km^2): 810	Sea Area/EEZ (million km^2): 3.6
Population (No.): 92,533 (2005 census)	Annual Growth (%): 2.5
Average Density (inhabitants/km^2):127	Rural Population (% of total population): 54
GDP (A$ million): 81.91 (2006) US$61.43	GDP per capita (A$): 870 (2006) US$653
GDP Real Growth (ave.2000-2006): 0.04% per annum	Primary Sector GDP (% of total GDP): 3.2% (2006)
Trade Balance – US$56,887,000 (Exports as % of imports) 9.9 % (2006)	Food & live Animals as a % of total imports 30.1 % (2005)
Budget Expenditure Agriculture & Fisheries(2006) A$ 1.83 m % of Total Budget Expenditure 2.3 %	Human Development Index N/A

Sources: FAO NMTPF 2009

Tuvalu - Country summary

Land Area (km^2): 26	Sea Area/EEZ (million km^2): 900,000
Population (No.): 9,561 (2002 census)	Annual Growth (%): 0.51 (1991-2002)
Average Density (inhabitants/km^2): 378	Rural (outer island) Population (% of total population): 58
GDP (A$ million): 27.49 (2002) US$18 million	GDP per capita (A$): 2,872 (2002) US$1,889
GDP Real Growth (ave.2003-2007): 2.6 % per annum	Primary Sector GDP (% of total GDP): 16.6 % (2002)
Trade Balance – US$11,071,006 (Exports as % of imports) 0.47 % (2005)	Food & live Animals as a % of total imports 25 % (2007)
Budget Expenditure Agriculture & Fisheries(2006) N/A	Human Development Index N/A

Sources: FAO NMTPF 2009

Tonga - Country summary

Land Area (km^2): 747	Sea Area/EEZ (km^2): 700,000
Population (No.): 101,134 (2006)	Annual Growth (percent): 0.4
Density (inhabitants/km2): 135	Rural Population (percent of total population): 57 % (2006)
GDP (US$ million): 178.504 (2004)	GDP per capita (US$): 1,781 (2004)
GDP Real Growth (ave. 1996-2006) : 2.5 % per annum	Primary Sector GDP (% of total GDP): 23.2 % (2004)
Trade Balance: -US$106,149,650 (exports as a % of imports): 5.6 % (2007)	Food as percent of total imports: 14 %
Budget allocation agriculture/forest/fisheries (2007): less than 2 %	Human Development Index (2004): 0.815 position 55 out of 177 countries

Sources: FAO NMTPF 2009

2. Tonga Compiled Questionnaire

Survey Questionnaire

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Introduction to the project:
This small one year project was developed to assist scientists in Tonga, Vanuatu, Kiribati and Tuvalu deal with the impacts of climate change on crop production. The aim is to determine what the priority issues are in each country and then explore possible solutions or methods for addressing these issues. The priorities will be identified through a questionnaire and country visits followed by a workshop. Linkages and networks will be developed and training and new project opportunities will be explored and developed. A summary of the project documentation is attached.

Questionnaire:
Following is a survey/questionnaire to identify the critical impacts of climate change (cc) on food security and biosecurity in the agricultural systems of four South Pacific countries (Tonga, Vanuatu, Kiribati and Tuvalu)

Our strategy:
The questionnaire is in 3 parts:
Part A: to be completed by the Country Collaborator prior to the Participants questionnaire.
Part A contains higher level questions relating to the country (statistics, capability, etc). The completed Part A country information will be supplied to the participants as background information, with their questionnaire.

Part B: to be completed by Country Collaborators, Biosecurity/quarantine and Policy Officials prior to the Participants questionnaire.
Part B contains questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event. The questions comprise 2 sections: Section1- Quarantine/Biosecurity Policy; Section 2- Quarantine/Biosecurity practice. The completed Part B information will be provided to the participants as background information, with their questionnaire (Part C).

Part C: To be completed by the country participants (To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.).
Part C contains questions relating to the experiences of the agricultural staff members selected by their Country Collaborator to participate in the survey (this should include the Country Collaborator, senior officials and science and extension staff). The questions are aimed at determining the key impacts of climate change on food crop security and biosecurity in the participating country. The questions comprise 3 sections: Section1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

General information: Survey Participants:

Participant name	Code	Position held	Main areas of responsibility/duties	Address	Email address
Kamilo Ali	KA	Senior Agri Officer (Extension)	Extension	P.O. Box 14, MAFFF, Nuk, Tonga	
Sione Foliali	SF	Deputy Director	Biosecurity, Export/Trade facilitation	MAFFF, Tonga	
Salesi Kaitu'u	SK				
Viliami Kami	VK	Principal Agriculture Officer	Entomology, Plant Protection, Plant Genetic Resources	Research Division, MAFFF, Tonga	maf-ento@kalianet.to
Tina Vao	TV	Technical Officer	Entomology,	Research Division, MAFFF, Tonga	
Malina Lolo	ML	Agriculture Officer	Entomology Section	Research Division, MAFFF, Tonga	m-siale@hotmail.com
Losaline Maasi	LM	Deputy Director – Head of Extension	Extension Services and Women in Development Section	MAFFF, Tonga	lmaasi@yahoo.com
Siutoni Tupou	ST	Agriculture Officer	Biosecurity, Export/Trade facilitation	P.O. Box 14, MAFFF, Nuk, Tonga	fruitfly@kalianet.to
Luseane Taufa	LT	Senior Psthologist	Plant Pathology	Research Division, MAFFF, Tonga	luseane04@yahoo.co.nz

Part A: To be answered by Country Collaborators:
Background information on the collaborating country

***Note*: Climate change (cc) for the purpose of this questionnaire is define by its related impacts such as – sea level rise, salt water intrusion, new pests and diseases, increase/decrease pest and diseases, shift pattern of and quantity of rainfall, changes in temperature, change in pattern and severity of extreme weather events etc.**

9. Summary background and resources available in your country to support the agriculture sector? Please update the table below :

Tonga - Country summary

Land Area (km^2): 747	Sea Area/EEZ (km^2): 700,000
Population (No.): 101,134 (2006)	Annual Growth (percent): 0.4
Density (inhabitants/km2): 135	Rural Population (percent of total population): 57 % (2006)
GDP (US$ million): 178.504 (2004)	GDP per capita (US$): 1,781 (2004)
GDP Real Growth (ave. 1996-2006) : 2.5 % per annum	Primary Sector GDP (% of total GDP): 23.2 % (2004)
Trade Balance: -US$106,149,650 (exports as a % of imports): 5.6 % (2007)	Food as percent of total imports: 14 %
Budget allocation agriculture/forest/fisheries (2007): less than 2 %	Human Development Index (2004): 0.815 position 55 out of 177 countries

Sources: FAO NMTPF 2009

10. How many farmers are there in your country?

Almost all Tongans who are dependant on farming are highly competent traditional farmers
9,539 household members 15 years old and over by sex - 96.5% male, 3.5% female
15,738 total households – 64.2% agriculturally active, 5.3% minor agricultural (agri census 2001 report)

11. What is the average farm size?

4 – 8 acres of which 6,447 households own tax allotment 2369 households rented out tax allotment to other households for farming purposes. (agri census 2001 report)

12. What are the main farming systems? Add extra numbers if required.

i. Small holders, 4-8 acres, traditional farmers, traditional subsistence;
ii. Shifting cultivation; commercial farming
iii. Subsistence farming – mixed cropping system mainly for family consumption
iv. Semi-commercial farming – mixed cropping system for family consumption and excess production are often sold at the domestic market
v. Commercial farming – ongoing supply of domestic market and larger scale production for export markets such as vanilla, kava, root crops and watermelon.

13. What are the main food crops in your country? (list in descending order of importance)

SF: i. Cassava, ii, Sweat Potato, iii. Taro (Colocasia and Xanthosoma) and Giant Taro, iv. Yams, v. Breadfruits.

SK: i. Yam, ii. Taro (Colocasia and Xanthosoma), iii. Cassava, iv. Sweet potato, v. banana, vi. Giant taro,

Lt –

i. yam
ii. *Colocasia esculenta*
iii. Sweet potato
iv. *Alocasia*
v. *Xanthosoma*
vi. Banana and plantain
vii. Breadfruit
viii. Cassava

14. Which of the major food crops have been affected by cc and how?

SF – All major food crops – due to changes in weather patterns

SK: Yam

LT - There is no adverse effect of climate change on major food crops. However, climate change is likely to have substantial and widespread impacts on areas around the coast. Among the most substantial damages would be losses of coastal infrastructure and coastal lands resulting from cyclones, or shoreline erosion. Climate change could also cause more intense cyclones and droughts, the failure of subsistence crops.

15. Are there special/reserve food crops eaten only during times of food shortages? Please list

SF– Not that I know of.

SK: i. Giant taro, ii. Teve (Dioescoria esculenta spp.).

LT –

i. Lotuma (wild yam at Niuatoputapu)
ii. Via (wild kape at Niuatoputapu)
iii. Palai (wild yam at ‘Eua)
iv. Some wild alocasia throughout Tonga
v. Wild green vegetables considered as underutilized indigenous greens.

16. What is the agricultural science/extension capacity in your country? (number of staff/educational level). Fill table 2 below.

Table 2. Country capability: Human resources in Agriculture Sector

Total MAFFF staff should be around 200+.

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	+50	+300	14	4	1	370+
Crop Research			3	2	1	6
Extension			20+			20

Quarantine	4			1		5
Policy						
Livestock						
Total	54+	300+	37+	7	2	400+

SK version

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production		12	2		1	15
Crop Research		12	3	1	1	17
Extension		13	3	1		17
Quarantine						
Policy						
Livestock						
Total		37	8	2	2	49

LT version

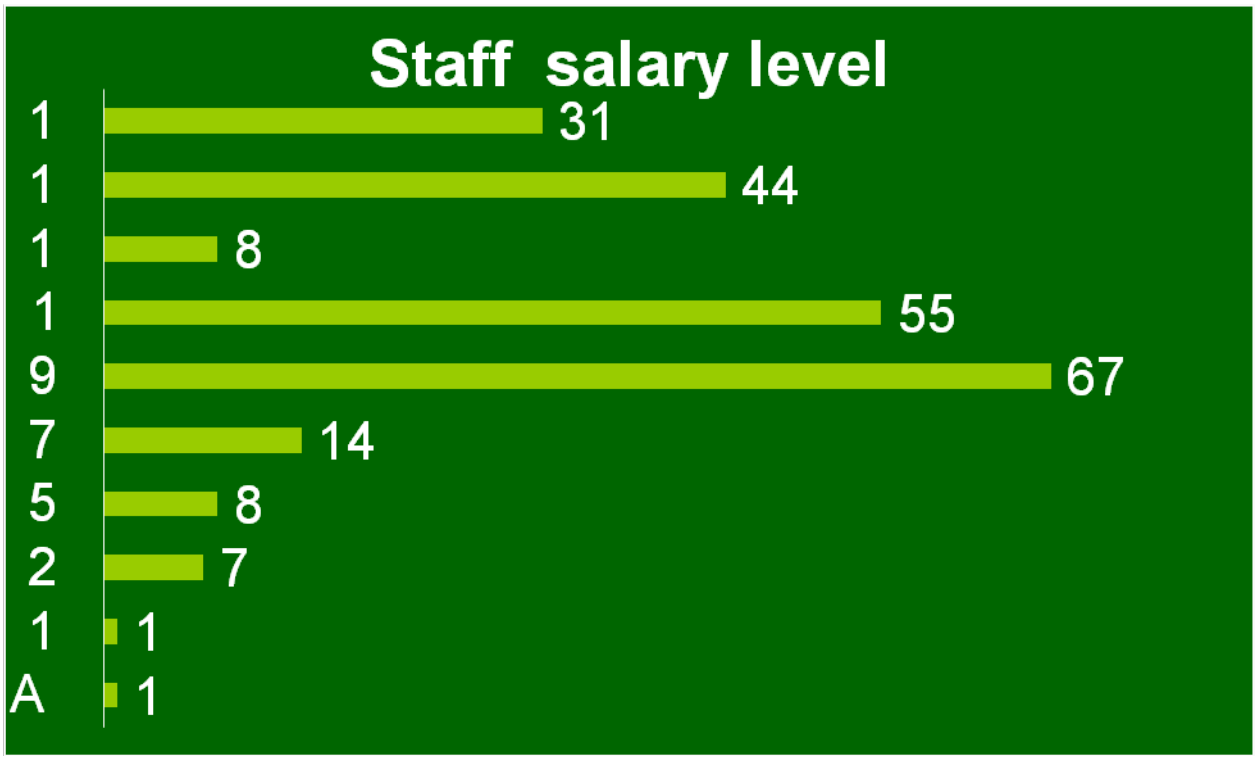
Table 2. Country capability: Human resources in Agriculture Sector

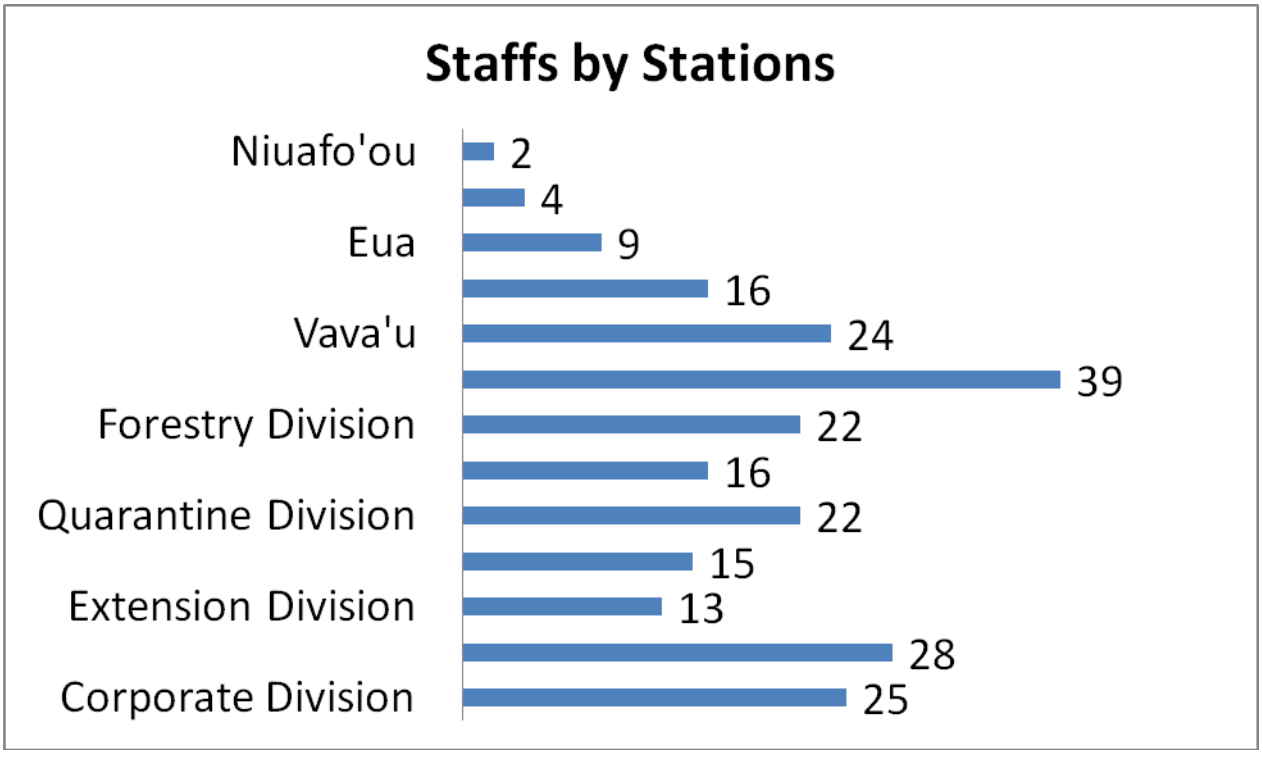
Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	6	10	1			17
Crop Protection		4	2		1	7
Extension		9	2	1		12
Quarantine	5	14	2			21
Policy	4	9	7	1	2	23
Food and agro-processing		2	1			3
Women development programs in the community	9	4		1		14
Forestry	12	11	4	1		28
Fisheries	22	14	6	4	1	47
Livestock	2	8	2	1		13
Others at the 4 outer islands	28	22	4	1		55
Total						**150**

Nb. Eighty five staff qualification are not recorded as they need confirmation.

Staff salary level and staff location give a more accurate record of MAFFF human resource with a total staff of

235.


Staff salary level
1
1
1
1
9
7
5
2
1
A
31
44
8
55
67
14
8
7
1
1


Staffs by Stations
Niuafo'ou
Eua
Vava'u
Forestry Division
Quarantine Division
Extension Division
Corporate Division
2
4
9
16
24
39
22
16
22
15
13
28
25

Part B: To be answered by Country Collaborators, Biosecurity/quarantine and Policy Officials:

Recovery of food crops and agricultural systems following a severe climatic event
Section 1:
Quarantine/biosecurity policy

1. With respect to food availability and crop production, are you aware of any contingency plans within your country to assist in recovery from an extreme climatic event? – Pls explain.

SF	As only part of the National Disaster Emergency plans under the ministry of Transport
SK	N/C
VK	National disaster committee
TV	Yes – National Disaster Committee
ML	Yes
LM	Yes – The National disaster Management Committee takes charge.
ST	Yes – MAFFF (i) annual crop surveys and (ii) regular domestic market surveys and projections
LT	MAFFF is monitoring and report on the annual food distribution and crop production through annual surveys and market analysis. The analysis projects the likely level of food production and the management plan for cropping areas are determined to assist with possible extreme climatic event particularly with prolong drought and seasonal cyclone.

2. If there is a need to import **staple foods** such as root crops and fruits, is a risk assessment of the source country undertaken?

SF	There is a need in case of an event, Non risk assessment done.
SK	Yes
VK	A risk assessment is mandatory
TV	Yes
ML	No
LM	Not really
ST	It is a must to do risk assessment of all agriculture produce even if it is a staple food, or introduced food crops
LT	It is a must to do risk assessment of all fresh agricultural produce even if it is a staple foods, or introduced food crops.

3. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods?

SF	Yes, New Zealand
SK	N/A
VK	Aust and NZ – preferred countries plus other countries that have bilateral quarantine agreement with Tonga
TV	Yes
ML	Yes
LM	No
LT	Not yet determined

4. Do you have quarantine regulations around the importation of foods?

SF	Yes, Plant Quarantine legislations (Act and Regulations)
SK	Yes
VK	Yes
TV	Yes
ML	Yes
LM	Yes – and also waiting to pass the National Food Bill by Parliament
ST	Yes – The Plant Quarantine Act, 1988 (Revised version)
LT	Yes, Plant Quarantine Act, year???

5. If so, are these regulations maintained during food emergencies?

SF	Yes
SK	Don't know, assume yes
VK	Yes, with possible exceptions if needed.
TV	Yes - sometimes
ML	Yes
LM	Food Bill – not implemented yet
ST	Yes – It is also in the Plant Quarantine Act 1988 (Revised version)
LT	Yes, it is also in the Plant Quarantine Act.

6. If you had to import **planting material/germplasm** into your country, is a risk assessment of the source country undertaken?

SF	Yes
SK	Yes
VK	Yes
TV	No
ML	No
LM	Yes, Quarantine division of MAFFF is well aware of places where not allowed to import from
ST	Yes – Risk assessment of the planting material must be taken prior to getting an import permit from NPPO and the Tonga Quarantine requirements stated on Import Permit must be met.
LT	Yes, risk assessment of the source country must be taken.

7. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm??

SF	Yes, especially source from country/free of freedom/ of production free sites
SK	Yes, SPC Germplasm
VK	This will depend on Risk Assessments. CEPACT, SPC is reliable due to efficient screening system against pests and diseases.
TV	Yes
ML	Yes
LM	Yes, this is known to Quarantine Division who provide import permit.
ST	Preferable from CePaCT, SPC but other countries may be permitted by taking a Pest Risk Analysis for the specific plant species.
LT	All countries are equally important in the light of biosecurity risks. Extra precaution measures are taken if the pests and diseases are not recorded in Tonga.

8. Do you have quarantine regulations around the importation of planting material/germplasm?

SF	Yes, Plant regulations 1995.
SK	Yes
VK	Yes
TV	Yes
ML	Yes
LM	Yes, it is available
ST	Yes, quarantine regulations have always been enforced
LT	Yes, quarantine regulations have always been enforced

9. If so, are these regulations maintained during disaster recovery periods?

SF	Yes, must be based on prior import risk analysis
SK	N/C
VK	Yes with exceptions based on discussion by appropriate authority
TV	Yes
ML	Yes
LM	Yes, they work within the policy to allow for the disaster period
LT	Regulations for disaster recovery are maintained at other government Ministry eg. Ministry of Environment.

10. Are there country specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster?

SF	Yes, such as importation of potato seeds – free areas of cyst nematodes.
SK	Yes
VK	Yes
TV	No
ML	No
LM	Yes
ST	Yes, especially countries and areas that have diseases and insect pests that are not yet present in Tonga.
LT	Yes, especially countries and areas that have diseases and insect pests that are not in Tonga

11. Do you have access to a back-up source of your local, preferred varieties of your staple crops? E.g. other islands in your country, regional germplasm centre, etc.

SF	Yes, SPC germplasm tissue culture facilities in Suva, Fiji
SK	No
VK	Yes – Have access to CEPACT facility in SPC, Fiji.
TV	Yes
ML	Yes
LM	This is not available locally, but we use the SPC Germplasm Centre to get back materials when there is a need.
ST	Yes, SPC-CePaCT has some of selected and favorable *colocasia* and *xanthosoma* cultivars.

	Tonga is in the process to ratify the International Treaty on Plant Genetic Resources for Agriculture and Food (PGRFA) which would give the advantage to benefit sharing of PGRFA to regional and international germplasm collections.
LT	SPC-CePaCT has some of selected and favorable *colocasia* and *xanthosoma* cultivars in their in-vitro germplasm collection. Tonga is in the process to ratify the International Treaty on Plant Genetic Resources for Agriculture and Food (PGRFA) which would give the advantage to access and benefit sharing of PGRFA to regional conventional collection and in-vitro SPC-CePaCT collection.

Section 2: Quarantine/ biosecurity practice

1. Do you use the SPC regional pest and disease list?

SF	Yes, Regional PLD is our vital tool - information
SK	Sometimes
VK	Yes
TV	Yes
ML	Yes
LM	Yes
ST	Yes, together with other countries official websites including CABI pest and disease database.
LT	Yes and it is the only pest and disease database use by Tonga

2. Do you have a country pest and disease list?

SF	Yes, include in the SPC RPLD
SK	Yes
VK	Yes – based on SPC list
TV	Yes
ML	Yes
LM	Yes
ST	Yes, with the collaboration of SPC database, whereby anthropods need updating.
LT	Yes, with the collaboration of SPC database.

3. If so, is the country pest and disease list available and used by extension staff?

SF	Yes, online thru SPC website – access by extension scientists always
SK	Yes
VK	Yes, indirectly
TV	Yes
ML	Yes
LM	Yes
ST	Yes, he Online Pest List ?Database on the SPC website.
LT	Yes, as it is the only available pest and disease list for use.

4. What are the highest risk exotic pest and disease threats to the main food crops in your country?

SF	Taro leaf blight, Taro beetle; Cassava blight
SK	Powdery and Downy mildew, anthracnose
VK	Powdery Mildew – Squash; Erwinia spp – Papaya; Silver leaf Whitefly – Range of crops; Viruses – Cucurbits
TV	Powdery mildew – squash
ML	N/C
LM	Giant African snails
ST	• Taro leaf blight *(phytophtora colocaisae)* • *Viral diseases of yam* • *Alomae and bobone virus* diseases on taro • Taro beetle • African snail • Fruitfly species that are not yet present in Tonga • *Huanglongbing citrus* disease • Bacterial diseases of banana • Papaya ring spot virus
LT	• Taro leaf blight *(phytophtora colocaisae)* • *Viral diseases of yam* • *Alomae and bobone virus* diseases on taro • Taro beetle • African snail • Fruitfly species that are not in Tonga • *Huanglongbing citrus* disease • Bacterial diseases of banana • Papaya ring spot virus

5. Do you have sufficient resources/staff/regional networks to be able to identify a new/unknown pest or disease?

SF	Yes – SPC , NZ plant pest diagnostic labs and experts
SK	Yes
VK	Yes – currently being trained
TV	No
ML	No
LM	Some but not sufficient
ST	Research Division of MAFFF has the diagnostic facility to identify new insect pest and disease incursion. However, confirmation on the new incursion should be confirmed by two other recognized institutions. Tonga has sufficient staff but need support on certain diagnostic resources in particular with virus diagnostic agents which are often expensive. The Remote Microscopy Diagnostic work with NZ Biosecurity and Australian Biosecurity needs to be implemented as soon as possible as we have the equipments in the laboratory already.
LT	Research Division of MAFFF has the diagnostic facility to identify new insect pest and disease incursion. However, confirmation on the new incursion should be confirmed by two other recognized institute. Tonga has sufficient staff but need support on certain diagnostic resources in particular with virus diagnostic agents which are often expensive.

6. What do you do when you are unable to identify a pest or disease?

SF	Contain, picture, report and seek expert advice on follow up actions
SK	Access to SPC database/PestNet, ask/seek advice of specialist personnel
VK	Access to Internet websites, pestNet forum, other forums
TV	Seek SPC help
ML	Library, internet, senior Officers
LM	Seek help from others such as PestNet, SPC and overseas colleagues.
ST	Consult other Plant Protection professions in the region and certain cases are posted in the PestNet if required broader dialogue on the identified pest and/or disease problem.
LT	Consult other Plant Protection professions in the region and certain cases are posted in the PestNet if required broader dialogue on the identified pest and/or disease problem.

7. What quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years?

SF	Introduction of giant mimosa sensitive weed into Vavau in 2008
SK	Not aware of
VK	Giant Mimosa – in Vava'u
TV	N/C
ML	N/C
LM	Giant African snails
ST	Nil
LT	*Erwinia papayae* on papaya

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?

SF	None, all interceptions were common pests such as aphids from New Zealand
SK	Thorny (Giant) giant weeds at Neiafu
VK	Giant Mimosa – in Vava'u
TV	N/C
ML	Rhinoceros beetles, Fruit flies
LM	1. Some weeds; 2. White fly
ST	(i) Silver Leaf White fly *(Bemisia argentifolii)* (ii) Erythrina gall wasp *(Quadrastichus erythrinae)* (iii) Papaya canker *(Erwinia spp.)*
LT	i. Spiralling White fly *(Aleurodecus disperses)* ii. Erythrina gall wasp *(quadrastichus erythrinae)* iii. *papaya canker (Erwinia papaya)*

Part C: Participants survey: To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.

What are the key impacts of climate change on food crop security and biosecurity in your country?

Section 1:

Part C: Participants survey: To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.

1. What are the major crops grown in your area? Please rank in order of importance below:

KA	1. Cassava, 2. Vegetables 3. Taro/Yam 4. Sweet Potato 5. Squash 6. Vanilla
SF	1. Yam, 2. Taro, Cassava, 4. Cucurbits (squash, watermelon), Coconuts, Vanilla
SK	1. Yam, 2. Taro (esculenta spp), 3. Sweet potato, 4. Cassava, 5. Giant Taro, 6. Banana
VK	1. Yam 2. Taro 3. Sweet Potato 4. Cassava 5. Aibika 6. Squash
TV	i. yam; ii.Taro; iii. Sweet potato; iv. Cassava ; v. Alocasia ; vi. watermelon
ML	i. yam; ii.Taro colocasia; iii. Sweet potato; iv. Cassava; v. watermelon; vi. Squash; vii. Vegetables and sweet corn
LM	1. Yam; 2. Taro; 3. Alocasia; 4. Cassava; 5. Sweet potato; 6. Banana.
ST	1.Yam 2. Sweet potato 3. Swamp taro 4. Cassava 5. Taro Tarua 6. Giant Taro
LT	****Luseanae has not completed this section

2. What are the major pests and diseases of these crops? Please rank in order of importance below:

KA	Yam – Anthracnose; Sweet Potato – Scab; Squash – Powdery mildew; Vegetables – insects (caterpillars, aphids, rose beetle), Bacterial wilt (Capsicum)
SF	i. Nematodes, ii. Fungal diseases, iii Powdery and downy mildews, iv. Rhino beetles and stick insects. V. Scale and mealey bugs, vi. Die-back of Vanilla
SK	1. Anthracnose; 2. Armyworms/cluster caterpillars; 3. Little leaves; 4. none; 5. Armyworms; 6. Bunchy top – Note answers are in line with crops listed in Q1.
VK	1.Anthracnose, rose beetle, yam scale – yam; 2. Taro hawkmoth, cluster caterpillar, Aphids – taro; 3. sweet potato weevil, - Sweet potato; 4. Rose beetle, leaf hopper – Aibika; 5. Powdery mildew, viruses, aphids - Squash
TV	1. Anthracnose; 2. Rots; 3. mites; 4. Powdery mildew; 5. Gummy stem blight
ML	1. Powdery mildew; 2. Anthracnose; 3. mites
LM	1. Weevil borer; 2. Sweet potato weevils; 3. nematodes; 4. fruit fly
ST	Yam – Anthracnose & rose beetle Sweet potato – sweet potato weevil Swamp taro – taro hawk moth Most root crops and vegetables – white flies

3. Do you think the seriousness of any of these pests/diseases has increased due to changes in climate (e.g. rise in water table, changes in rainfall etc)? Please explain.

KA	Tonga has not experienced a major pest outbreak related to causes from CC impacts, but it would probably happen in the near future.
SF	Yes, Changes in temperature, humidity and rainfall causes pest mutations to adjust to changes in habitat environments.
SK	Yes. High rainfall contribute very much to the high incidence of some pest and disease e.g. anthracnose.
VK	No
TV	Yes
ML	Yes
LM	Not really
ST	Yes for silver white fly, in terms of drought spell cause the flare up of outbreaks.

4. Have you seen any new pests/diseases arrive in your country in the last 5 years which have impacted on food crop production? Please explain; and what actions were taken (i.e. survey, controls, elimination, etc)

Table 3. New pests and diseases

Name Code	**Name of Pests/ Diseases**	**Actions taken**				
		Survey	**Control**	**Elimination**	**Ignore**	**Comments**
KA	No					
SF	No new introduction or incursions					
SK	N/C					
VK	N/C					
TV	N/C					
ML	N/C					
LM	N/C					
ST	Silver leaf whitefly	yes	Chemical & Biocontrol	no		Needs more training on IPM for successful pre-harvest control.
	Erythrina gall wasp	No	Nil	no		Needs survey, research & control
	Papaya canker (*erwinia*)	Delimiting survey schedule for end of Nov,2011	Nil	no		Incursion of *Erwinia* spp. recorded in August, 2009. No emergency response plan in place. It takes two years before a delimiting survey to be conducted.

Section 2: Experiences with crop production and climatic events

1. Have you experienced the effect of climatic factors (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in your area? **Yes/No** If yes please answer the more specific questions below

KA	Yes, cyclone and drought.
SF	Yes, more cyclones in the past years – causes excess damages to our major food crop production, causes delay in fruiting and maturity expectations.
SK	N/C
VK	Yes
TV	Yes, it causes low yield
ML	Yes, reduce production of crops nowadays.
LM	Yes, some of our major fruit trees like mango and local lychees, we hardly get any harvest and mostly no harvest at all.
ST	No

2. Have you had any experience with the impact of a cyclone on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details of the impacts.

KA	Yes. I was on the outer island of Vavai when Cyclone Waga occurred and food was short. Tongatapu supplied us with root tubers (taro) and also there was food aide from Nz and Australia.
SF	Yes – as above
SK	N/C
VK	All cyclones within 100 km of Kingdom – have caused destruction of agricultural crops
TV	NC
ML	N/C
LM	Destruction of food crops, loss of planting materials and food shortages
ST	N/C

3. Have you had any experience with the impact of a drought on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

KA	Yes, but not as serious as the impact of cyclone. Drought has a serious negative on vegetables, but root crops persist, so it is not as bad as a cyclone unless if it had happened for longer.
SF	Yes, between September and December – drought occurs often. Causes shortages in vegetable production and supply. Yam and taro production often excessively reduce in yield.
SK	N/C
VK	Long drought – most recent was 2010 – had huge impact
TV	N/C
ML	N/C
LM	Death of crops, low or no harvest at all.
ST	N./C

4. Have you had any experience with the impact of flooding on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

KA	No
SF	No
SK	N/C
VK	N/C
TV	N/C
ML	N/C
LM	N/C
ST	No

5. Have you had any experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

KA	No
SF	No
SK	N/C
VK	N/C
TV	N/C
ML	N/C
LM	N/C
ST	No

6. Are there any other climatic events that you believe impact on food security in your country? **Yes/No**
If yes, please provide details.

KA	There is evidence that sea levels in Tonga are rising but impacts on agriculture (food security) have not been that serious. This would be different in the future.
SF	No
SK	N/C
VK	N/C
TV	N/C
ML	N/C
LM	Rainfall pattern and intensity have greatly changed and have significant negative impacts on fruit tree flowering due to physical damage and more serious disease levels, leading to low and no harvest.
ST	No

Section 3: Capacity building:
Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)
(Yes, no, N/A- please elaborate on questions relevant to your job)

1. What sources of germplasm/planting material do you have access to?

KA	Small collection at the government farm
SF	Taro, yam, sweet potato, bananas
SK	N/C
VK	Cassava, banana, plaintains, other crops
TV	Rootcrops
ML	N/A
LM	Locally from farmers
ST	The SPC-CePaCT in collaboration with Tonga MAFFF Plant Pathology Team

2. Are you able to multiply germplasm?

KA	Only via seeds and cuttings
SF	Yes
SK	N/C
VK	Yes in TC or in the field
TV	Yes
ML	N/A
LM	Tissue culture – yes, Field multiplication – yes, but resources are required
ST	It is the responsibility of MAFFF Plant Pathology Team at Vaini Research Station

3. Do you have adequate resources for diagnostics and recognition of new pests and diseases?

KA	No
SF	Not adequate at this stage
SK	N/C
VK	Need updated equipment eg. Microscope and digital capacity
TV	No
ML	No
LM	No
ST	No, pending online diagnostics due to low capacity Internet connection and remote diagnostic resources and skills.

4. Do you have access to regional diagnostic expertise and remote diagnostic services via the internet?

KA	No
SF	No
SK	N/C
VK	To an extent - Yes
TV	No
ML	No
LM	No
ST	Yes, we have Remote Microscopy Diagnostic Unit and microscopes, but

	limited due to low Internet capacity

5. Do you have adequate internet access?

KA	Just recently
SF	Yes
SK	N/C
VK	Yes
TV	Yes
ML	Yes
LM	No
ST	No, internet capacity needs to be increased to enable Remote Microscopy Diagnostics to take place.

6. Which regional CC projects do you have linkages to?

KA	GTZ/SPC Climate Change project
SF	SPC and SPRED
SK	N/C
VK	None
TV	None
ML	N/A
LM	N/A
ST	N/A

7. Do you have training needs to deal with CC? (crop production under changing climate, diagnostics, CC impact minimization,)

KA	Yes, crop varieties that can withstand CC impacts.
SF	Yes
SK	N/C
VK	No
TV	Yes
ML	Yes
LM	Training in the area is needed for extension and women in development staff
ST	No

8. If you are involved in quarantine/biosecurity, would you benefit from networking/training opportunities with Australian/NZ biosecurity agencies? Pls explain.

KA	N/A
SF	Definitely, would benefit networking
SK	N/C
VK	Yes – much needed
TV	Yes – on diagnostics
ML	N/A
LM	This is important as we trade mostly with these two countries that both happen to have very strict quarantine requirements.
ST	Yes, we have just completed 4 Pest & Disease Diagnostic trainings from NZ

	Biosecurity which include Remote Microscopy Diagnostic with Australian Experts.

End of Questionnaire

2. Vanuatu Compiled Questionnaire

Survey Questionnaire

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Introduction to the project:
This small one year project was developed to assist scientists in Tonga, Vanuatu, Kiribati and Tuvalu deal with the impacts of climate change on crop production. The aim is to determine what the priority issues are in each country and then explore possible solutions or methods for addressing these issues. The priorities will be identified through a questionnaire and country visits followed by a workshop. Linkages and networks will be developed and training and new project opportunities will be explored and developed. A summary of the project documentation is attached.

Questionnaire:
Following is a survey/questionnaire to identify the critical impacts of climate change (cc) on food security and biosecurity in the agricultural systems of four South Pacific countries (Tonga, Vanuatu, Kiribati and Tuvalu)

Our strategy:
The questionnaire is in 3 parts:
Part A: to be completed by the Country Collaborator prior to the Participants questionnaire.
Part A contains higher level questions relating to the country (statistics, capability, etc). The completed Part A country information will be supplied to the participants as background information, with their questionnaire.

Part B: to be completed by Country Collaborators, Biosecurity/quarantine and Policy Officials prior to the Participants questionnaire.
Part B contains questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event. The questions comprise 2 sections: Section1- Quarantine/Biosecurity Policy; Section 2- Quarantine/Biosecurity practice. The completed Part B information will be provided to the participants as background information, with their questionnaire (Part C).

Part C: To be completed by the country participants (To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.).
Part C contains questions relating to the experiences of the agricultural staff members selected by their Country Collaborator to participate in the survey (this should include the Country Collaborator, senior officials and science and extension staff). The questions are aimed at determining the key impacts of climate change on food crop security and biosecurity in the participating country. The questions comprise 3 sections: Section1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

General information: Survey Participants:

Participant name	Code	Position held	Main areas of responsibility/duties	Address	Email address
James Wasi	JW	Principal Agriculture officer	My job revolves around the management of Extension Programs of the Department of Agriculture. This also means the supervision of a cadre of Provincial Agriculture Extension officers deployed around the country. I support their work in terms of putting out work plans and facilitating resources to implement work plans.	Agriculture Department, PMB 9040, Port Vila, Vanuatu	address:jwasi@vanuatu.gov.vu
Marie Melteras	MM	CEO	Management of VARTC	BP 231, Luganville Santo.	m_melteras@vanuatu.com.vu
Oniel Dalesa	OD	Farming System 2	Facilitate and identify farmers production problems with farmers by carrying out PRAs (Participatory Rural Appraisal approach). Propose solutions of targeted sites of the northern regions of Vanuatu Design appropriate extension approaches to validate these proposed technologies Establish and monitor farming systems trials in the field in collaboration with extension staff and farmers concerned Collect and maintain qualitative and quantitative data on performances of technologies applied and other field work undertaken. Report on field trial results and propose recommendations for dissemination by field staff to farmers Liaise with organizations on related activities . Assist in the distribution of planting materials and other recommended species as required. Prepare quarterly reports. Conduct trainings and workshop to support the development of national capacities of staffs and agriculture farmers	C- Department of Agriculture and Rural Development (DARD) PMB 002 Luganville Santo Island	odalesa@vanuatu.gov.vu
Peter Iesul	PI	Farming System Officer 1.	Shefa & Tafea Province	Department of Agriculture and Rural Development. PMB 9040 Port Vila; VANUATU	piesul@vanuatu.gov.vu
Antoine Ravo	AR	Provincial Agriculture Officer for Shefa Province.	Shefa Province	Department of Agriculture and Rural Development. PMB 9040 Port Vila; VANUATU	aravo@vanuatu.gov.vu

Part A: To be answered by Country Collaborators:
Background information on the collaborating country

***Note*: Climate change (cc) for the purpose of this questionnaire is define by its related impacts such as – sea level rise, salt water intrusion, new pests and diseases, increase/decrease pest and diseases, shift pattern of and quantity of rainfall, changes in temperature, change in pattern and severity of extreme weather events etc.**

1. Summary background and resources available in your country to support the agriculture sector? Please update the table below :

Vanuatu - Country summary

Land Area (km^2): 12,189	Sea Area/EEZ (km^2): 680,000
Population (No.): 217,000 (2005)	Annual Growth (%): 2.6
Density (inhabitants/km2): 16 (2005 estimate)	Rural Population (% of total population): 76%
GDP (US$ million): 368.9 (2005)	GDP per capita (US$): 1,700 (2005)
GDP Real Growth (ave.1996-2006): 2.5 % per annum	Primary Sector GDP (% of total GDP): 14.7 % (2006)
Trade Balance –US$75 million (exports as % of imports): 14.8% (2007)	Food & Live Animals as % of total imports: 17.2% (2006)
Budget allocation agriculture (2007): VT 405 million (US$ 4 m) % of Total Budget 3.4 %	Human Development Index 0.674 (2008): position 120 out of 177 countries

Sources: FAO NMTPF 2009

2. How many farmers are there in your country?
38,870 households engaged in Agricultural activities (2007 Ag census). On average 5 people per household.
3. What is the average farm size? Less than 1 ha

4. What are the main farming systems? Add extra numbers if required.
   i. Mixed cropping systems where different crops are planted simultaneously on the same piece of land
   ii. Intercropping systems (cattle under coconuts, cocoa under coconuts etc)
   iii. Mono crop systems e.g kava
   iv. Agro forestry systems where food crops are inter planted with leguminous trees like glyricidia

5. What are the main food crops in your country? (list in descending order of importance)
   i. yams
   ii. taro
   iii. rice
   iv. cassava

v. bele
vi. sweet potato
vii. flour

6. Which of the major food crops have been affected by cc and how?

Rotting is most common resulting from excessive ground water. Taro, cassava and bele have been affected especially on low laying areas.

7. Are there special/reserve food crops eaten only during times of food shortages? Please list

vi. Some varieties of wild alocasia
vii. .
viii. .
ix. .

8. What is the agricultural science/extension capacity in your country? (number of staff/educational level). Fill table 2 below.

Table 2. Country capability: Human resources in Agriculture Sector

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	2	1	1	1	1	6
Crop Protection		2	2	0	0	4
Extension	20	10	5	3	0	39
Quarantine	10	5	3	1	0	19
Livestock	4	2	1	1		8
Policy				1		1
Others						
Total						77

Part B: To be answered by Country Collaborators, Biosecurity/quarantine and Policy Officials: Recovery of food crops and agricultural systems following a severe climatic event

Section 1:
Quarantine/biosecurity policy

1. With respect to food availability and crop production, are you aware of any contingency plans within your country to assist in recovery from an extreme climatic event? – Pls explain.

No such plans in place. In the event of extreme climatic events, the Govt, NGOs and donor partners will contribute resources to meet food needs based on assessments made.

2. If there is a need to import **staple foods** such as root crops and fruits, is a risk assessment of the source country undertaken?

Yes

3. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods?

No

4. Do you have quarantine regulations around the importation of foods?

Yes

5. If so, are these regulations maintained during food emergencies?
Yes
6. If you had to import **planting material/germplasm** into your country, is a risk assessment of the source country undertaken?
Yes
7. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm??
No
8. Do you have quarantine regulations around the importation of planting material/germplasm?
Yes
9. If so, are these regulations maintained during disaster recovery periods?
Yes
10. Are there country specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster?

Yes especially from some Asian countries such as Indonesia and China
11. Do you have access to a back-up source of your local, preferred varieties of your staple crops? E.g. other islands in your country, regional germplasm centre, etc.

Some genetic materials are in tissue culture at SPC Suva. Materials are kept at sites in Vila and Santo.

Section 2:
Quarantine/ biosecurity practice
1. Do you use the SPC regional pest and disease list?
Yes we do but we also use the Vanuatu pest list provided by the Vanuatu pest list database.
2. Do you have a country pest and disease list?
Yes, it is provided by the Vanuatu pest list data base
3. If so, is the country pest and disease list available and used by extension staff?
It is available but only use by the Quarantine officers. It can be used by extension staff if a training is provided on how to use it.
4. What are the highest risk exotic pest and disease threats to the main food crops in your country?
The main following are the main pests and diseases that represent a big threat to the main food crops in Vanuatu.

- Taro leaf blight *(phytophtora colocaisae)*
- Queensland fruit fly *(bactrocera tryionii)*
- Bunchy top virus
- Melon fly
- Papaya mealy bug *(paracoccus marginatus)*

5. Do you have sufficient resources/staff/regional networks to be able to identify a new/unknown pest or disease?

Currently Vanuatu do not possess any adequate diagnostic facility to identify pests and diseases. Also equipments such as compound microscopes and other laboratory apparatus are needed to conduct good analysis of pests and diseases. However, Vanuatu has a good regional network and link with regional institutions such as SPC, Landcare and MAF in New Zealand, CSRIO and Allan Fletcher Research station in Australia.

6. What do you do when you are unable to identify a pest or disease?

We send the specimens for identification to SPC, MAF New Zealand, Landcare Research Station in New Zealand and CSRIO, Australia.

7. What quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years?

During the past 5 years no new pests and diseases have been intercepted on the border; Only fresh produced have been confiscated from the incoming passengers.

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?

i. Spiralling White fly *(Aleurodecus disperses)*

ii Erythrina gall wasp *(quadrastichus erythrinae)*

Iii Parthenium weed (weed)

iv. Leucas lavandulifolia. (weed)

Part C: Participants survey: To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.

What are the key impacts of climate change on food crop security and biosecurity in your country?

Section 1: General information

1. What are the major crops grown in your area? Please rank in order of importance below:

JW	1. Yam 2. Bele 3. Banana 4. Sweet potato 5. Taro 6. Cassava
MM	i. Food Crops (Yams, taro, Sweet potato, Cassava, Bananas &Plantain, island cabbage) ii. Coconuts iii. Cocoa and Coffee iv. Pepper, vanilla v. Breadfruits
OD	i. Banana ii. Taro (Fiji and Island) and Yam iii. Manioc and Kumala iv. Cash crops (kava, coconut, cocoa v. Fruit trees and vegetables vi. Spices
PI	*i.* Root Crops *(cassava, sweet potato, yam & taro)* ii. Banana iii. High value crops *(coconut, kava, coffee, cocoa, vanilla, pepper)* iv. Vegetables *(island cabbage, beans, tomato, lettuce)* v. Tree Crops *(breadfruit, mango, pawpaw, orange, lemon)* vi. Maize & others
AR	*i.* Root Crops *(cassava, sweet potato, yam & taro)* ii. Banana & maize iii. Vegetables *(Aibika, tomato, tomato, etc…)* iv. fruit trees & citrus *(breadfruit, mango, pawpaw, orange, lemon)* v. legumes crops *(peanut & beans)* vi. Watermelon, pineapple, eggplant, carrot, ginger & spring onion.

2. What are the major pests and diseases of these crops? Please rank in order of importance below:

JW	1. Anthracnose

	2. Sweet potato weevil 3. Taro beetle (papuana spp) 4. Root fungus (phythoptora) 5. Giant African snail
MM	i. Yam dieback, or anthracnose, is caused by the fungus *Colletotrichum gloeosporioides.* ii. Black Sigatoka Disease or Black Leaf Streak Diseases caused by *Mycosphaerella fijiensis* is a major problem for banana & plantain in Vanuatu. iii. *Papuana spp*. are major pests for taro *iv.* Sweet potato Scab *(Elsinoe batatas)* is the main disease for Sweet Potato v. *Phytophthora spp* and canker are the major problems for cocoa industry
OD	i. Papuana Beetle and PhytophthoraAntracnose (yam, banana, mangoes). ii. Nematode and scale insect iii. Banana leaf streak, and Fruit fly iv. Leaf eating insects and slugs and rat
PI	i. Root crop- Taro beetle, Anthracnose, Kumala scab, cassava mosaic disease. Sweet potato weevil ii. Banana- Black leaf streak, Root knot, banana weevil. iii. High value crops- Cocoa Black pod & canker, Coconut stick insect, coffee dieback disease, kava dieback iv. Vegetables- Catapillar,aphids, downy mildew, bacterial wilt, leaf spot & plight, mealy bugs, v. Tree crops-Fruit Piecing moth, flying fox, Papaya black spot & foot rot. vi. Maize and others- corn stem borer,
AR	i. Taro beetle; banana scab moth ii. Sigatoka disease, black cross disease & cordana *(banana leaves)* iii. Root rot *(over mature cassava)*, black spot of fruits *(moth)*. iv. Sweet Potato weevil v. Anthracnose disease *(yam)* vi. Stem Collar rot, aphides, mealy bugs, corn stem borer *(Aibika stem, leaves & vegetable).*

3. Do you think the seriousness of any of these pests/diseases has increased due to changes in climate (e.g. rise in water table, changes in rainfall etc)? Please explain.

JW	Yes I think the incidence of attack has increased for some pests and diseases. Anthracnose is particularly bad during periods of excessive rainfall. This is also true for root fungus. The taro beetle on the other hand does not like too water in soil and tends to be more prevalent in the drier

	parts of the country. For this reason farmers normally grow their taro in land and avoid the dry coastal plains. The potato weevil attacks are bad during prolonged dry months.
MM	Most of those diseases are fungus. Since they are fungus, their development depends on the weather in place. With the current LA NINA situation, the more we have rain the more those funguses develop mainly for yam dieback, the black sigatoka disease and the phytophotora on cocoa.
OD	Yes: High average rainfall- • increases incidence of pest and disease occurrences in all crops (root crops; fruits; vegetable and cash crops) • increase flooding - tuber crops to rot; land slide and crop damage; rotting of plants from roots and stem up- wards • rise of water level increase water- borne diseases for animals and humans (e.g increase incidence of malaria; diarrhea) Prolonged sunny periods- • causes spots on plant leaves and vegetables; • increase tuber rots (nematode); • weakens plant growth due to lack of water
PI	Yes: It is evident that changes in climate add to the seriousness of this pests/disease. High temperature increase the incidence of black leaf streak on banana leaves and may be responsible for damage such as sunscald of fruit and foliage. It some areas it has been reported that long spells of drought encourage insects to feed on plants that they have never feed on before because of food scarcity thus becoming major pests. Increases in precipitation add to the serious devastating effects of cocoa black pod and coffee die black diseases. Furthermore, downy mildew, damping off are some diseases of vegetables attributed to high precipitation. Water logging also experience during excessive rainfall drowns and destroys the plant root system. This reduces the growth of the plant and may predispose the plant to invasions by microorganisms.
AR	Yes, during long period of drought there is an increased on sigatoka and black cross disease on banana leaves. Excessive rainfall leads to water logging (high soil moisture content) increased taro beetle, aphides, sweet potato weevil, mealy bugs population and develop root rot on cassava tubers, black spot on fruits vegetable like tomato, mango and citrus plants.

4. Have you seen any new pests/diseases arrive in your country in the last 5 years which have impacted on food crop production? Please explain; and what actions were taken (i.e. survey, controls, elimination, etc)

Table 3. New pests and diseases

Name Code	Name of Pests/Diseases	Actions taken				
		Survey	Control	Elimination	Ignore	Comments
JW	N/A					
MM	N/A					
OD	Bananna leaf rust (??)					VQIS has given control advice
OD	Anthracnose (yam; mangoes banana)					VQIS has given control advice
OD	White- fly					VQIS has given control advice
OD	Nematode					VQIS has given control advice
	Papuanna beetle					VQIS has given control advice
PI	Fruit fly.		✓			
PI	Red fire Ants		✓			
AR	N/A					

Section 2: Experiences with crop production and climatic events

1. Have you experienced the effect of climatic factors (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in your area? **Yes/No** If yes please answer the more specific questions below

JW	Yes.
MM	Not yet.
OD	Yes. Increase damage from salt spray for gardens near coastal areas Coastal erosion from strong wind causing large sea waves move further in- land
DL	Yes.
PI	Yes.
AR	Yes.

2. Have you had any experience with the impact of a cyclone on agricultural systems that affect food supply and crop production? **Yes/No**

If yes, please provide details of the impacts.

JW	Yes: The impact of cyclones drastically reduces food supply. Farmers could live on salvaged crops 2 weeks after a bad cyclone but after that they will look elsewhere for food supply. It is noted that root crops, if managed properly prior to a cyclone season will suffer less damage. For example, removing the excessive branches of cassava will help keep the plant from falling over in a cyclone. After a cyclone, farmers would plant quick producing crops like corn and sweet potato.
MM	No yet.
OD	Yes: Crop/ plant damage (broken branches; leaves; up- rooted tubers of manioc) Plant weakens and die after cyclones, causing tuber crops to rot

	Plants dry- up after cyclone due to damages Low fresh food production at the local market Most fresh food sold at the market are mostly damaged plants, hence they are either harvested too early, or have scratches, scar or damaged from the strong wind. Flooding on some areas near rivers and coastal shores Increase damage from salt spray for gardens near coastal areas Coastal erosion from strong wind causing large sea waves move further in- land
PI	This year alone we had two cyclones that destroyed most of the crops. The strong winds uprooted crops like cassava, breaking stakes of yam and legume crops, banana and other crops and even damaging branches of fruit trees bringing down fruits to the ground. Cyclone may also cause flooding especially in areas close to rivers and streams, submerging most of the crop especially those crops that are grown in swamps like Taro. Flooding caused landslide and soil is washed away to river which then pollute the marine Ecosystem. In areas where water table is close to the surface of the ground, water logging damaged most of the crops in the area.  ***i) Double damage d of cyclone & Volcanic Ash on Yam, Tanna. ii) Cyclone damage on cassava plants, Aneityum.***
AR	Yes, Cyclones causing sea water inundation of farmland killing food crops. Strong wind has caused damage to cassava, yam stakes, banana leaves & fruit trees especially in the low islands and Salt spray has effect on sweet potato and cassava growth and in some areas it completely kills the crops. Soil erosion has caused by strong/heavy rainfall in some areas.

3. Have you had any experience with the impact of a drought on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

JW	Yes. The impact of drought is particularly bad for cattle farmers who mostly rely of rain water to sustain their livestock. Large numbers of cattle have died during prolonged dry weather on North Malekula and Santo in the past. Small islands are also hit badly during drought periods because of limited water resources (rivers, lakes etc). In most cases the Government intervenes with food aid. Currently there is little scope for Agriculture Department to assist in drought situations unless we develop appropriate technology.
MM	No yet.
OD	Yes: Weakened leafy plants, that normally wilts if the sun period is too long. Smaller yield size of food crops especially root crops Increase fungal infestation of leaf lap lap (Musa sp)…Leaf rust (??)

	Increase fruit yield Tuber crops (e.g. Manioc, yams and taro) rot because the leaves dry- up (wilt/ shrivel) Dying livestock (cattle, pigs and chicken) especially if they are not free range, there is higher mortality rate, because of no water.
DL	Yes: Drought is the main problem on agricultural Kiribati. Lack of mountain and river, well water is the main source of water. However, dry season last too long and caused getting salty of well water, so drought brings salinity stress of crops.
PI	Yes: Seedlings and newly planted crops suffered from heat. Leave of plants are dried up by the strong heat. Most of the crops in the field will not produce well because of deficit soil moisture and the outbreak of new disease will make matters worse. Livestock also suffered from heat stress. Some root crops like cassava will develop fiber and will not be palatable for consumption and the same to some leafy vegetables.
AR	Yes, taro and banana leaves suffer from heat stress. Deficit soil moisture content results from plants wilt and death. Low yield of crop harvested & soil degradation. Shortage of planting materials to distribute by extension workers and between the farmers themselves.

4. Have you had any experience with the impact of flooding on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

JW	No.
M M	No yet.
OD	Yes: Plants start to rot from the roots, the stem, and eventually the whole plant dies on area where water level increases (river tables, and salt water flooding) Where running river/ or water level movements are experienced, land slide is experienced Running river damages bridges, delay of transport communication for local market Most food crops are destroyed from moving river/ strong current, up- rooting plants, or miss-placing plants, damaging plant parts (i.e. broken branches/ leaves etc.) Less fresh food supply in the local market Most farmers have to re- establish their gardens again, hence consume hardy root crops (Nummularia sp; Navia) ,flour, processed rice and canned food for food supply
DL	No.
PI	Yes: Flooding washed away soil nutrients and plants with shallow root system. Plants not adapted to water will die.  ***iii) Flooding of Agricultural land, Aneityum vi) Landslides, Aneityum v) Damaged crops,***

	Aneityum
AR	Yes, increased amount of rainfall causes flooding and water logging in few areas – high soil moisture content not good for plant growth such as sweet corn, sweet potato, cassava, Aibika, taro and pumpkins (creeping legume and vegetable). Soil erosion is a problem - leaching of soil nutrients.

5. Have you had any experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

JW	No.
MM	No yet.
	Yes: Rising sea level has become a regular and serious problem in Kiribati. Inundation events and occurrences have affected the crop production and food supply which affect the livelihood of many of the I-Kiribati especially on South Tarawa. Soil becomes infertile with the increasing salinity from salt water intrusion.
OD	Yes: most crops not adapted to salt conditions die- out (dry- land taro, yams, manioc and vegetables) Most sea water level rise is caused by strong wind, and waves causing sea to come further in- land to damage crops (physically, and increase soil salination) Where there is no wind break, strong wind damages tall trees and food crops (plant breakage) Salt spray on crops cause the leaves
PI	Yes: Rising sea water causes sea water inundation of Farms that are close to the sea killing plants. Also salt spray cause during cyclones will also shrivel up crop leaves and also killing plant that are fragile.
AR	Yes, rising seas and cyclones causing sea water inundation of farmland - killing food, feed and cash crops such as fruit trees, Aibika, cassava, taro and banana growing near coastal area especially at the low islands; For instance in Mataso island.

6. Are there any other climatic events that you believe impact on food security in your country? **Yes/No**
If yes, please provide details.

JW	Yes: Volcanic ash has affected some parts of the country in the past even though this is not related to climate change. Volcanic ash burns crops and facilitates rotting. It contaminates water systems and affects livestock. It displaces whole communities which brings on a whole set of social issues that the government has to deal with. The Department of Agriculture had supported farmers with new planting materials where communities were relocated to new sites.
MM	No.
OD	**Yes:** Volcanic damage- water pollution; food damage from acid rain; Tsunami- salt damage on crops; damaged infrastructure Earth- quake- land slide; food damage; damaged buildings
DL	Yes: Increased temperature cause some crops cannot survive in Kirribati anymore and increased water evaporation waste the treasured pure water for crops.
PI	Yes: Acid rain killing plants that have soft structures mostly vegetables and destroying flower of tree crops. For example, on the eastern part of Tanna, an island in the southern part of the country people only plant crops that produce underground like cassava and Taro because crops produce above the ground are killed by acid rain. Thunderstorms also

	destroyed plantations of high value crops such as coconut, cocoa and coffee.
AR	Yes, acid rain derived from volcano ash have grate disturbance on the growth of vegetables, fruit trees and other cash crops like kava.

Section 3: Capacity building:
Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)
(Yes, no, N/A- please elaborate on questions relevant to your job)

1. What sources of germplasm/planting material do you have access to?

JW	We have our national collection of elite varieties based in Tagage and Santo.
MM	VARTC is maintaining currently Local germplasm (over 1000 accessions of food crops) and regional through SPC.
OD	Coffee, Cocoa; Coconut; Taro, cassava, sweet potato, yam; Yam and fruit trees (orange; mandarin; grapefruit; avocado; mangoes)
PI	Taro, cassava, sweet potato, yam
AR	Taro, banana, Aibika, citrus, cassava, sweet potato, yam,

2. Are you able to multiply germplasm?

JW	Yes but may be slow when dealing with vegetative material. This may be a constraint in terms of meeting big demands in a short space of time.
MM	The multiplication of selected planting material and distribution to farmers is done with the collaboration of DARD.
OD	Yes- Vanuatu Agriculture Research and training Center (VARTC) distributes germplasm to farmers and other Agriculture Institute for consumption and multiplication purpose
PI	Yes. The work is carried out by the Vanuatu Agriculture Research Technical Center (VARTC). The department plays a key role in the distribution of planting materials to farmers.
AR	No, the work is done by Vanuatu Agriculture Research Technical Center (VARTC). The department of agriculture may facilitate in collecting Germplasm on farmer's field and established gen bank in each province. However, since this is an expensive activity funding is our major constrain.

3. Do you have adequate resources for diagnostics and recognition of new pests and diseases?

JW	No we will need support in this area.
MM	No, apart from field observation.
OD	No.
PI	No. (this is relevant to the quarantine section).
AR	No. (this is relevant to the quarantine section).

4. Do you have access to regional diagnostic expertise and remote diagnostic services via the internet?

JW	We have the SPC support. However the process with SPC is often slow and may not be suitable if we want to contain and eliminate an incursion.
MM	Pestnet.
OD	No.
PI	No.
AR	Yes.

5. Do you have adequate internet access?

JW	Yes
MM	Yes
OD	Yes, we have access to some authorized websites, especially web search engines
PI	Yes.
AR	Yes.

6. Which regional CC projects do you have linkages to?

JW	We have the SPC/GIZ project and the EU-ARD project with NARI being undertaken in Vanuatu.
MM	Adapting clonally propagated crops to climatic and commercial changes (VARTC is Partner) Generation and adaptation of improved agricultural technologies to mitigate climate change-imposed risks to food production within vulnerable smallholder farming communities in Western Pacific countries (VARTC is associate)
OD	GIZ Project, NARI Climate change project
PI	GIZ Project, DARD/NARI Climate change project & Live and Learn.
AR	GIZ project, DARD/NARI Climate change project & Live and Learn.

7. Do you have training needs to deal with CC? (crop production under changing climate, diagnostics, CC impact minimization,)

MM	Yes if available somewhere
OD	Yes…agricultural staff must be trained to diagnose effect, as impacts can be mixed up with other factors
PI	Yes. There is a need for expertise on CC for the country.
AR	Yes. There is a need for expertise on CC for the country (postgraduate and masters graduate).

8. If you are involved in quarantine/biosecurity, would you benefit from networking/training opportunities with Australian/NZ biosecurity agencies? Pls explain.

JW	N/A
MM	N/A
OD	Yes, networking and training will help because the Australian/ NZ bio-security is well developed, and we can use their challenges to tackle pest and disease control in our country
PI	Yes training will improve work performance and skills.
AR	Yes, training opportunities will be very useful for me to learn and understand doing on hands trial.

End of Questionnaire

3. Kiribati Compiled Questionnaire

Survey Questionnaire

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Introduction to the project:
This small one year project was developed to assist scientists in Tonga, Vanuatu, Kiribati and Tuvalu deal with the impacts of climate change on crop production. The aim is to determine what the priority issues are in each country and then explore possible solutions or methods for addressing these issues. The priorities will be identified through a questionnaire and country visits followed by a workshop. Linkages and networks will be developed and training and new project opportunities will be explored and developed. A summary of the project documentation is attached.

Questionnaire:
Following is a survey/questionnaire to identify the critical impacts of climate change (cc) on food security and biosecurity in the agricultural systems of four South Pacific countries (Tonga, Vanuatu, Kiribati and Tuvalu)

Our strategy:
The questionnaire is in 3 parts:
Part A: to be completed by the Country Collaborator prior to the Participants questionnaire.
Part A contains higher level questions relating to the country (statistics, capability, etc). The completed Part A country information will be supplied to the participants as background information, with their questionnaire.

Part B: to be completed by Country Collaborators, Biosecurity/quarantine and Policy Officials prior to the Participants questionnaire.
Part B contains questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event. The questions comprise 2 sections: Section1- Quarantine/Biosecurity Policy; Section 2- Quarantine/Biosecurity practice. The completed Part B information will be provided to the participants as background information, with their questionnaire (Part C).

Part C: To be completed by the country participants (To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.).
Part C contains questions relating to the experiences of the agricultural staff members selected by their Country Collaborator to participate in the survey (this should include the Country Collaborator, senior officials and science and extension staff). The questions are aimed at determining the key impacts of climate change on food crop security and biosecurity in the participating country. The questions comprise 3 sections: Section1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

General information: Survey Participants:

Participant name	Code	Position held	Main areas of responsibility/duties	Address	Email address
Tianeti I Beenna	TB	Deputy Director of Agriculture	Staff matter (attendance and report, temporary), Coordinate Research Activities, PAPGREN national coordinator, Plant Genetic Resource Contact Point, FAO National Correspondence	Agriculture Department Ministry of Environment, Lands and Agricultural Development PO Box 267 Tanaea Bikenibeu, Tarawa	beenna_ti@yahoo.com
Riibeta Abeta	RA	Climate Change Officer	Vulnerability and adaptation assessments, climate change adaptation planning, climate change awareness and advocacy	Ministry of Environment, Lands and Agricultural Development PO Box 267 Tanaea Bikenibeu, Tarawa	riibetaa@gmail.com.ki
Conchitta Tatireta	CT	Project Officer	Appraising and analyzing projects proposals as well as developing project documents.	Ministry of Environment, Lands and Agricultural Development PO Box 267 Tanaea Bikenibeu, Tarawa	miragirlster@gmail.com
Daniel Lee (Lee Yi-Long)	DL	Specialist of Horticulture Project of Taiwan Technical Mission	Extension work on vegetables	Temaiku, Taiwan Technical Mission Demonstration Farm (PO Box 29, Bairiki, Tarawa	y.l.lee@icdf.org.tw
Etera Teangana	ET		Farmer	Tarawa	

Part A: To be answered by Country Collaborators:
Background information on the collaborating country

1. Summary background and resources available in your country to support the agriculture sector? Please update the table below :

Kiribati – Country summary

Land Area (km^2): 810	Sea Area/EEZ (million km^2): 3.6
Population (No.): 92,533 (2005 census)	Annual Growth (%): 2.5
Average Density (inhabitants/km^2):127	Rural Population (% of total population): 54
GDP (A$ million): 81.91 (2006) US$61.43	GDP per capita (A$): 870 (2006) US$653
GDP Real Growth (ave.2000-2006): 0.04% per annum	Primary Sector GDP (% of total GDP): 3.2% (2006)
Trade Balance – US$56,887,000 (Exports as % of imports) 9.9 % (2006)	Food & live Animals as a % of total imports 30.1 % (2005)
Budget Expenditure Agriculture & Fisheries(2006) A$ 1.83 m % of Total Budget Expenditure 2.3 %	Human Development Index N/A

Sources: FAO NMTPF 2009

2. How many farmers are there in your country?

In terms of large scale farmers (coconut plantation and giant swamp taro), more than 80% are farmers, in terms of household or home gardening closed to 30% have at least a small backyard garden

3. What is the average farm size?

Coconut plantation size ranges from 3 acre to 10 acres per family, giant swamp taro ranges from a quarter acre to 1 acre per family, household home gardening ranges from as small as 50 sq m to 200sq m.

4. What are the main farming systems? Add extra numbers if required.
   i. Since the replanting scheme ceased in 1995 when the project identify the major nutrient deficiencies for coconut and ways to solve the problem using chemical fertilizers, all agriculture activities used composting methods.
   ii. The giant swamp taro is cultivated in water logged condition.

5. What are the main food crops in your country? (list in descending order of importance)
   i. coconut
   ii. breadfruit
   iii. pandanus
   iv. giant swamp taro
   v. Fig tree
   vi. Banana, pawpaw, pumpkin, sweet potato, cassava,

6. Which of the major food crops have been affected by cc and how?

Coconut, breadfruit, pandnaus, giant swamp taro (prolonged drought has reduced yield, and standing plants are dying due to lack of fresh water.

7. Are there special/reserve food crops eaten only during times of food shortages? Please list

i. Polynesian arrow root (not all islands have this)

8. What is the agricultural science/extension capacity in your country? (number of staff/educational level). Fill table 2 below.

Table 2. Country capability: Human resources in Agriculture Sector

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production	3	1	2	2		
Crop Research	3			1		
Extension	16	1	1			
Quarantine	6		1	1		
Policy				2		
Livestock	4		2			
Total	32	6	6	6		

Part B: To be answered by Country Collaborators, Biosecurity/quarantine and Policy Officials:

Recovery of food crops and agricultural systems following a severe climatic event
Section 1:
Quarantine/biosecurity policy

1. With respect to food availability and crop production, are you aware of any contingency plans within your country to assist in recovery from an extreme climatic event? – Pls explain.

Quarantine	Yes, the government will advocate and continue to monitor the situation. However, to address the emerging issue, The National Food Security Task Force was set up to oversee this situation, Ministry of Commerce and Industry was tasked to ensure that basic imported food (cereals) are not run out and price are reasonable, while the Ministry of Environment, Lands and Agricultural Development through the Department of Agriculture is tasked to ensure that domestic food crops production are sustainable.
Tianeti Beenna	Yes, the Government has setup the National Food Security Task Force, chaired by the office of the President, and the implementation of the work to ensure that every household do access to traditional food crop planting materials and livestock is lead by the Ministry of Environment, Lands and Agricultural Development through the Department of Agriculture.

2. If there is a need to import **staple foods** such as root crops and fruits, is a risk assessment of the source country undertaken?

Quarantine	Yes
Tianeti Beenna	Encouragement of opening up import of root crops from neighbouring countries.

3. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods?

Quarantine	Yes, but only when they are safe and meet our guidelines set in our biosecurity regulations.
Tianeti Beenna	Yes, those with similar condition and climate to Kiribati

4. Do you have quarantine regulations around the importation of foods?

Quarantine	Yes
Tianeti Beenna	Yes, our Biosecurity Bill is under the first reading and will wait for second reading for endorsement

5. If so, are these regulations maintained during food emergencies?

Quarantine	Yes
Tianeti Beenna	

6. If you had to import **planting material/germplasm** into your country, is a risk assessment of the source country undertaken?

Quarantine	Yes, only through SPC tissue culture

7. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm??

Quarantine	Yes, through tissue culture and approved systems only.

8. Do you have quarantine regulations around the importation of planting material/germplasm?

Quarantine	Yes

9. If so, are these regulations maintained during disaster recovery periods?

Quarantine	Yes

10. Are there country specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster?

Quarantine	Yes, restricted from some Asian countries.

11. Do you have access to a back-up source of your local, preferred varieties of your staple crops? E.g. other islands in your country, regional germplasm centre, etc.

Quarantine	Yes, with SPC CePaCT

Section 2:
Quarantine/ biosecurity practice

1. Do you use the SPC regional pest and disease list?

Quarantine	Yes

2. Do you have a country pest and disease list?

Quarantine	Yes

3. If so, is the country pest and disease list available and used by extension staff?

Quarantine	Yes, can be made available

4. What are the highest risk exotic pest and disease threats to the main food crops in your country?

Quarantine	• Taro beetle • Fruit fly • Spiraling white fly • Breadfruit Rot disease (phytophtora) • Coconut scale

5. Do you have sufficient resources/staff/regional networks to be able to identify a new/unknown pest or disease?

Quarantine	The department of Agriculture, does not have adequate diagnostic facility, however, we do get assistance from SPC and CSRIO for confirmation. The department also does not have a capacity to work specifically on this issue.

6. What do you do when you are unable to identify a pest or disease?

Quarantine	Send sample to SPC for assistance

7. What quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years?

Quarantine	No new disease except the coconut scale that has just confirmed since 2008

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?

Quarantine	i. Coconut scale insect

Part C: Participants survey: To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.

What are the key impacts of climate change on food crop security and biosecurity in your country?

Section 1: General information

1. What are the major crops grown in your area? Please rank in order of importance below:

TB	1. Coconut 2. Giant swamp taro 3. Breadfruit 4. Pandanus 5. Fig tree 6. Banana 7. Pawpaw, pumpkin, sweet potato, bele, kangkong, vegetables (fruit and leafy)
RA	N/A
CT	i. Coconut tree ii. breadfruit iii. pawpaw iv. pumpkin v. pandanus vi. vegetables (Chinese cabbage, egg plant, snake beans, tomatoes, cucumber)
DL	i. Chinese cabbage ii. Little tomato iii. cucumber iv. capsicum v. eggplant vi. papaya
ET	i. Chinese cabbage ii. banana iii. tomato iv. sweet potato

	v. cassava vi. pumpkin

2. What are the major pests and diseases of these crops? Please rank in order of importance below:

TB	1. Ship rat, Polynesian rat 2. Taro beetle 3. coconut scale 4. mealy bug 5. spiraling white fly, fruit fly 6. wood louse
RA	N/A
CT	i. Te bakabaka (don't know their English names) ii. Te manibinou (don't know their english names) iii. Bugs eating away the leaves of the Chinese cabbage iv. There might be others but are not that obvious
DL	i. Nematode ii. Whitefly
ET	i. Wood lice ii. Caterpillar of moth iii. Taro beetle attack cassava and sweet potato

3. Do you think the seriousness of any of these pests/diseases has increased due to changes in climate (e.g. rise in water table, changes in rainfall etc)? Please explain.

TB	Yes, when the drought period is experienced, rat damaged on coconut, papaya, pumpkin and banana, sweet potato was reported
RA	There is noticeable evidence that crops tends to be more vulnerable to diseases and pests with changing weather and climate patterns over the past years.
CT	Pest disease has become a major problem in Kiribati and has been happening regularly. Given regular and prolong drought has caused many introduced pest disease which now hasn't been realized yet.
DL	1. These two years, dry season last long time and flies problem were so serious 2. This year, rainy season came and overwhelming rainfall caused water flooding and nematodes spreaded soon and infected tomato, capsicum, eggplant, cucumber and melon.
ET	Yes: Drought period encouraged the attack of the moth.

4. Have you seen any new pests/diseases arrive in your country in the last 5 years which have impacted on food crop production? Please explain; and what actions were taken (i.e. survey, controls, elimination, etc)

Table 3. New pests and diseases

Name Code	Name of Pests/Diseases	Actions taken				
		Survey	**Control**	**Elimination**	**Ignore**	**Comments**
TB	Coconut scale	yes	Under investigation			Dealing with overseas partners to comeup with the best approach
RA	N/A					
CT	N/A					
DL	Nil					
ET	Red ant, beetle, moth					

Section 2: Experiences with crop production and climatic events

1. Have you experienced the effect of climatic factors (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in your area? **Yes/No** If yes please answer the more specific questions below

TB	Yes: Due to prolonged drought, the quantity and quality of coconut fruit, breadfruit have been reported to be very small
RA	Yes: The drought tends to affect the food crops. However other seasonal climatic factors such as flood, storms also impacted on the crops.
CT	Yes: Salt water intrusion is the most common climatic factor that affects the growth and production of crop in my area. Soil becomes so dry, saline causing crops to hardly bare fruit, or if they bare fruits they won't reach the big size and comes off at their very early age.
DL	Yes.
ET	Yes: Prolonged drought affected well water quality.

2. Have you had any experience with the impact of a cyclone on agricultural systems that affect food supply and crop production? **Yes/No**

If yes, please provide details of the impacts.

TB	No: No cyclone has ever hit Kiribati
RA	No.
CT	No: Kiribati hasn't faced a real cyclone however the major drastic events happen recently are only king tides, storm surges etc which have greatly affected the livelihood of the I-Kiribati. These events caused saltwater intrusion which affect soil fertility and in turn affect crops production and food supply.
DL	No.
ET	No.

3. Have you had any experience with the impact of a drought on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

TB	Yes as in 1 (Yes, due to prolonged drought, the quantity and quality of coconut fruit, breadfruit have been reported to be very small)
RA	Yes: Drought period affects the quality of food crops such as coconuts, breadfruits. It is experienced that traditional foods tends to be very hard to find during drought periods.
CT	Yes: Recently (end of 2009 till 2010) Kiribati has been experiencing prolong drought where trees in particular coconut trees have fallen off onto the ground, at early age they became senile and are found to bare very few fruits. Others ended up with yellowish leaves and they hardly bare fruits.
DL	Yes: Drought is the main problem on agricultural Kiribati. Lack of mountain and river, well water is the main source of water. However, dry season last too long and caused getting salty of well water, so drought brings salinity stress of crops.
ET	Yes: Prolonged drought affected well water quality.

4. Have you had any experience with the impact of flooding on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

TB	No: No flooding here also
RA	Yes: Not so much affects the food supply but tends to affect crops placed at close proximity to coastal areas. These include coconut trees and pandanus trees.
CT	Yes: During heavy rains is when we have rich soil and have greener grass and brings life to all our food crops. Flooding during prolong rainy seasons have greatly affected the crops but not as bad and devastated as the impact of salt water intrusion and drought.
DL	No.
ET	N/A

5. Have you had any experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production? **Yes/No**
If yes, please provide details.

TB	Yes: Some breadfruit trees, banana has been affected with sea water effect, some babai pit have been lost in outer islands where sea water inundation and intrusion due to sea level rise.
RA	Yes: Not so much affects the food supply but tends to affect crops placed at close proximity to coastal areas. These include coconut trees and pandanus trees.
	Yes: Rising sea level has become a regular and serious problem in Kiribati. Inundation events and occurrences have affected the crop production and food supply which affect the livelihood of many of the I-Kiribati especially on South Tarawa. Soil becomes infertile with the increasing salinity from salt water intrusion.
DL	Yes: The same impact with drought, rising sea water levels caused salinity of well water. We have to buy pure water during high tide periods and it costs a lot.
ET	N/A

6. Are there any other climatic events that you believe impact on food security in your country? **Yes/No**

If yes, please provide details.

TB	Yes: Prolonged drought, sea level rise are more and frequent, and rain or wet period are getting less and less frequent (changing of pattern is obvious)
RA	Yes: Variability in rainfall patterns (e.g. heavy rain followed by intense heat)
CT	Yes: Global warming (increase in temperature) is another major climatic event that really affect the life of our food crops and that makes many people suffer. However, new pest, new diseases will soon encroach or invade our land which hasn't been yet obvious and realized, but given the occurrences of prolong droughts, flooding, inundation and so forth, will introduce new pests that are more adaptable to these extreme conditions and therefore their impacts would be more disastrous.
DL	Yes: Increased temperature cause some crops cannot survive in Kirribati anymore and increased water evaporation waste the treasured pure water for crops.
ET	N/A

Section 3: Capacity building:

Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

(Yes, no, N/A- please elaborate on questions relevant to your job)

1. What sources of germplasm/planting material do you have access to?

TB	On farm (buying materials from farmers, and through regional germplasm centres such as CePaCT at SPC
RA	N/A
CT	I may leave this question blank, however at home I use seeds from Taiwan, and plantlets from the Agriculture department, no fertilizers as I use manure and 99.9% organic/compost.
DL	Chinese cabbage, tomatoes, cucumber, capsicum, eggplant, papaya, melon, sweet potato, cosmos, zinnia
ET	Taiwanese technical Mission Farm, FSP Supply, Agriculture Dept. (from SPC).

2. Are you able to multiply germplasm?

TB	Yes at farmers, community and nursery fields
RA	N/A
CT	N/A
DL	No.
ET	N/A

3. Do you have adequate resources for diagnostics and recognition of new pests and diseases?

TB	No
RA	It is important to have robust knowledge on the trends of impacts of pests and diseases on food crops with different climate scenarios (changing climate patterns). The impact of other alien species (plants and insects, animals) on food crops with changing climate patterns is another area to consider that can affect supply and security of food as well.
CT	We have our very active department that has the expertise in these areas and fields however there might be limitations of knowledge, technical experience, and even equipment and tools to have these new pests recognized and diagnosed.
DL	No.

ET	N/A

4. Do you have access to regional diagnostic expertise and remote diagnostic services via the internet?

TB	Yes but at times it is quite difficult to get through regional expertise due to poor connection, and also inability of staff to use this technology to either sending or downloading relevant information
R/A	N/A
CT	Personally speaking, I really don't know if the Agriculture have access to this via internet, and I'll leave the answers to the Tianeti.
DL	No.
ET	N/A

5. Do you have adequate internet access?

TB	Yes
RA	N/A
CT	Internet is ok however there are times when we faced difficulties in accessing it. Have experienced almost a month without internet.
DL	Yes, but with limited speed of internet (128 KBS/s)
ET	N/A

6. Which regional CC projects do you have linkages to?

TB	SPC, SOPAC programme
RA	N/A He is a climate change officer- should have answered this.
CT	There is a regional project on "Adaptation to climate change in the Pacific Island Region (ACCPIR)" which is very limited to only 3 countries and does not include Kiribati. This year another broader cc regional project is extending to other countries which include Kiribati, " Coping with Climate Change in the Pacific Island Region (CCCPIR)" a newly developed project after appraisal and evaluation conducted to the pacific regions. If there are any I would leave that to Agriculture- Tianeti for more answers
DL	None.
ET	N/A

7. Do you have training needs to deal with CC? (crop production under changing climate, diagnostics, CC impact minimization,)

TB	Yes, crop production under climate change (producing climate change proof crop, and ability to diagnose the situation and produce sound conclusions, adaptability to CC
RA	N/A He is a climate change officer- should have answered this.
CT	Yes, that is very much the need of the country even at the homes of the farmers with these problems would discourage them from farming as the crop production might fall or won't be able to provide enough for the family. Would be good if there are new and more adaptable germplasm to diversify more of the food crops that can withstand extreme events.
DL	Yes.
ET	N/A

8. If you are involved in quarantine/biosecurity, would you benefit from networking/training opportunities with Australian/NZ biosecurity agencies? Pls explain.

TB	Yes, to get more interlinked with people that have wider scope of experience and rich resources in this area
RA	N/A
CT	Though am not involved in those fields, I think the benefit from having this networking/training would be very important rather than having none. Would be an opportunity for us to give in our concerns and areas where we need improvements to be covered especially on biosecurity and quarantine.
DL	N/A
ET	N/A

End of Questionnaire

4. Tuvalu Compiled Questionnaire

Survey Questionnaire

Impact of climate change on food security and biosecurity of crop production systems in small Pacific nations. (APN Project Ref: ARCP2010-08NSY-Freeman)

Introduction to the project:
This small one year project was developed to assist scientists in Tonga, Vanuatu, Kiribati and Tuvalu deal with the impacts of climate change on crop production. The aim is to determine what the priority issues are in each country and then explore possible solutions or methods for addressing these issues. The priorities will be identified through a questionnaire and country visits followed by a workshop. Linkages and networks will be developed and training and new project opportunities will be explored and developed. A summary of the project documentation is attached.

Questionnaire:
Following is a survey/questionnaire to identify the critical impacts of climate change (cc) on food security and biosecurity in the agricultural systems of four South Pacific countries (Tonga, Vanuatu, Kiribati and Tuvalu)

Our strategy:
The questionnaire is in 3 parts:
Part A: to be completed by the Country Collaborator prior to the Participants questionnaire.
Part A contains higher level questions relating to the country (statistics, capability, etc). The completed Part A country information will be supplied to the participants as background information, with their questionnaire.

Part B: to be completed by Country Collaborators, Biosecurity/quarantine and Policy Officials prior to the Participants questionnaire.
Part B contains questions about procedures undertaken during recovery of food crops and agricultural systems following a climatic event. The questions comprise 2 sections: Section1- Quarantine/Biosecurity Policy; Section 2- Quarantine/Biosecurity practice. The completed Part B information will be provided to the participants as background information, with their questionnaire (Part C).

Part C: To be completed by the country participants (To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.).
Part C contains questions relating to the experiences of the agricultural staff members selected by their Country Collaborator to participate in the survey (this should include the Country Collaborator, senior officials and science and extension staff). The questions are aimed at determining the key impacts of climate change on food crop security and biosecurity in the participating country. The questions comprise 3 sections: Section1- General Information; Section 2- Experiences with crop production and climatic events; Section 3- Capacity building.

General information: Survey Participants:

Participant name	Code	Position held	Main areas of responsibility/duties	Address	Email address
Itaia Lausaveve	IL	Director of Agriculture	Policy, Department overall Management; Staff affairs; budget coordination and compilation; project profiles, Training needs coordination, department structuring; aid coordination, regional and international conventions, agreements, frameworks, policy coordination pertaining to agriculture development	Department of Agricuture, Ministry of Natural Resources & Lands, PMB, Vaiaku, Funafuti, TUVALU. Phone (688) 20836	ilausaveve@yahoo.com, itaialausaveve@gmail.com
Sam Panapa	SP	Head of Quarantine and Biosecurity	Quarantine and biosecurity	Department of Agricuture, Ministry of Natural Resources & Lands, PMB, Vaiaku, Funafuti, TUVALU.	sampanapa@gmail.com
Akinesi Sianoa	AS	Senior Agricultural Extension and Information Officer		Department of Agricuture, Ministry of Natural Resources & Lands, PMB, Vaiaku, Funafuti, TUVALU.	akisianoa@gmail.com
Tavau Teii	TT	NPC for FSSLP	Co-ordination of projects which are funded by FAO FSSLP (regional project). 14 countries PIF	Vaiaku, Funafuti Atoll, Tuvalu	
Iosia Siose	IS	Extension Officer	Field assistance	Department of Agricuture, Ministry of Natural Resources & Lands, PMB, Vaiaku, Funafuti, TUVALU.	
Evolini Mami	EM	Local Counterpart Taiwan Technical Mission			
Peleti Pole	PP	Livestock Officer	Mostly poultry and pigs	Agriculture Department, Teone, Funafuti, Tuvalu	
Tim Panapa	TP	Agricultural Assistant (Livestock)	Poultry and pigs production	Dept of Agric. Teone, Funafuti, Tuvalu	
Annie Honasi	AH	CEO TANGO			

Part A: To be answered by Country Collaborators:
Background information on the collaborating country

1. Summary background and resources available in your country to support the agriculture sector? Please update the table below :

Tuvalu - Country summary

Land Area (km^2): 26	Sea Area/EEZ (million km^2): 900,000
Population (No.): 9,561 (2002 census)	Annual Growth (%): 0.51 (1991-2002)
Average Density (inhabitants/km^2): 378	Rural (outer island) Population (% of total population): 58
GDP (A$ million): 27.49 (2002) US$18 million	GDP per capita (A$): 2,872 (2002) US$1,889
GDP Real Growth (ave.2003-2007): 2.6 % per annum	Primary Sector GDP (% of total GDP): 16.6 % (2002)
Trade Balance – US$11,071,006 (Exports as % of imports) 0.47 % (2005)	Food & live Animals as a % of total imports 25 % (2007)
Budget Expenditure Agriculture & Fisheries(2006) N/A	Human Development Index Available in 2011 national Budget

Sources: FAO NMTPF 2009

2. How many farmers are there in your country?

Itaia Lausaveve	An estimated 60% of the population lives in rural Tuvalu, and one third of them would be active farmers, the rest being the young, and old people.
Tavau Teii	Most of the population live on subsistence agriculture.

3. What is the average farm size?

Itaia Lausaveve	An estimated less than half an acre.
Tavau Teii	Vary from 0.01-0.4 Ha

4. What are the main farming systems? Add extra numbers if required.

Itaia Lausaveve	i. Pulaka pit cultivation including banana, and taro colocassia farming. (subsistence) ii. Vegetable home gardening including taro colocassia and sweet potatoes and cassava farming (subsistence) iii. Coconut and toddy production (subsistence) including gathering of wild figs (felo), Polynesia arrow roots and pandanus (subsistence). iv. Household pigs and poultry farming (subsistence) v. Commercial production of eggs and vegetables only on Funafuti (Cash crop) vi. Village production of Breadfruits, bananas and pandanus
Tavau Teii	i. .Traditional agroforestry type of subsistence farming system. ii. .Household food garden for vegetables.

	iii. .Pulaka pit cultivation (communal plots)

5. What are the main food crops in your country? (list in descending order of importance)

Itaia Lausaveve	i. Coconuts. ii. Pulaka iii. Breadfruits iv. Bananas v. Pandanus and pawpaws vi. Vegetables
Tavau Teii	i. Coconut palm ii. Giant swamp taro (pulaka). iii. Breadfruit (mei). iv. Taro (Colocasia) (talo) v. Banana (futi) vi. Pandanus spp. (fala) vii. Wild fig (felo) viii. Pawpaw (olesi) ix. Kumara

6. Which of the major food crops have been affected by cc and how?

Itaia Lausaveve	1. Pulaka by incursion of saltwater and floods during heavy rains and prolonged dry weather 2. Pandanus and coconut trees during long dry weather and coastal erosion from king tides impact 3. Homegardens in low lying areas from floods during spring and king tides 4. Banana patches in low lying areas from floods from king tides.
Tavau Teii	Pulaka and breadfruit

7. Are there special/reserve food crops eaten only during times of food shortages? Please list

Itaia Lausaveve	i. ii. iii. iv.	pulaka breadfruit banana sweet potato
Tavau Teii	i. ii. iii.	Xanthosoma spp. (taamn) Wild fig (felo) pandanus spp. (fala)

8. What is the agricultural science/extension capacity in your country? (number of staff/educational level). Fill table 2 below.

Table 2. Country capability: Human resources in Agriculture Sector

Sections in Ministry	**Number with qualifications**					
	Certificate	**Diploma**	**Bachelor**	**Masters**	**PhD**	**Total**
Crop Production		2				3
Crop Protection			1			2
Extension		2	1			3

Quarantine			1			1
Policy		1				1
Others		1	1			2
Total						12

Part B: To be answered by Country Collaborators, Biosecurity/quarantine and Policy Officials:

Recovery of food crops and agricultural systems following a severe climatic event
Section 1:
Quarantine/biosecurity policy

1. With respect to food availability and crop production, are you aware of any contingency plans within your country to assist in recovery from an extreme climatic event? – Pls explain.

Quarantine (Sam Panapas)	Plant protection officer→Director of Agriculture→Secretary→Minister
Itaia Lausaveve	In the meantime, there is not any contingency plan of that sort. However, there is a National Disaster Management Committee where its role would be in line with developing such plan but nothing has been prepared yet. SPC has already assisted the department in developing its Emergency Response Plan but requires further review to accommodate extreme climatic events.
AS	No.
TT	-
IS	-
PP	Island council→Disaster management group→Secretary to Government
TP	

2. If there is a need to import **staple foods** such as root crops and fruits, is a risk assessment of the source country undertaken?

Quarantine	Actually, we import root-crops and fruit, thus, we do have conditions and procedures with which the exporters must comply.
Itaia Lausaveve	Tuvalu's food security will continue to rely on food imports including staple foods such as root crops and fruits because our local production of these food commodities remains to be low given their increasing demand. This is why we supported the Tuvalu – Rotuma Trade arrangement that SPC assisted which has taken place in the beginning of this year. So far only cassava, taro and sweet potatoes from Rotuma are allowed under this arrnegemnt. Two shipments have already taken place so far enabled by our shipping service and this will undoubledly increase into the foreseeable future. A PRA was conducted for each of the root crops prior to their importation. Plans are under way to conduct PRA for non-fruit fly prone fruits and other vegetables from Rotuma with the assistance of SPC.
AS	We are still importing staple food due to low production.
TT	Yes, this exercise is usually carried out by SPC Plant health Division.
IS	Yes
PP	Yes
TP	Yes

3. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks of importing staple foods?

Quarantine	Actually, we only import from Australia, New Zealand and Fiji.
Itaia Lausaveve	We will continue to allow vegetable and fruits from NZ and Australia, Fiji which have been our kind of traditional trading partners in fruits and vegetables and root crops from Fiji, and Rotuma recently that we believe will continue to increase and expand in the near future.
AS	We will continue the importation of fruit and vegetables from Australia and NZ. Our rootcrops were imported from Rotuma since the beginning of 2011
TT	Australia, NZ and Fiji.
IS	No
PP	Yes
TP	Yes

4. Do you have quarantine regulations around the importation of foods?

Quarantine	Yes, it is the Plant Act.
Itaia Lausaveve	We have are limited to; the Plants Act which does control importation of fresh fruits, animal importation act controlling importation of live animals; Food Safety Act over processed and stored foods and food handling practices.
AS	Yes- Plant Act.
TT	Yes, Biosecurity Act is on its way to Parliament for approval.
IS	Yes
PP	Yes
TP	Yes

5. If so, are these regulations maintained during food emergencies?

Quarantine	Yes.
Itaia Lausaveve	Maybe food emergencies are not fully addressed and so the regulations would need to be reviewed for further improvement.
AS	Yes
TT	Yes
IS	The current regulation does not mention or elaborate on that.
PP	Yes
TP	Yes

6. If you had to import **planting material/germplasm** into your country, is a risk assessment of the source country undertaken?

Quarantine	Actually, the importation of planting materials is prohibited, unless they come through tissue culture.
Itaia Lausaveve	So far, we believe what we have been receiving from Fiji through the SPC – CePACT arrangement do undertake risk assessments. Between us and SPC, we have to sign the Material Transfer Agreement, for all planting materials that come from CePACT. We know that what SPC gives us are not necessarily materials from Fiji but from other countries as well within and beyond the region. But since they are being distributed by SPC, most would have undertaken Risk Assessment. From our experience with the Tuvalu – Rotima arrangement, where all the allow crops went through PRA and auditing of facilities, it will be the basis for any other new food crop that we want to import from any other country in the region and beyond in the near future.
AS	Yes- Tuvalu- Rotuma Agreement.

TT	Yes
IS	Should be before importing not after importing.
PP	Yes

7. Are there preferred supply countries in the Pacific region to minimize the biosecurity risks when importing planting materials/germplasm??

Quarantine	Yes, only three the countries- NZ, Australia and Fiji.
Itaia Lausaveve	Yes to some extent, specifically from countries where the cultivation of Pulaka; Giant swamp taro; Cyrtosperma chamissonis is also commonly practiced, because of our interest to access more salt tolerant pulaka varieties for our adaptation program. The countries that we are interested to receive their pulaka are; Kiribati and FSM. Up to date the CePACT has collected few known varieties from Kiribati and Fiji and FSM These are still being cultured in the CePACT as tissue cultures and are yet to be released for Tuvalu until they have been virus indexed.
AS	Yes- especially from the countries where they have salt-tolerant GP of swamp taro like Guam and Kiribati.
TT	No, but planting materials and germplasm are cleared by SPC prior to arriving in the country.
IS	No favour in any country but so far we are importing only from Fiji, NZ, Australia but dry conditions is impacting into the country, should be accepted provided it agrees with our regulation.
PP	No
TP	Yes

8. Do you have quarantine regulations around the importation of planting material/germplasm?

Quarantine	Yes, Plant Act.
Itaia Lausaveve	Yes we do have quarantine regulations for the importation of planting materials / germplasm that is old and needs reviewing to allow new countries that we are importing from currently, and more in line with our current practices in accessing planting materials these days. However we do have the Biosecurity Bill that is yet to be tabled to Parliament that we believe is more suitable to our current practices and needs however, until certain contents of the Bill have been supported by other stake holders.
AS	Yes – we have old quarantine regulations for the importation of planting materials.
TT	Yes, “Plant Act” regulation re importation of plant products into Tuvalu.
IS	Yes
PP	Yes
TP	Yes

9. If so, are these regulations maintained during disaster recovery periods?

Quarantine	
Itaia Lausaveve	The current regulations do not seem to address this however the new Biosecurity Bill is worth exploring to see if it covers this specific issue.
AS	-
TT	Yes
IS	The regulation does not mention the use of the regulation during disasters; maybe should look upon that too.
PP	Yes
TP	Yes

10. Are there country specific or regional quarantine restrictions on the large scale movement of planting material/germplasm or food aid following a disaster?

Quarantine	Yes.
Itaia Lausaveve	No definitely we do not have such restrictions. Normally we may seek SPC Plant Protection and Biosecurity Advising Units for their advice.
AS	No
TT	No
IS	For a country like us with a small land mass it should be that there is no other impact on our food security and biosecurity.
PP	Yes
TP	Yes

11. Do you have access to a back-up source of your local, preferred varieties of your staple crops? E.g. other islands in your country, regional germplasm centre, etc.

Quarantine	No.
Itaia Lausaveve	For traditional food crops especially; breadfruits, coconuts, pandanus, giant swamp taro, and other root crops such as sweet potatoes, and cassava that have widely been grown through out the islands. More recently, we have CePACT with SPC that has begun collecting some of our traditional crops example; the giant swamp taro of Tuvalu's cultivars, and other root crops and bananas that SPC has in tissue culture.
AS	Yes- on our traditional food crops such as breadfruits, coconuts, giant swamp taro, bananas, etc.
TT	No, but SPC can be requested to clean up materials (giant swamp taro) variety especially "te ikataoi" from Kiribati and the other atoll states in the Pacific prior to importation to Tuvalu.
IS	At the moment there is no genebank located for such, but we hope our normal practices will help during that time.
PP	No
TP	No

Section 2:
Quarantine/ biosecurity practice

1. Do you use the SPC regional pest and disease list?

Quarantine	Yes
Itaia Lausaveve	Yes
AS	Yes
TT	Yes
IS	Yes
PP	Yes
TP	Yes

2. Do you have a country pest and disease list?

Quarantine	Yes we do have a pestlist database.
Itaia Lausaveve	Yes but incomplete and a more thorough survey has to be conducted. SPC has most of our new pests list that were provided to them by an Entomologist we contacted in the mid nineties that included plant viruses and potential pests but a lot

	of them too at the time, had not been identified until todate.
AS	No proper one.
TT	Yes, but may need updating.
IS	Yes
PP	Yes
TP	Yes

3. If so, is the country pest and disease list available and used by extension staff?

Quarantine	No
Itaia Lausaveve	It could be made available but needs to be improved in content, and translated to local language not only for extension but for local farmers awareness.
AS	We still can use our pest and disease list available, although it was incomplete.
TT	-
IS	Yes, Quarantine, Extension get information from quarantine.
PP	No
	Yes

4. What are the highest risk exotic pest and disease threats to the main food crops in your country?

Quarantine	Pest- mealy bug
Itaia Lausaveve	Taro beetle, Coconut Rhino beetle, fruit flies, coconut scale insects, mealy bugs that is badly affecting tomatoes, cucmbers and capsicums in home gardens.
AS	Coconut rhinoceros beetle, coconut scale insect, fruit flies
TT	Taro beetle, taro leaf blight, rhinoceros beetle, coconut stick insects.
IS	Coconut scale, fruit fly
PP	Coconut scale insect
TP	Coconut scale insect

5. Do you have sufficient resources/staff/regional networks to be able to identify a new/unknown pest or disease?

Quarantine	No
Itaia Lausaveve	No. This is why we continue to rely on SPC's assistance, financially, and technically.
AS	Not at all, we need assistance from SPC and interested countries/organizations that are keen to assist us, technically and financially.
TT	No, but we depend on SPC to carryout the task of identifying new pests/diseases.
IS	No
PP	No
TP	No

6. What do you do when you are unable to identify a pest or disease?

Quarantine	We send the specimen to SPC.
Itaia Lausaveve	Refer the specimen to LRD - SPC
AS	-
TT	The plant health division staff usually seek SPC's advice.
IS	Contact SPC, take a picture if we can.
PP	Ask SPC for assistance
	Ask assistance from SPC.

7. What quarantine interceptions of new pests and diseases of food crops have occurred in the last 5 years?

Quarantine	Pest- Acmaeodera (Maronela) scalaris wood-boring beetle
Itaia Lausaveve	1. A fruit fly spp still contained on Niulakita 2. A caterpillar that devastated foliage of the Cartappa Tree on Funafuti 3. More recently this year, a caterpillar attack on the kanava trees on Nanumea island that continues to date. We are working closely with SPC and the Nanumea council and communities to bring this under control by starving the pest from pruning this tree host; locally known as "kanava" as advised by SPC. Kanava is not a food crop but is an important shoreline coastal protection tree because of its strong root system.
AS	Coconut scale insect at Nanumaga Island spread later to Vaitupu. Caterpillar attack on a local tree (Kanava) commonly grown on the shoreline foe coastal erosion protection.
TT	-
IS	Coconut scale and fruit fly
PP	-
TP	-

8. What biosecurity incursions (new pests and diseases) have been found in food crops in the last 5 years?

Quarantine	Bactrocera xanthodes- found in one island only
Itaia Lausaveve	None
AS	-
TT	-
IS	On food trees only so far.
PP	-
TP	-

Part C: Participants survey: To be filled by all including Agriculture staff, biosecurity/quarantine, livestock, forestry, women programs, NGOs, district officials, prominent farmers etc.

What are the key impacts of climate change on food crop security and biosecurity in your country?

Section 1: General information

1. What are the major crops grown in your area? Please rank in order of importance below:

IL	i.	Coconuts
	ii.	Pulaka
	iii.	Breadfruits
	iv.	Bananas
	v.	Taro colocassia
	vi.	Vegetables and pawpaws
	vii.	Panadanus
SP	i.	Coconut trees
	ii.	Breadfruits
	iii.	Bananas

	iv.	Pawpaw
	v.	Cabbages
	vi.	Tomatoes
AS	i.	Coconuts
	ii.	Pulaka
	iii.	Breadfruits
	iv.	Bananas
	v.	Taro
	vi.	Pawpawa
	vii.	Vegetables- cabbage, cucumber, tomatoes
TT	i.	Coconut
	ii.	Pulaka (giant swamp taro)
	iii.	Breadfruit
	iv.	Bananas
	v.	Taro
	vi.	Pandanus (edible spp.)
	vii.	Wild fig (felo) -hardy crop
IS	i.	Breadfruit
	ii.	Pulaka (Giant swamp taro)
	iii.	Vegetables
EM	i.	Cucumber
	ii.	Cabbage
	iii.	Pawpaw
	iv.	Eggplant
	v.	Tomato
PP	i.	Coconut tree
	ii.	Breadfruit tree
	iii.	Banana
	iv.	Giant swamp taro
	v.	Cabbage
	vi.	Pumpkins
AH	-	

2. What are the major pests and diseases of these crops? Please rank in order of importance below:

IL	i.	Coconut scale insect
	ii.	Rats
	iii.	Fruit flies
	iv.	Meal bugs
	v.	Ants
SP	i.	Mealy bug
AS	i.	.Rats
	ii.	.Coconut scale insect
	iii.	.Fruit flies
	iv.	.Mealy bugs
TT	i.	Coconut palm- coconut scale, rodents, brown scale
	ii.	.Pulaka- corm rot, crabs
	iii.	.Bread fruit- mealy bug, fruit rot

	iv. v. vi. vii.	Banana- .banana aphid, nematode Taro-.Taro leafhopper, corm rot Pandanus- Mealy bugs, rodent, Wild fig- none known
IS	-	
EM	i. ii.	Aphids Mealy bugs
PP	i. ii. iii.	Coconut scale insects Mealy bugs Leaf streak
TP	i. ii. iii.	Coconut scale insects Mealy bugs Leaf streak
AH	-	

3. Do you think the seriousness of any of these pests/diseases has increased due to changes in climate (e.g. rise in water table, changes in rainfall etc)? Please explain.

IL	Most recently on the island of Nanumea, although the outbreak of this pest is not affecting any food crops so far but only the "kanava' tree that typically grows on the island coastlines of most islands with lagoons, the pest a caterpillar has devastated the kanava feeding on the leaves. A cultural control method by heavy pruning to starve the catepillars is already continuing to this date assisted by the island community following SPC LRD advice. The department of agriculture is currently supervising the control and monitoring its impact and frequent reports sent to SPC every week. The department in its own assessment, the pest is not an intrusion from smuggling plant material as the pest is also known locally, but suspected to be triggered by the prolonged drought currently experienced throughout Tuvalu. The pest wanting more water may have caused to over feed this specific tree that is also host to the caterpillar know to be originated from Hawaii. So prolonged drought and increase in temperature that was recorded in May of this year may have worsen the situation. The pest began to be noticed late last year. The USP through Professor Randy Thaman and his Tuvaluan Master student who reported this situation have also taken an interest in the pest outbreak and say they have found a biological agent. However, the department in recognizing their interest and assistance have is yet to respond positively, but as the last resort until the department's counterpart for such outbreaks, the SPC LRD advices so.
SP	Yes, especially during droughts
AS	Yes, due to prolonged drought which contributes to the increase of dryness which may encourage the pest to look/search for water.
TT	Yes 1) Corm rot in pulaka and taro due to increase of quantity of underground water lense especially during the king tide period beginning of wach year Jan- Mar. 2) Increase in population of mealy bug during prolonged drought periods.
IS	Its either climate change,or the delay in Government support of the current situation.
EM	-
PP	Yes
TP	Yes
AH	-

4. Have you seen any new pests/diseases arrive in your country in the last 5 years which have impacted on food crop production? Please explain; and what actions were taken (i.e. survey, controls, elimination, etc)

Table 3. New pests and diseases

Code	Name of Pests/Diseases	Actions taken				
		Survey	Control	Elimination	Ignore	Comments
IL	Fruit flies					Traps continue to be used.
	Coconut scales					Bio-control continues to be monitored and strict movement of planting materials and frsh commodities including brown coconuts. Salt water dipping is applied of these commodities. This is supervised by our agricultural agents with the assistance of the Island councils of Vaitupu and Nanumaga alone where this pest exist.
SP	B. xanthodes		√			Trapping
AS	-					
TT	-					
IS	-					
EM	Coconut scale		√	√		Host plant/plant affected
PP	Coconut scale insect		√			Bioagent Chilocores nignita
TP	Coconut scale insect		√			Bioagent Chilocores nignita
AH	-					

Section 2: Experiences with crop production and climatic events

1. Have you experienced the effect of climatic factors (cyclone, flood, salinity, drought, increased temperature etc) on crop production and food availability in your area? **Yes/No** If yes please answer the more specific questions below.

IL	Yes
SP	Yes
AS	Yes
TT	Yes
IS	-
EM	Salinity and drought, only when it is high tide (Feb and March), drought (dry season) (May-Sept)
PP	Yes
TP	Yes
AH	Yes

2. Have you had any experience with the impact of a cyclone on agricultural systems that affect food supply and crop production? If yes, please provide details of the impacts.

IL	Yes. Waves that came overland and impacted the pulaka pit on Nukulaelae island in 2005 damaging more than an acre of pulaka crops. The pulaka died of salt water and could not be used because they tasted saltier.
SP	Yes, destroy the pre-mature fruits, even though uprooted the crops

AS	Yes, the pulaka pit on Nanumaga had been affected by salt water.
TT	Yes. Most of the food crops are damaged by strong winds, high swells from the Oceanside producing abnormal wave height. Crops like coconuts, breadfruits, bananas, pulaka especially pits near ocean side of the island.
IS	-
EM	No
PP	Yes, destroys/damages to all young and ripening fruits.
TP	Yes, destroy/damage to all young and ripening fruits
AH	Yes. Damage to food crops but slow recovery/slow response

3. Have you had any experience with the impact of a drought on agricultural systems that affect food supply and crop production? If yes, please provide details:

IL	Yes. The Nanumaga Drought in 2006 killed about two acres of pulaka because of the prolonged drought. Most crops were not used as they rotted and the islanders were slow to harvest them as they awaited with expectations of some rain to recover them that never happened at the time.
SP	Yes, the production drop, crops bear no fruits, fruits get smaller in size.
AS	Yes, the vegetable crops production was really affecte very low production.
TT	Yes. Size of normal coconuts reduced, pulaka crops- the corms got rotten due to high salinity of water lens. Bananas and breadfruit normal size of fruit reduced.
IS	-
EM	No
PP	Yes, less yield in crops and small size of fruits or bear no fruits.
TP	Yes, decrease yield of crops, small size of fruits and bear no fruits
AH	Yes. Lack/limited food supply and low crop productions.

4. Have you had any experience with the impact of flooding on agricultural systems that affect food supply and crop production? If yes, please provide details.

IL	Yes. This is a more frequent and obvious happening throughout the year during spring tides, king tides. In 2007, the kingtide flooded the Funafuti pulaka pits with saltwater incursion, where the community sought government assistance. However the problem was minimal due to subsequent continuous heavy rains that washed away the accumulated salt in the pulaka pit from the saltwater incursion from this particular king tide. The department of agriculture was tasked to look into the situation, and basically the assessment involve testing salinity levels from 15 different locations in the 3 pulaka pits and inspecting dying plants, by uprooting them, and close observation of young and old plants, where the majority had already shown recovery by newly developed leaves. The water samples potent levels. We also actually tasted the water but no saltiness tasted, just fresh water. So that was our Dept. conclusion, the pulaka were recovering because of the following heavy rains washed out salts following the salt water incursion from the king tides of March of that year. The flood impacts from spring tides and king tides also frequently damages home gardens in lower lying areas on the capital island of Funafuti. People have grown their vegetables in containers or raised beds placed on platforms made of timber to avoid more floods.
SP	Yes, killed some crops
AS	Yes, the king tide affect the vegetable crops in some home gardens at low lying areas. Pulaka pits were also affected.
TT	No. The only flooding occurred to pulaka pits close to oceanside- crops have to be harvested immediately before they get rotten due to high salinity of water in the pits. Otherwise flooding is not common and only takes place during king tide period and cyclones.
IS	-

EM	No
PP	No
TP	No
AH	Yes, with sea level rise and storm surges

5. Have you had any experience with the impact of rising sea water levels on agricultural systems that affect food supply and crop production? If yes, please provide details.

IL	Yes. Yellowing of coconut trees and in higher trees and bushes in low lying areas of all islands in the interior. Pulaka pits that are dug right down to the water lens have nore obvious impacts in the yellowing or worst, dying and rotten later.
SP	Yes, killed some crops
AS	Yes, coconut trees and pulaka were affected- their leaves turn yellow due to salt damage.
TT	Yes. Sea water intrusion in pulaka pits causing pulaka corms to rot if left to grow. Deep rooted breadfruit trees started to die back from the top.
IS	-
EM	Yes. Nannmaga and Niutao sea water in pulaka pits.
PP	No
TP	No
AH	Yes, with sea level rise and storm surges

6. Are there any other climatic events that you believe impact on food security in your country? **Yes/No**

If yes, please provide details.

IL	Yes. Prolonged drought, saltwater incursions, coastal erosion from storm surges and wave and tidal impacts. This has caused many coconuts and pandanus and other higher trees along the coastlines where fallen trees are so obvious
SP	Yes, by fire, which killed some crops
AS	Yes, coastal erosion from tidal impacts/waves that caused many trees and pandanus on the coastline to fall. -saltwater damage -drought
TT	No. Most of the food crops cultivated in Tuvalu have adapted to a certain degree of salinity, though all will not withstand if the whole island gets flooded with seawater, not like a flood situation in Fiji is because too much water from heavy rains and not seawater so that all the vegetation gets affected.
IS	-
EM	-
PP	Yes, tidal wave.
TP	Yes, tidal waves
AH	Hurricanes.

Section 3: Capacity building:

Preparedness for dealing with impacts of CC on crop production systems (food security/biosecurity)

(Yes, no, N/A- please elaborate on questions relevant to your job)

1. What sources of germplasm/planting material do you have access to?

IL	Mostly cuttings, corms/tubers and shoots of traditional food crops including sweet potates, and cassava; and vegetables from the Taiwan Mission. The department also imports vegetable seeds from NZ

SP	Tissue culture
AS	Cuttings, tubers, young shoots from local crops. Vegetable seed from NZ and Taiwan Technical Mission.
TT	-
IS	-
EM	Seeds, cuttings
PP	Tissue cultures
TP	Tissue culture
AH	-

2. Are you able to multiply germplasm?

IL	The department has been doing this with breadfruit variety from the Niutao variety during the DSAP project and distributed to other islands who were interested in this low fruiting breadfruit. The department recently has not been very active recently in this for other traditional food crops because of the lack of funds. However it has the capability given its allocation of land leases including a pulaka pit that is available to conduct these activities.
SP	Yes
AS	Yes, only the new breadfruit tree found on Nuitao after the cyclone Nuia (DSAP).
TT	-
IS	-
EM	No
PP	Yes
TP	Yes
AH	-

3. Do you have adequate resources for diagnostics and recognition of new pests and diseases?

IL	No.
SP	No
AS	Not to remote diagnostics service via the internet. However we just sent photos and specimens to SPC for identification.
TT	-
IS	-
EM	No
PP	No
TP	No
AH	-

4. Do you have access to regional diagnostic expertise and remote diagnostic services via the internet?

IL	We can access SPC technical personnel but we do not have access to remote diagnostic service via the internet. We once tried using Pestnet but the response had been slow. Sending photos of pests and describing their impacts and sending sending them to SPC has been most effective with prompt results from SPC.
SP	Through SPC
AS	No.
TT	-
IS	-
EM	No
PP	No
TP	No

5. Do you have adequate internet access?

IL	Yes, but always experience daily cuts, slowing down, heavy traffic, been like this in the last 10 years!!! The problem of the government internet system is that it has a small bandwith that is congested at most times. Telcom operates an ISP with faster connection but the charges are too high that we could not afford from our budget (AuD 500.00 per month) is our access category if we register with Telecom ISP.
SP	No
AS	Yes, we have internet but it does not work well- too slow sometimes.
TT	-
IS	-
EM	Yes
PP	No
TP	No
AH	-

6. Which regional CC projects do you have linkages to?

IL	The Environment GEF funded National Adaptation Plan of Action (Salt tolerant crop varieties) – 3 more years Sustainable Land Management (EU) Pulaka pit terracing farming system1.5 years Food Security & Sustainable Livelihood Program (FSSLP) of the FAO addressing; food production, fisheries, added value foods, health, trade and climate change
SP	FSSLP
AS	Food Security and Sustainable Livlihood (FSSLP)-FAO, SLNI and NAPA (National Adaptation Plan of Action).
TT	-
IS	-
EM	No
PP	FSSLP
TP	FSSLP
AH	-

7. Do you have training needs to deal with CC? (crop production under changing climate, diagnostics, CC impact minimization,)

IL	Composting, agronomy, improved farming systems, biosecurity, identification of pests, pest control; IPM, Pest forecasting software through environmental changes, sustainable agriculture practices on atolls.
SP	Yes, Crop protection and Management under climate change and Crop Protection
AS	-Improve farming system and composting -IPM -Biosecurity
TT	-
IS	-
EM	Yes
PP	Yes, crop production under climate change and diagnostics.
TP	Yes
AH	-

8. If you are involved in quarantine/biosecurity, would you benefit from networking/training opportunities with Australian/NZ biosecurity agencies? Pls explain.

IL	This would be most useful, to expose our staff to learning advance methods and experience from these countries that in return would undoubtedly improve the knowledge and capabilities of our staff to carry out their responsibilities and more specific tasks, identifying solutions and managing problems with more confidence with efficiency in a timely manner..
SP	Yes, it would build up the capacity of understanding in biosecurity issues and technology through this advanced expertise.
AS	Yes, we will be able to learn more and may also exchange ideas with others.
TT	-
IS	-
EM	Yes
PP	Yes, it build up the capacity of understanding in biosecurity issues through this advance expertise and technology with time.
TP	Yes, it build up the capacity of understanding in biosecurity issues through their advance expertise and technology techniques.
AH	-

End of Questionnaire

Appendix 6. Conference presentations.

Freeman A, Taufatofua P, Rodoni B, Luck J. 2010. Impact of climate change on food security and biosecurity in small Pacific nations. Proceedings of Global Biosecurity 2010: Safeguarding agriculture and the environment. Brisbane, pg 68, 28 Feb-3 Mar 2010. (Presentation below).

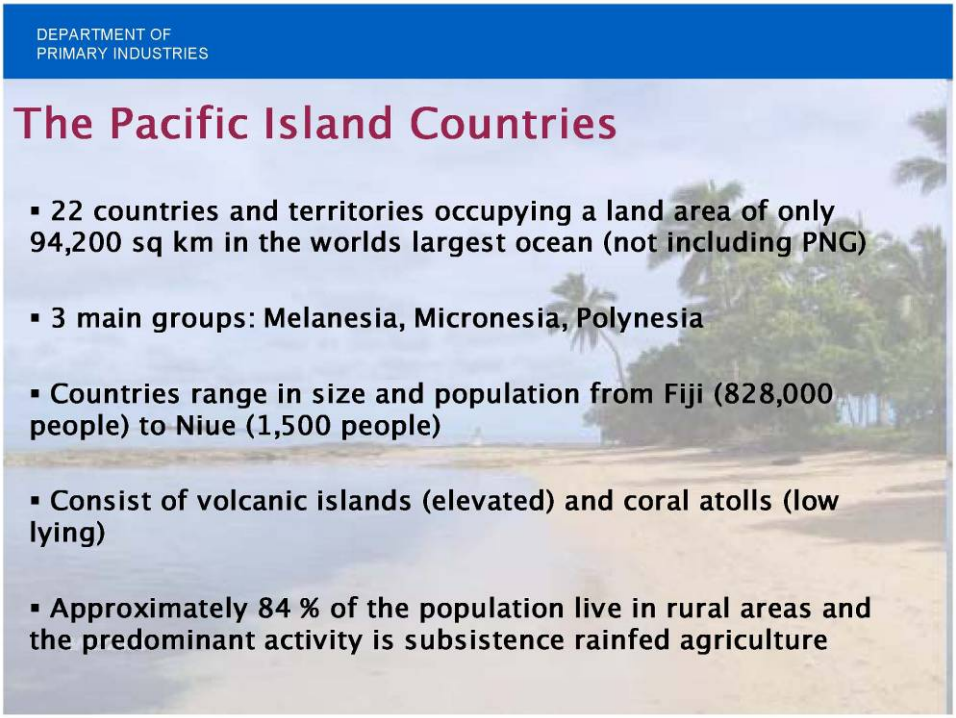
Freeman, A., Rodoni, B. and Taufatofua. (2011). Impact of climate change on food security and biosecurity in small Pacific nations. The 4th Asian conference on Plant Pathology, concurrent with The 18th Biennial Australasian Plant Pathology Society Conference. Darwin 26-29 April 2011. (Modified from above presentation- not presented below).

Impact of climate change on food security and biosecurity in small Pacific nations.

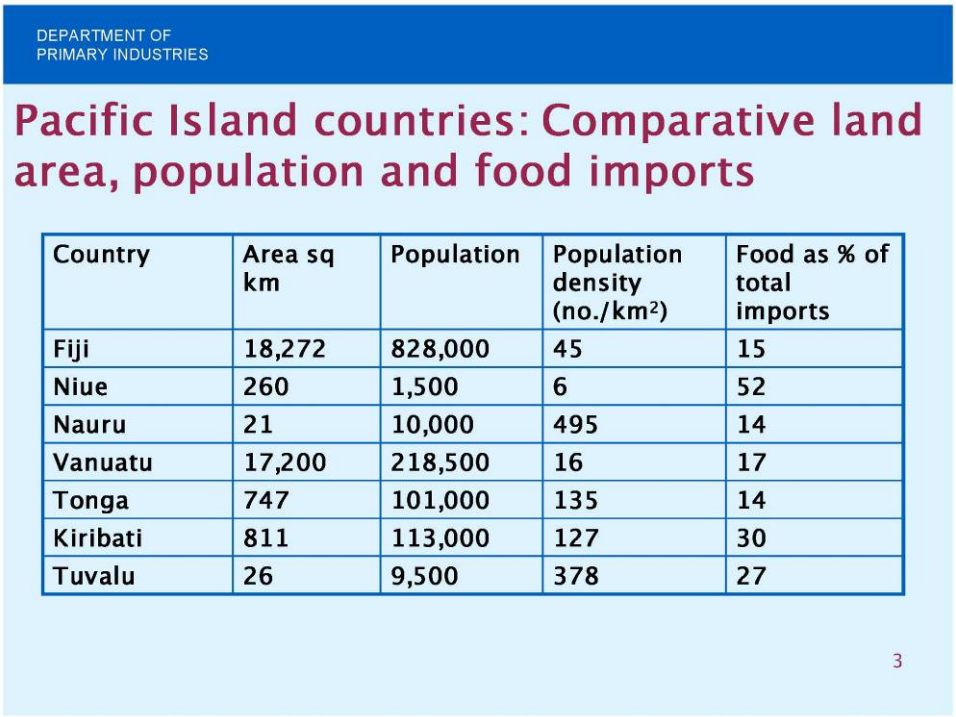
(Global Biosecurity 2010: Safeguarding agriculture and the environment.)

Slide 1

Slide 2

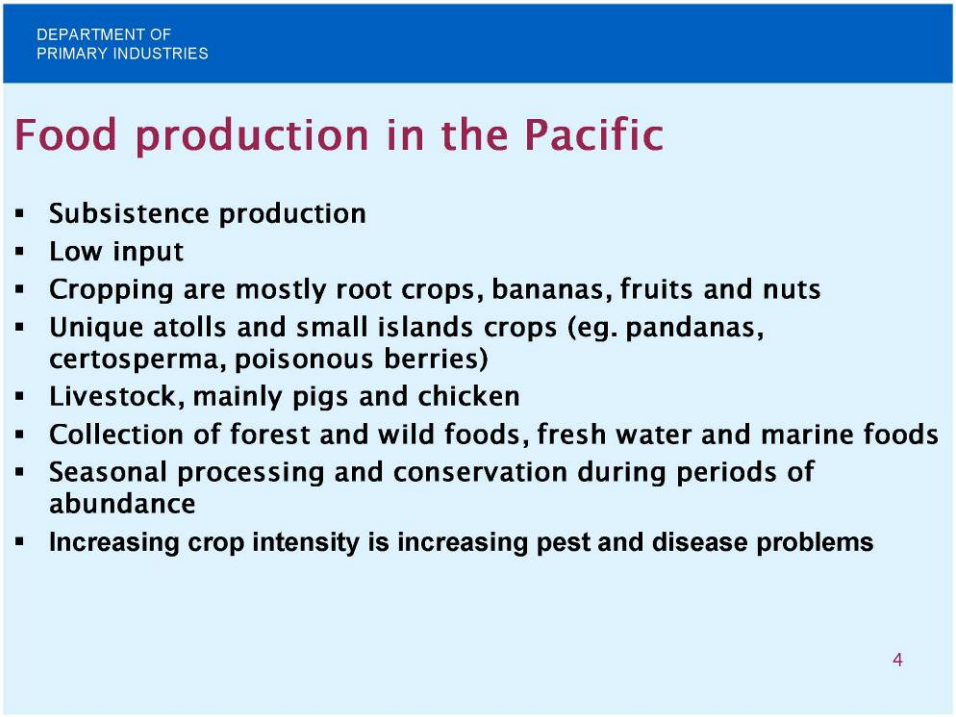


Slide 3



Country	Area sq km	Population	Population density (no./km²)	Food as % of total imports
Fiji	18,272	828,000	45	15
Niue	260	1,500	6	52
Nauru	21	10,000	495	14
Vanuatu	17,200	218,500	16	17
Tonga	747	101,000	135	14
Kiribati	811	113,000	127	30
Tuvalu	26	9,500	378	27

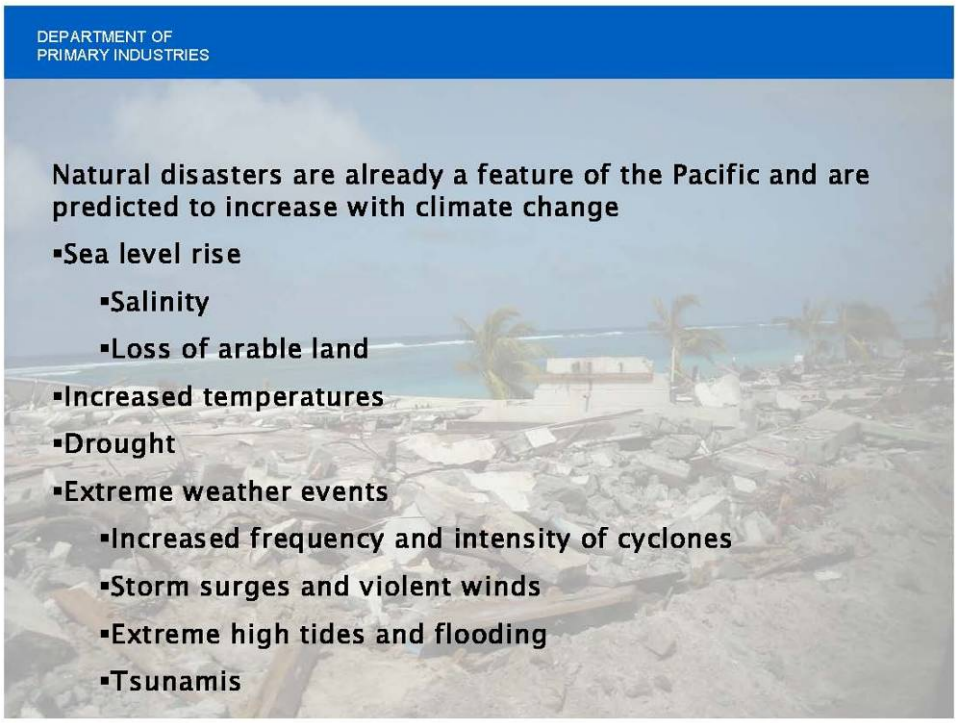
Slide 4



Slide 5

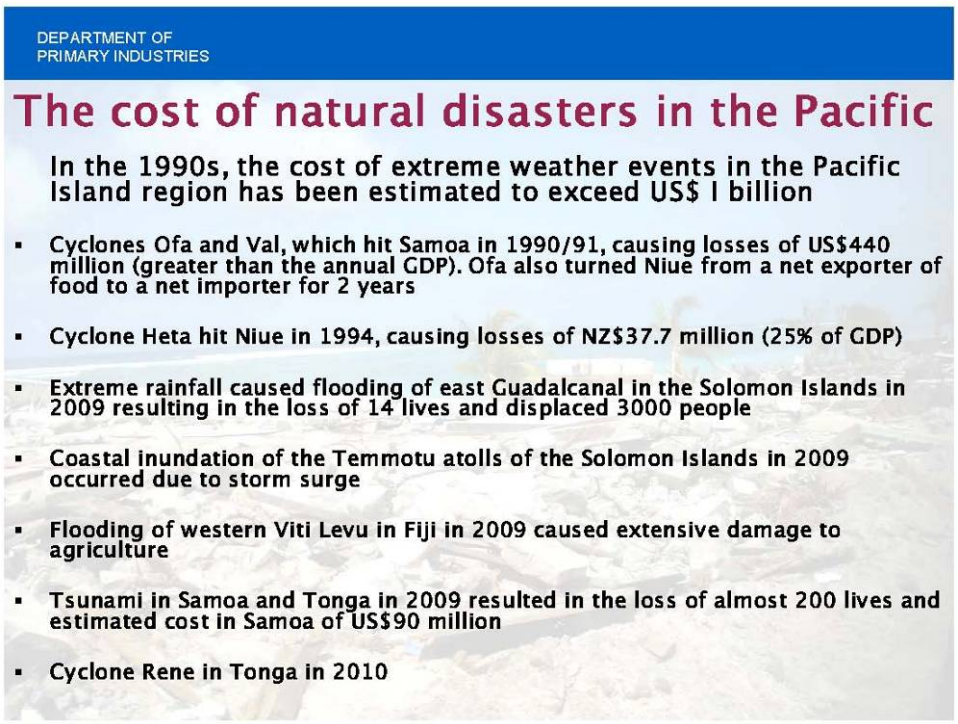
Food crops TL - Cassava (Tonga) TM - Certosperma (Kiribati) TR - Sweet potato (Solomons) BL – yams (Vanuatu) BM - pawpaw (Tuvalu) BR – market day (Vanuatu)

Slide 6



Background – tsunami destruction of coastal villages in Samoa 2009

Slide 7



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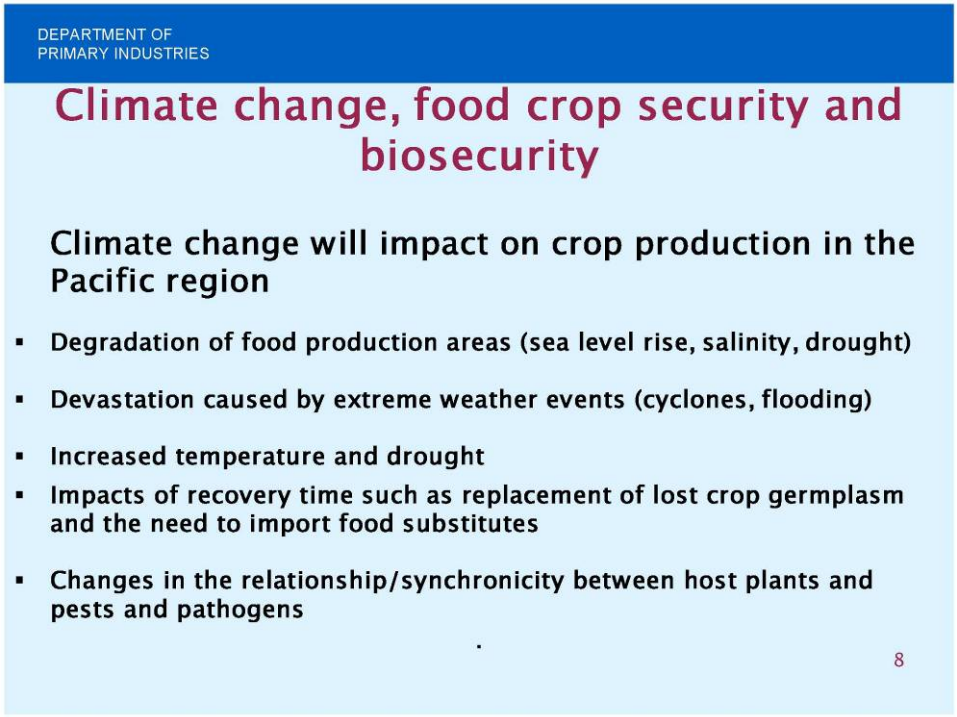

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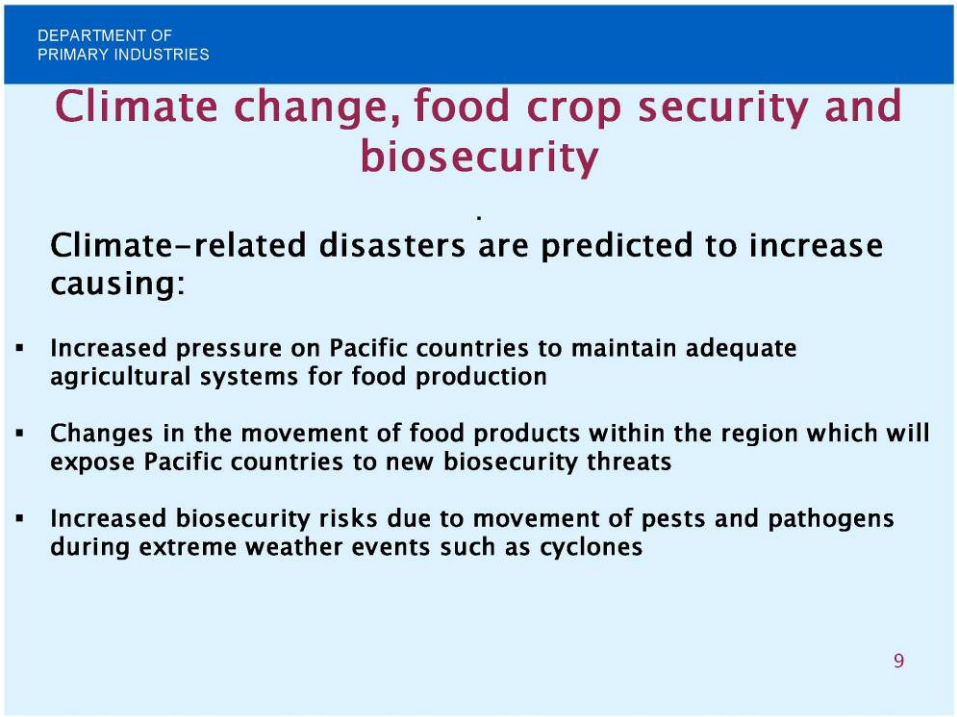
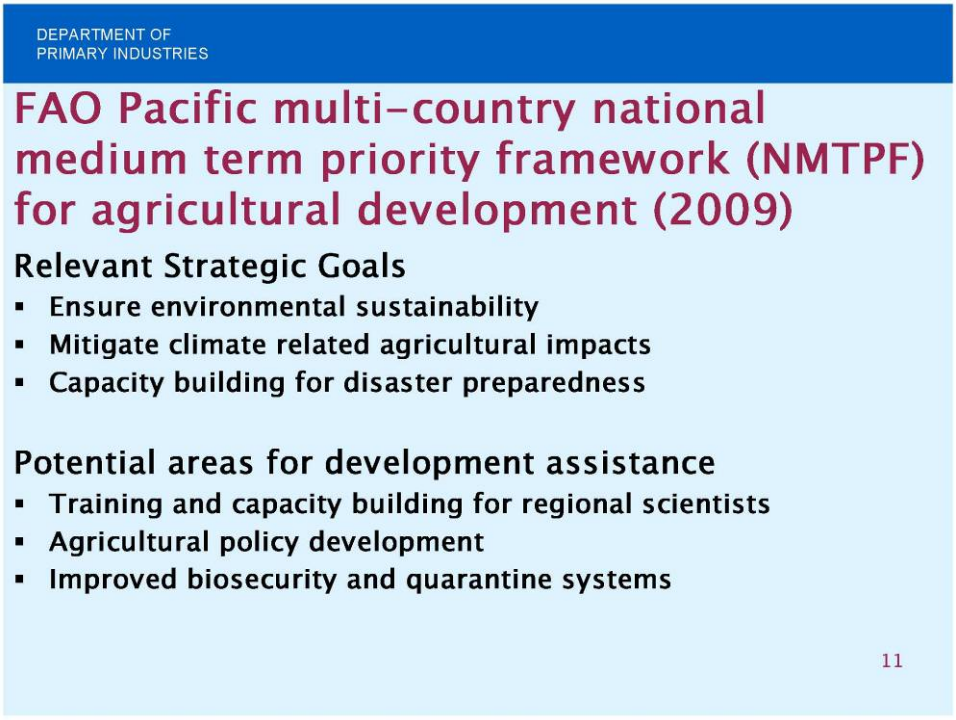


Slide 10

Top L – James standing where father's house was 3 months ago. TM - Swim and laundry where food garden was 3 mths ago. TR – where is the bridge – and road? BL – Flood displaced 15 yo Benuel wonders about his future. BMnR – flood silted garden lands prone to erosion

Slide 11



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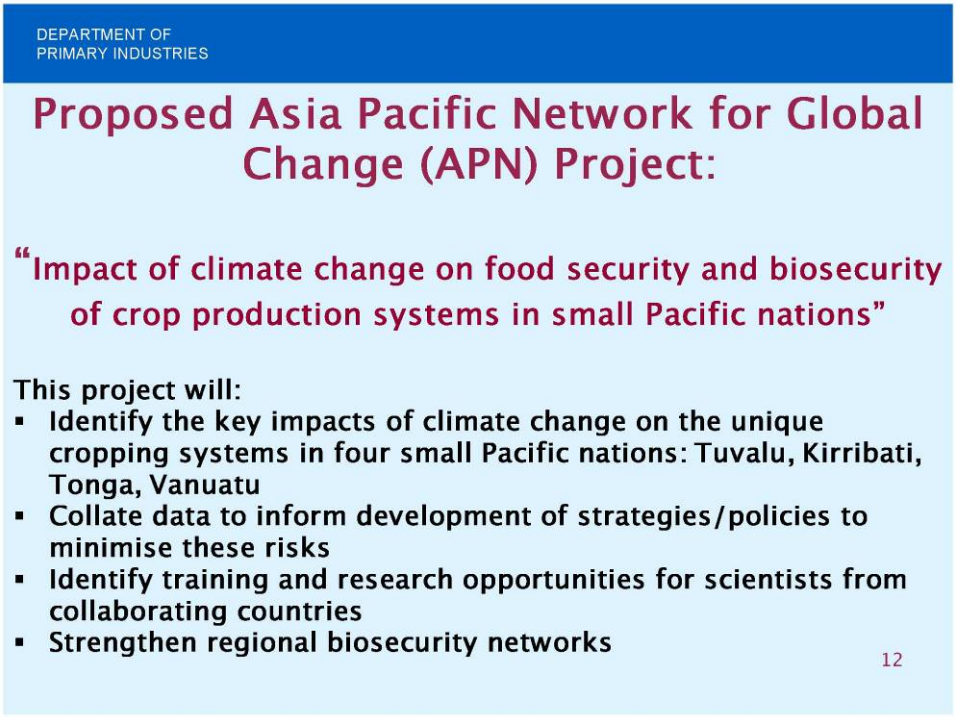


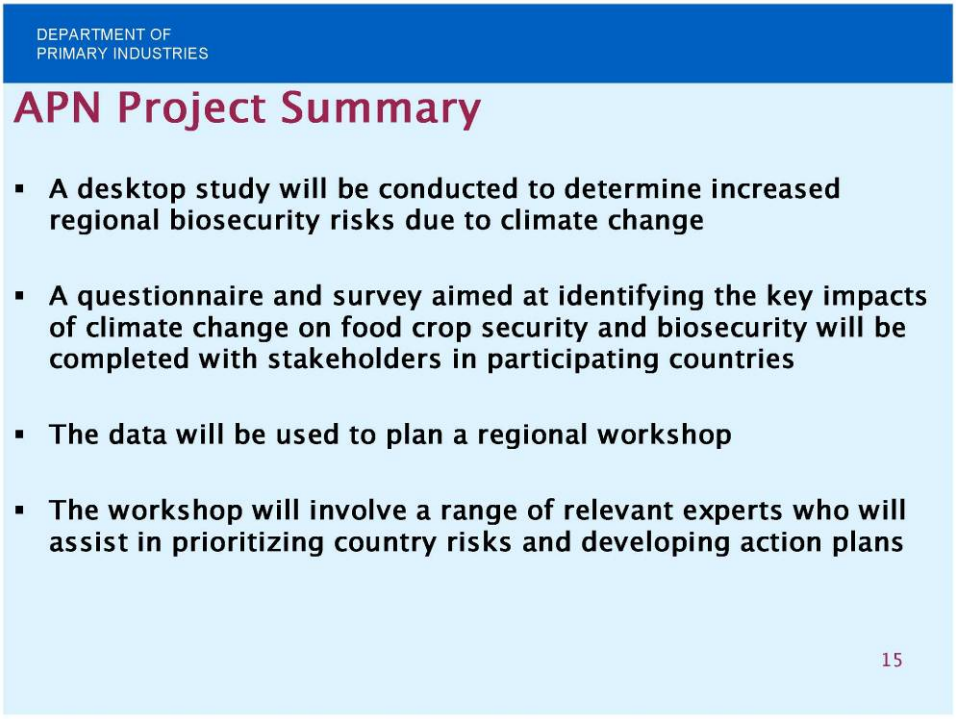
Slide 13

Some Some challenges: TL – cropping on limestone (Niue) TM – cropping on, in, under pure sand (Atolls). TR – soil-less cropping, compost only (Tuvalu). B - Unique crops: BL Certosperma. BM – Pandana. BR – taro crop

Slide 14

More challenges – Serious pests, diseases spreading from Mid (Melanesia) to North (Micronesia) and South (Polynesia)

Slide 15



Slide 16

DEPARTMENT OF
PRIMARY INDUSTRIES

APN Project outcomes

Data on impacts of climate change on food security and biosecurity will be used to inform:

- Policy and regulation
  - Strategies to prepare for or mitigate impacts
  - Biosecurity policy aimed at protecting agriculture in these countries
- Practice change
  - Preparation/practices to reduce impacts
  - Increased regional networks
  - Strengthening of regional biosecurity
- Research and development
  - Collaborative research projects
  - Training opportunities

16

Slide 17

What kind of future are we leaving behind for our children? Is there a future?