SI-6

A MULTIDISCIPLINARY RESEARCH STRATEGY TO MITIGATE THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION IN PNG

John S. Bailey and Raghunath D. Ghodake
The National Agricultural Research Insitute (NARI) of Papua New Guinea, Highlands Programme, P.O. Box 210, SIL, Ukarumpa, Eastern Highlands Province 444, Papua New Guinea

ABSTRACT

Historically, agriculture has proved to be fairly adaptive to changing environmental conditions, but this may not hold true in the present global climate change scenareo. Worldwide, land and ocean temperatures are increasing at unprecendented rates, raising the global average sea level and significantly altering the intensity and distribution of precipitation events, thus bringing more frequent droughts, floods and sea inudations, particularly to tropical latitudes (IPCC, 2007). Papua New Guinea (PNG), situated on the western rim of the tropical pacific, is being affected not only by global warming, as shown by recent annual temperature increases (Fig. 1) and rising sea levels, but is also vulnerable to extremes in rainfall intensity linked to the El Niño Southern Oscillation (ENSO). The most widespread food shortages in PNG have resulted from severe drought conditions brought on by strong El Niños. Interspersed with these events have been excess rainfall conditions, linked to La Niña events, which have been almost equally detrimental to crop production, since excessively wet conditions prevent sweet potato, (PNG's staple food crop) from producing tubers (Bourke, 2005) and trigger fungal diseases in this and many other crops. The threat posed by disease is particularly concerning because of the narrow genetic base of PNG's sweet potato germplasm, and the risk that local varieties would be unable to cope with increased disease pressure under warmer/moister conditions, and indeed there is evidence that this is happening already. The 1997 El Niño drought was unexpected because an event of such severity had not occurred since 1914. Scientific evidence suggests, however, that this event was the strongest in a series of strengthening El Niños that are now recurring every 10-15 years and giving rise to food and water shortages throughout much of PNG, and that another major event is likely around 2012 (Fig.2).

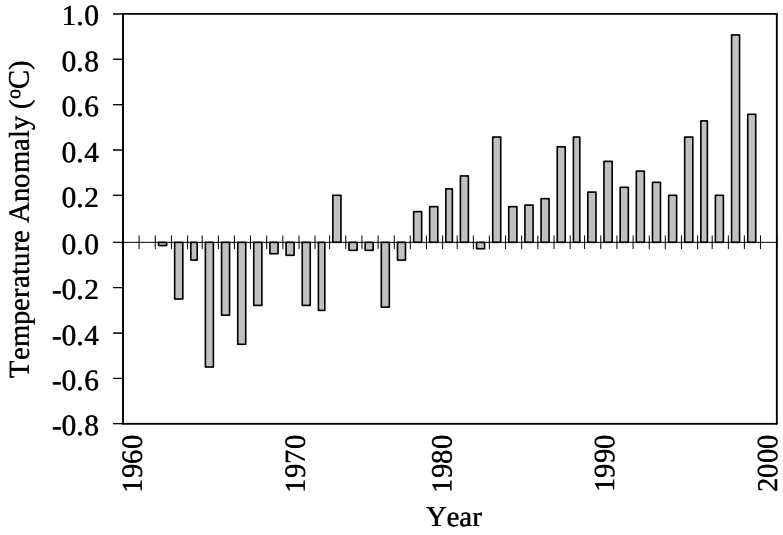


Figure 1. Temperature anomalies for PNG (Inape and Humphrey, 2000)

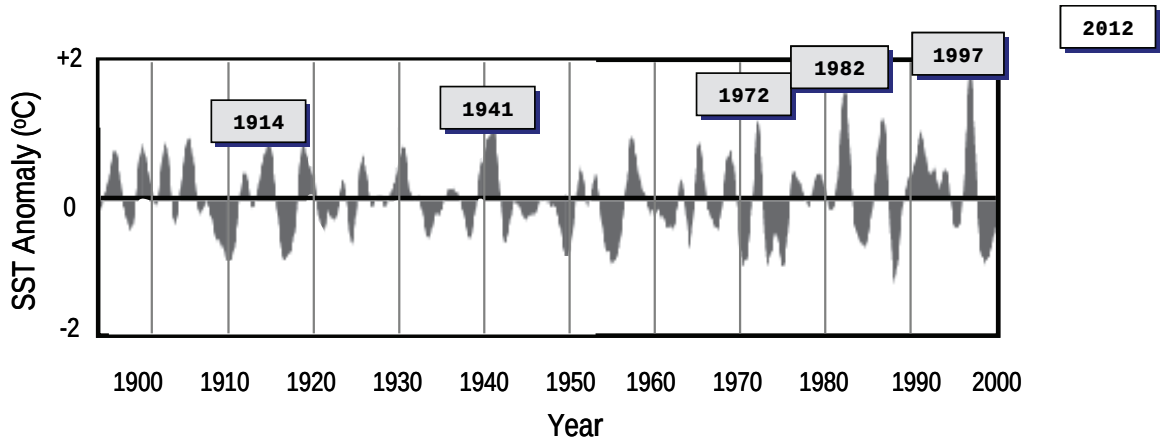


Figure 2. Sea surface temperature (SST) anomalies in the equatorial pacific – 1900 to 2000; red peaks are El Niño events and blue peaks La Niña events; yellow boxes show years when major droughts occurred in PNG

In response to the threat of climate change, a series of projects are being developed by NARI in collaboration with other agencies and overseas institutions in a 4-part multidisciplinary research strategy aimed at mitigating the impacts of global warming and ENSO activity on food production in PNG.

As the first line of defence, an early warning system is being developed through an ACIAR (Australian Centre for International Agricultural Research) funded project entitled "Early warning and drought preparedness for improved management of crop production in PNG". This will involve the development of a drought forecasting and early warning system for PNG through customization of SCOPIC (Seasonal Climate Outlooks for Pacific Island Countries) software and the use of historical production data for important subsistence and cash crops (sweet potato & coffee) to provide models capable of predicting the impacts of various climate change scenarios on production.

The second and more fundamental risk aversion stratagem is the diversification of genotypes and cropping systems to allow for unforseen as well as predictable impacts of climate change on crop production. This will include the preservation and broadening of existing national gene pools of staple crops such as sweet potato to ensure ample genetic scope for crop adaptations in future climate change scenarios. It will also involve the selection and breeding of crop varieties with genetically imparted tolerances to biotic and abiotic stresses. Already a breeding and hybridization program is underway to develop early maturing, high yielding recombinants of sweet potato to facilitate the speedy recovery of food production following drought or excess rainfall conditions. Further work is also in the pipeline to screen highland and lowland sweet potato germplasm to identify genotypes displaying drought, cold or excess moisture tolerance and resistance to viral and fungal disease infections. These will then be crossed with other elite local and exotic genotypes to produce high performing recombinant clones tolerant to a range of biotic and abiotic stresses. As well as widening the gene pools of specific crop species, research will also be conducted to evaluate the benefits of diversifying traditional cropping systems by introducing new high-performing varieties of maize, rice, yam and peanut, etc. Such diversification should help to prevent the build-up of host-specific pests and diseases and minimise the risk of outright crop failure due to abiotic stresses e.g. frost or drought. Sustainable methods of maintaining soil fertility under such diversified cropping systems will also be explored in a suite of ACIAR and NARI funded projects.

Figure 3. Polycross breeding of new sweet potato clones

The third element in the research strategy specifically targets the problem of heightened pest and disease outbreaks owing to climate change. Already PNG has suffered the virtual destruction of its potato industry following the outbreak of late potato blight disease in the late 1990's, and viral disease and pest infestations of sweet potato and other crops are increasingly hampering production and marketing. In response to these problems a series of ACIAR funded projects have been developed to tackle the issues of late potato blight in 'Irish' potato, oribius weevils and virus attacks on sweet potato, and fruit fly infestations in various crops. Biotechnological solutions are being implemented including the micro-propagation and field testing of blight free and blight resistant potato clones, and the development of 'clean' pathogen tested sweet potato planting materials. Biological, cultural and low cost chemical methods for controlling oribius weevils and fruitflies are also being investigated.

The final element in the research strategy focuses on the provision of water supply facilities to sustain crop production in a scenario of recurring El Niño-induced drought events. Regional geological surveys are needed to investigate aquifer accessibility and terrain suitability for the construction of mini-reservoir, spring and borehole supply facilities in the five main agro-ecological regions of PNG (high altitude highlands, highlands, dry lowlands, wet lowlands and islands). Community surveys will be needed to establish local preferences for specific types of water supply and to deal with water and land ownership issues. Thereafter, pilot studies will be needed in each region to assess the feasibility, practicalities, costs and effectiveness's of the different methods of supplying water for (drinking and) crop irrigation. NARI has identified a number of partner organizations, including water institutes in Europe that would assist in the research and development, but substantive government funding will be needed if the initiative is to proceed.

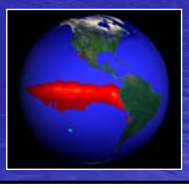
KEYWORDS
Climate change, crop diversification, El Niño-induced drought, gene pool broadening, irrigation.

REFERENCES
Bourke, R. M., 2005: Ethnology Monographs 19, Oceania Monographs 56, 15-24.
Inape, K. and B. Humphrey, 2000: ACIAR Proceedings, No 99, 73–78.
IPCC, 2007: Intergovernmental Panel on Climate Change, Fourth Report.

A MULTIDISCIPLINARY RESEARCH STRATEGY TO MITIGATE THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION IN PNG

John Bailey
National Agricultural Research Institute of Papua New Guinea





Presentation Outline

1. Background
2. Climate Change (CC) Impacts on PNG
3. Strategy for mitigating CC impacts
4. Conclusion

Background

Global Warming

"Now Unequivocal" - IPCC 2007

TOP 5 WARMEST YEARS WORLDWIDE SINCE 1890's

1. 2005
2. 1998
3. 2002
4. 2003
5. 2004

Background

Floods 2002




Worst Floods in Centuries across Europe

Worst Floods in Decades across Asia



Background

Drought 2006


AUSTRALIA Suffers Worst Drought in Centuries




Background

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Climate Change 2007: The Physical Science Basis

Summary for Policy Makers – February 2007

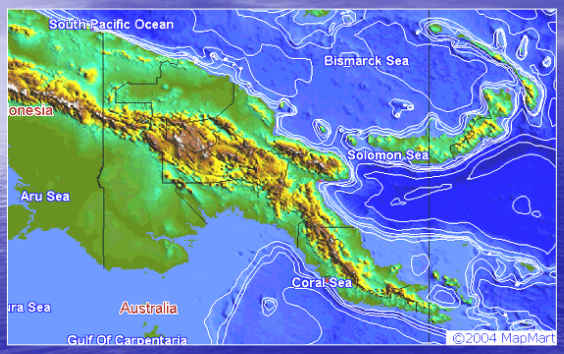
"For the next two decades a warming of 0.2°C per decade is projected"

"Anthropogenic warming will continue for centuries --- even if greenhouse gas concentrations are stabilized"

"It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent"

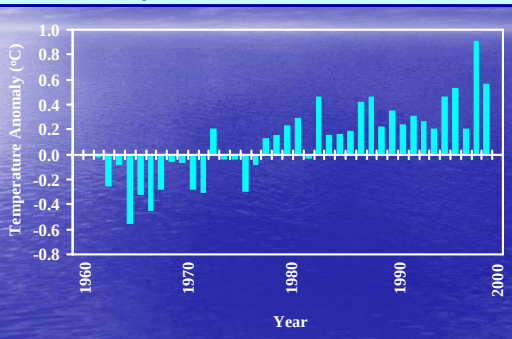
"It is likely that the area affected by drought will increase"

Climate Change Impacts on PNG



Climate Change Impacts on PNG

Increased temperatures



Temperature anomalies for PNG (*Inape and Humphrey, 2000*)

Climate Change Impacts on PNG

Increased pest and disease attacks

- *Virtual elimination of PNG's potato industry in the last decade due to the outbreak of Potato Late Blight Disease*
- *Leaf scab disease is almost at epidemic proportions in many sweet potato varieties in the highlands*
- *In the last year, Oribius weevils have begun to feed on coffee berries in the highlands – something unheard of!*

Climate Change Impacts on PNG

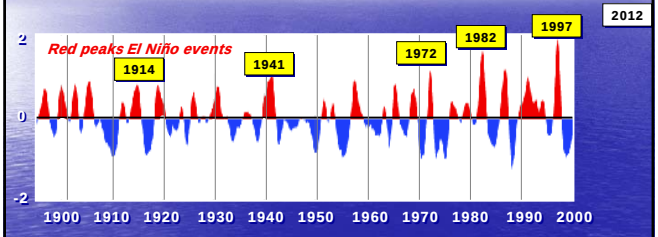
El Niño – devastating drought events

Climate Change Impacts on PNG

La Niña – excessively wet conditions

Climate Change Impacts on PNG

El Niño – becoming stronger & more frequent



Average SST anomalies in the Equatorial Pacific 1900-2000

Strategy for mitigating CC impacts

A 4-part strategy

- In response to the threat of climate change, a series of projects are being jointly implemented and/or developed by various Australian and PNG institutions including UQ, QDPI & QCCCE, NARI, CIC, NWS and FPDA.
- These projects may now be regarded as elements of a multidisciplinary research strategy aimed at mitigating the impacts of global warming and ENSO activity on food production in PNG.
- The strategy basically has four main parts which tackle different aspects of the climate change problem in PNG.

Strategy for mitigating CC impacts

Part 1: Early warning system

- Many Pacific Island countries including PNG rely on subsistence farming and as such are vulnerable to the impacts of climate variability and climate extremes (floods and droughts).
- The ability of PNG to respond to these challenges will be largely influenced by its preparedness at local, institutional and national levels.
- An early warning system based on seasonal climate forecasts and building local capacity to use this technology is seen as a major step towards meeting these challenges.

Strategy for mitigating CC impacts

Part 1: Early warning system

- Project: "Early Warning and Drought Preparedness for Improved Management of Crop Production in PNG" – ACIAR (QCCCE, NWS and NARI)

Project Objectives

- Develop a drought forecasting and early warning system for PNG by customising and refining 'SCOPIC' software
- Collect and analyse historical production data for a subsistence crop (sweet-potato) and a commercial crop (coffee) to identify the impact of past climate on production

Strategy for mitigating CC impacts

Part 1: Early warning system

Project Objectives (continued)

- Develop strategies to minimize the adverse impacts of climate and maximize opportunities in favorable seasons through discussions with key PNG agencies
- Build local capacity in key government agencies (NWS and NARI) to use and apply forecasting tools and to increase stakeholder awareness of climate variability and its impacts through targeted workshops and training in Australia and PNG

This early warning system can be viewed as PNG's 1st line of defence against climate change impacts.

Strategy for mitigating CC impacts

Part 2: Crop/genotype diversification

- The second and more fundamental risk aversion stratagem is the diversification of genotypes and cropping systems to allow for unforeseen as well as predictable impacts of climate change on crop production
- This will include the preservation and broadening of existing national gene pools of staple crops such as sweet potato to ensure ample genetic scope for crop adaptations in future climate change scenarios.

Strategy for mitigating CC impacts

Part 2: Crop/genotype diversification

- It will also involve the selection and breeding of crop varieties with genetically imparted tolerances to biotic and abiotic stresses.
- Already a breeding and hybridization program is underway to develop early maturing, high yielding recombinants of sweet potato to facilitate the speedy recovery of food production following drought or excess rainfall conditions.

Strategy for mitigating CC impacts

Part 2: Crop/genotype diversification

- As well as widening the gene pools of specific crop species, research will also be conducted to evaluate the benefits of diversifying traditional cropping systems by introducing new high-performing varieties of maize, rice, yam and peanut, etc.
- Such diversification should help to prevent the build-up of host-specific pests and diseases and minimize the risk of outright crop failure due to abiotic stresses e.g. frost or drought.

Strategy for mitigating CC impacts

Part 3: Biotechnology targeting of pests & disease

- The third element in the research strategy specifically targets the problem of heightened pest and disease outbreaks owing to climate change.
- Already PNG has suffered the virtual destruction of its potato industry following the outbreak of potato late blight disease in 2003, and viral disease and pest infestations of sweet potato and other crops are increasingly hampering production and marketing.

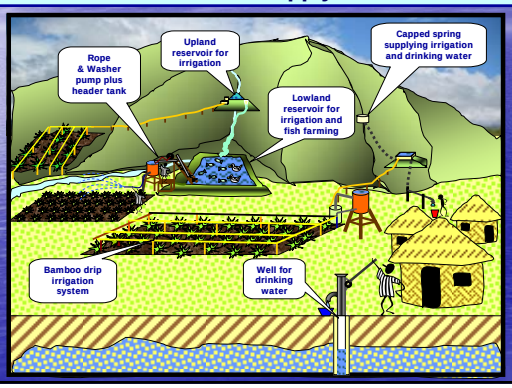
Strategy for mitigating CC impacts

Part 3: Biotechnology targeting of pests & disease

- Biotechnological solutions are being implemented including the micro-propagation and field testing of blight free and blight resistant potato clones, and the development of 'clean' pathogen tested sweet potato planting materials.
- Biological, cultural and low cost chemical methods for controlling Oribius weevils and fruit flies are also being investigated

Strategy for mitigating CC impacts

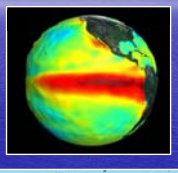
Part 4: Sustainable water supply facilities

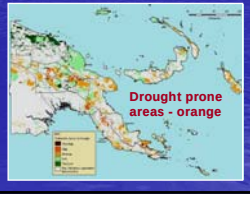


Strategy for mitigating CC impacts

Part 4: Sustainable water supply facilities

- The final element in the research strategy focuses on the provision of water supply facilities to sustain crop production in a scenario of recurring El Niño-induced drought events.
- Regional geological surveys are needed to investigate aquifer accessibility and terrain suitability for the construction of mini-reservoir, spring and borehole supply facilities in the five main agro-ecological regions of PNG





Strategy for mitigating CC impacts

Part 4: Sustainable water supply facilities

- Community surveys will be needed to establish local preferences for specific types of water supply.
- Thereafter, pilot studies will be needed in each region to assess the feasibility, practicalities, costs and effectiveness's of the different methods of supplying water for (drinking and) crop irrigation.

Conclusion

- With present global food shortages and rising fuel costs, PNG is being forced to look after its own interests – with the help of overseas institutions.
- The multidisciplinary research strategy for mitigating the impacts of climate change on agricultural production should help to prepare the nation for predicted food and water shortages in the global climate change scenario.

NARI

FRESH PRODUCE DEVELOPMENT AGENCY
SELF SUFFICIENCY FOR PAPUA NEW GUINEA

THANK YOU

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

NATIONAL WEATHER SERVICE

Queensland Government
Department of Primary Industries and Fisheries

ACIAR
Australian Centre for International Agricultural Research