ADOPTION OF ACIAR PROJECT OUTPUTS

2013

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Australian Centre for
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Editors: David Pearce, Amir Jilani and Debbie Templeton

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Research that works for developing countries and Australia

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The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

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ACIAR Adoption Studies

ACIAR seeks to ensure that the outputs of the research it funds are adopted by farmers, policymakers, quarantine officers and other beneficiaries. As part of its efforts to monitor the outputs and outcomes of its projects, ACIAR commissions project leaders and participants to revisit projects 3–4 years after completion, and report back to ACIAR on the medium-term outcomes of the work. This series reports the results of these studies. Numbers in this series are distributed internationally to selected individuals and scientific institutions, and are also available from ACIAR's website at <aciar.gov.au>.

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Foreword

The Australian Centre for International Agricultural Research (ACIAR) has made a practice of revisiting a sample of past projects some time after their completion, and this is the tenth in our series of adoption studies. We commission specialists to undertake assessments 3 to 4 years after a large project is completed to determine the level of uptake of the findings and gauge the extent of the project's legacy. This process has provided valuable insights that have helped in making decisions about further involvement in certain areas of research, and also provided accounts of lessons learned that aid in planning and developing new projects. Many have yielded success stories that further confirm the value of ongoing investment in agricultural research as a means of development assistance.

This report comprises studies of seven projects completed around 2008–09. They involved five partner countries—China, Indonesia, Papua New Guinea, Solomon Islands and Vietnam—and covered a diverse range of subjects. The authors have studied the outputs under three broad categories: the emergence of new technologies or practical approaches to tackle problems or issues; the gaining of new knowledge that would lead to better understanding of scientific and socioeconomic aspects of agriculture; and the introduction of new structures to assist policymakers with decisions about the welfare of farmers and associated stakeholders.

It is gratifying that all seven studies revealed medium to high levels of adoption of results. Some of the highlights include substantial improvements to sweetpotato–pig systems in Papua province, Indonesia, all of which promise better human health and animal productivity. In Papua New Guinea, the enthusiastic uptake of the project's integrated pest and disease management (IPDM) for cocoa pod borer has improved yields and crop sustainability while averting a crisis that threatened the entire industry. These results have encouraged the adoption of IPDM by farmers in other countries. In another success, the emergence of the peeled-veneer industry using plantation-grown eucalypts in Vietnam is pointing to greater demand for logs and higher financial returns to growers and processors.

ACIAR places great store on improving the capacity for research and development through project activities, and all these projects have shown substantial capacity-building outcomes. The authors found that, in most cases, the new research capacity and infrastructure introduced during the projects continue to be used.

The report lists the common factors found to have contributed to the adoption of these project outcomes. It also discusses the lessons that emerged, such as the importance of involving local partners and agencies and the need to recognise the role and significance of women in agriculture. Importantly, the authors stress the need for ongoing research and engagement to maintain the momentum developed during the projects. This could help to retain personnel who received specialised training during the projects and would otherwise move on at their conclusion.

Nick Austin
Chief Executive Officer, ACIAR

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Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AusAID	Australian Agency for International Development
BMKG	Badan Meteorologi Klimate dan Geofisika (Indonesian Meteorological Agency)
CCI	Cocoa Coconut Institute Limited (PNG)
CERC	China Eucalypt Research Centre
CIC	Coffee Industry Corporation
CIP-ESEAP	International Potato Center—East and Southeast Asia and the Pacific
CPB	cocoa pod borer
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EU	European Union
GFRI	Guangxi Forest Research Institute
HACCP	hazard analysis and critical control point
ILETRI	Indonesian Legumes and Tuber Crops Research Institute
IPDM	integrated pest and disease management
IQQM	integrated quantity and quality model
KGA	Kastom Gaden Association
MAL	Ministry of Agriculture and Livestock (Solomon Islands)
NARI	National Agricultural Research Institute (PNG)
NGO	non-government organisation
PNG	Papua New Guinea
PPAP	Productive Partnerships in Agriculture Project
SARDI	South Australian Research and Development Institute
SICHE	Solomon Islands College of Higher Education
VAFS	Vietnamese Academy of Forest Science
WNT	West Nusa Tenggara

Overview

David Pearce, Amir Jilani and Debbie Templeton

Introduction

This report summarises the adoption results for seven Australian Centre for International Agricultural Research (ACIAR) projects completed in 2008–09. The projects involved:

- five partner countries—China, Indonesia (two projects), Papua New Guinea (PNG) (three projects), Solomon Islands and Vietnam (two projects)
- four food- and crop-related projects—sweetpotato (two projects), cocoa and coffee
- one forestry-related project intended to improve the value chain for eucalypt plantations
- one livestock project addressing the village poultry sector
- one climate-change project looking at climate monitoring and forecasting for better water and crop management in agriculture.

The outputs from the projects were as diverse as the countries and research areas they covered. Most projects developed new technologies (often new varieties of a crop), while others developed practical approaches designed for use by farmers (crop growers), project staff, managers or crop breeders.

Some projects also developed new scientific knowledge that will aid future research and management decisions. This included a better understanding of key pest and disease problems in crops and of scientific methodologies for feeding trials of village poultry in Solomon Islands.

Four of the projects also developed knowledge for policy and policymakers, ranging from advice on best-practice poultry farming to increased awareness of climate variability and climate change and their implications for agriculture. One project also helped to identify constraints on improving smallholder cocoa productivity.

All of the projects involved extensive capacity building in partner countries and institutions, ranging from formal university-based training to a variety of training modules and on-the-job training activities for technical staff, research scientists and farmers. Some projects developed training manuals to facilitate the transfer of knowledge in the project areas and in other parts of the country. Others also involved the establishment of research facilities and infrastructure (however, this continues to be used in only one project).

The seven adoption studies indicate medium to high levels of adoption of the project results, although in some cases adoption by final users was limited. In each case, the adoption results provide some useful lessons and observations.

What was discovered—project outputs

ACIAR's adoption studies classify outputs into three broad categories:

- **new technologies or practical approaches** dealing with particular problems or issues and designed to ultimately be applied at the farm, processing or marketing levels or, in some cases, at the breeder level
- **new scientific knowledge or basic understanding** (pure or basic science) of the phenomena or social institutions that affect agriculture, designed as inputs into further research processes, ultimately to help in the future development of practical approaches for smallholders, processors, wholesalers and retailers
- **knowledge, models and frameworks for policymakers** or broad-level decision-makers, which will influence the environment in which farmers, processors, wholesalers and retailers must operate.

Given the diversity of ACIAR-funded research, there is considerable overlap between these categories, and many projects contribute to more than one of them. Table 1 summarises the outputs for the seven projects covered in this report.

New technologies or practical approaches were the major outputs of most of the projects. They were targeted both at the farm level, as well as more broadly at research project managers, scientists and breeders.

New technologies at the farm level included:

- new clones of sweetpotato and modified diets for pigs
- tailored pest and disease management options to suit smallholder farmers
- radial scanning technologies for tension-wood research
- peeled-veneer production techniques
- information pamphlets demonstrating how to feed village poultry
- decision-support tools for use in climate forecasting, water allocation and cropping decisions, as well as a comprehensive database of daily and monthly climate and hydrological data
- promising sweetpotato varieties and a dissemination technique that uses farmers as multipliers and evaluators of planting material.

New scientific knowledge was an important output from two projects. The subject matter varied from the major constraints affecting the PNG coffee industry to farmers' criteria for the adoption of sweetpotato varieties in PNG.

Four projects also developed **knowledge or models relevant to policymakers**. This included increased awareness of the need to focus on cup quality in the specialty coffee market in PNG and on best-practice poultry farming in Solomon Islands. New information on climate variability and climate change, and their effects on agriculture in Indonesia, is also relevant to policymakers.

Table 1. Summary of project outputs

Project	New technologies or practical approaches	Scientific knowledge	Knowledge or models for policy and policymakers
Poverty alleviation and food security through improving sweetpotato–pig systems in Papua, Indonesia	Five new clones of sweetpotato—three for humans and two for pigs Modified diets for pigs Modified pig housing (pig confinement system) Development of a foraging system for pigs using *lalekens* (small paddocks) planted with high-protein pastures Modified boar–sow management system to increase production Training material covering sweetpotato cultivation and production as well as pest and disease identification to facilitate transfer of knowledge and for use across the country		
Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices	Tailored integrated pest and disease management (IPDM) options and adaptation to cocoa pod borer (CPB)—a major pest of cocoa plantations IPDM training manual covering all aspects of cocoa management, including pruning, harvesting and sanitation activities and translated into English, Pidgin, Bahasa Indonesia and Vietnamese		Economic analysis of IPDM options to demonstrate the returns on increased investment Increased knowledge of constraints on improving smallholder cocoa productivity

continued ...

Table 1. (continued)

Project	New technologies or practical approaches	Scientific knowledge	Knowledge or models for policy and policymakers
Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality	A verified generic hazard analysis and critical control point (HACCP)–based quality management system Six training modules covering agronomy, improved coffee processing, nursery production, pest and disease control, marketing and household budgeting	Improved understanding of: ■ the major constraints affecting the PNG coffee industry ■ the need for a holistic system-based approach to improving rural livelihoods ■ the need for collaborative marketing groups and the need to link those groups to exporters	Increased awareness of the need to: ■ revise quality standards to focus on cup quality in the specialty coffee market ■ regulate cherry marketing ■ discourage smallholder farmers from direct marketing ■ discourage the mandatory introduction of a formal quality-assurance system
Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying	Radial scanning technologies for tension-wood research Peeled-veneer production technique Sawing methods known as linear sawmills and reciprocating sawmills that use either logturning devices/equipment or moving saws Sawn-wood drying methods		
Feeding village poultry in Solomon Islands	Information pamphlets demonstrating how to feed village birds Fact sheets and videos on how to feed meat birds using a concentrate ration developed in PNG		Fact sheets on best-practice poultry farming, including best-practice housing and feeding methods for village poultry

continued ...

Table 1. (continued)

Project	New technologies or practical approaches	Scientific knowledge	Knowledge or models for policy and policymakers
Seasonal climate forecasting for better irrigation system management in Lombok	FlowCast: seasonal climate forecasting software CropOptimiser: software for optimising the selection of crops and areas		A hydrological integrated quantity and quality model (IQQM) for planning and evaluating water resource management policies at the river-basin scale that can also be used to evaluate the impact of climate on water allocation and cropping decisions A point-scale water-balance model (HowLeaky), to explore the implications of alternative land use for water balance, run-off, erosion and drainage
Farmer evaluation and multiplication of sweetpotato varieties on the north coast of Papua New Guinea	Fourteen improved sweetpotato varieties from National Agricultural Research Institute (NARI) trials A dissemination technique that uses farmers as multipliers and evaluators of planting material	Understanding of farmers' criteria for the adoption of sweetpotato varieties in PNG	

Capacity development

Most of the projects reported here had explicit objectives to improve the capacity for research and development in partner countries, and all had substantial capacity-building outcomes. Table 2 summarises the capacity built and used in the projects.

Capacity development included training in basic experimental and research skills and farming practices through both formal training and less formal on-the-job training. Some projects involved training to obtain higher academic qualifications, including PhD and masters studies.

A number of projects included the provision or development of research infrastructure, varying from basic global positioning system (GPS) equipment and computers provided as part of the project to the development of poultry research and demonstration facilities that continue to be used for training in Solomon Islands.

In most cases, the research capacity and research infrastructure continue to be used. The collaboration developed between organisations remains in place, and staff skills and expertise developed through training continue to be used. However, there are some exceptions. For example, equipment such as computers and cameras provided in the smallholder cocoa production project in PNG no longer works, and Indonesian staff from the Water Planning and Infrastructure Department trained in the use of decision-support tools during the climate-forecasting project have moved on, resulting in limited capacity to use the technical models developed.

Table 2. Research capacity and infrastructure built by the projects and continued use

Project	Partner-country research capacity built	Research infrastructure	Capacity used
Poverty alleviation and food security through improving sweetpotato–pig systems in Papua, Indonesia	Linkages and networks were established between various partner organisations, including the South Australian Research and Development Institute (SARDI) and Papua Assessment Institute for Agricultural Technology. Eight scientists received training while employed in the project. Farmers and local technical staff completed training in modified sweetpotato–pig production systems, including 54 village farmers, 7 farmers to train other farmers and 5 technical staff from local non-government organisations (NGOs) associated with other farmer networks.		Collaboration between agencies has continued and has expanded to include Australian and Indonesian universities, as well as national, provincial and regional Indonesian Government agencies and NGOs. Farmers and scientists trained in this project are also involved in a new project that commenced in 2009; their expertise is being used to develop new crops and livestock production systems.

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Table 2. (continued)

Project	Partner-country research capacity built	Research infrastructure	Capacity used
Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices	In all, 300 workshop participants, including farmers and extension staff, were trained to identify key farming practices, constraints on production, and the main pest and disease problems. More than 132 farmers in East New Britain province and more than 1,000 farmers and extension staff in Bougainville were trained in integrated pest and disease management (IPDM). Four senior scientific staff from the PNG Cocoa Coconut Institute were trained to assist in the roll-out of IPDM. Final-year agriculture students were trained in cocoa management.	Vehicles, GPS equipment, cameras and computers were provided.	Farmers trained in IPDM now train others and foster the adoption of IPDM improvements in other cocoa blocks in their villages. In many cases, trained farmers became extension staff and extension staff became private-sector consultants. Some students established IPDM plots in their villages as part of their practical work requirements. Equipment provided was widely used, particularly during the cocoa pod borer response. However, most of the equipment no longer works.
Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality	Two hazard analysis and critical control point (HACCP)–based interactive training workshops on quality management were completed. Nineteen Coffee Industry Corporation (CIC) staff attended the CIC workshop. The industry workshop included seven farmers, four CIC staff and one industry liaison officer.		From the training workshops, a generic HACCP-based quality management system was developed and subsequently verified by growers, processors and exporters through in-depth meetings.

continued ...

Table 2. (continued)

Project	Partner-country research capacity built	Research infrastructure	Capacity used
Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying	Six research staff from the China Eucalypt Research Centre (CERC) and the Vietnamese Academy of Forest Science (VAFS) took a course in sawmilling and wood drying to improve their knowledge. Twenty research staff from China and Vietnam improved their knowledge of processing sawn wood and veneer developed as a by-product of the research project. Researchers gained the skills required to monitor research projects. The project identified important tree and log characteristics that could be used for genetic improvement in tree improvement programs.		Research staff trained and involved in the project are now engaged at CERC as well as other institutions. CERC continues to develop and oversee projects to improve veneer production. Methodologies for monitoring research projects became standard procedures for all projects in the forestry research program.
Feeding village poultry in Solomon Islands	Through training programs designed by SARDI, staff from the Ministry of Agriculture and Livestock (MAL), the Solomon Islands College of Higher Education (SICHE) and the Kastom Gaden Association (KGA) gained knowledge and skills that enabled them to run poultry feeding trials and demonstration and training programs. The capacity of other staff was built through on-the-job training in running demonstration and feeding trials as part of the project. One project team member from MAL undertook a masters degree in Australia to examine the genetic traits of village poultry in Solomon Islands.	Poultry infrastructure was developed, including the construction of a poultry research facility at SICHE and a demonstration unit at KGA.	Students are now taught poultry production at SICHE each year and are involved in hands-on training with birds. The poultry demonstration facility at KGA was, and continues to be, used to demonstrate best-practice village poultry farming and provide training to village farmers. The poultry research facility at SICHE also continues to be used for training. The MAL staff member who gained a masters degree has since been appointed Director of the Livestock Section in MAL. Collaboration is ongoing between SARDI, SICHE, KGA and MAL.

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Table 2. (continued)

Project	Partner-country research capacity built	Research infrastructure	Capacity used
Seasonal climate forecasting for better irrigation system management in Lombok	Local scientific capacity was built through workshops and training sessions in Indonesia and Australia on various aspects of climate research, including drought management, climate forecasting, water and crop management and climate-change adaptation. Leadership capacity was built in Indonesia through the successful completion of two PhDs, one masters degree and the awarding of an Australian Academy of Technological Sciences and Engineering Crawford Fund Scholarship in Australia. An extensive network has developed between various organisations in Australia, South-East Asia and Indonesia.		Some staff continue to be involved in subsequent research and training related to climate change, while others who were trained in the use of decision-support tools are no longer working in this area. One staff member completed a PhD through a scholarship funded by ACIAR and the Australian Agency for International Development (AusAID) and others continued to receive training in climate change and related topics through training programs and workshops even after the project was completed.
Farmer evaluation and multiplication of sweetpotato varieties on the north coast of Papua New Guinea	A total of 612 farmers were trained in aspects of sweetpotato production and marketing. Seven technicians employed in the project did on-the-job training and acquired skills in sweetpotato production, disease recognition, project management, community mobilisation, and data collection and analysis.		Farmers who participated in the training: ■ established a collective to market a sweetpotato variety to local institutions and markets in Madang ■ established and developed local recipes to improve nutrition and the utilisation of the crop ■ distributed material to relatives and friends and recognised the value of the new varieties ■ set up a trade store. Technicians developed continuing relationships with the community.

Uptake of the research and development outputs—progress along adoption pathways

Most of the projects had a number of different objectives and outputs. Summarising the often complex adoption outcomes for a range of projects is inevitably a difficult task and involves an element of judgment. For the summary presented in Table 3, a four-level classification scheme has been used (as in previous adoption reports).

In this classification scheme, the lowest level of adoption is *0*, or no uptake of the results by either initial or final users of the outputs of the project. Only two projects had no adoption of *some* of the project outputs (although there was medium to high adoption of other project outputs). In the plantation-grown eucalypt sawn-wood project, radial scanning technologies were not used by next or final users in Vietnam, and in the climate-forecasting project in Indonesia, one particular policy output, HowLeaky, a biophysical model, is not being used at all.

The next level of adoption is *N*, in which there has been some uptake by initial users but not by final or ultimate users of the research. Three projects had some outputs in this category (although other components had higher levels of adoption), including the poverty alleviation and food security project in Indonesia and Vietnam, the plantation-grown eucalypt sawn-wood project in Vietnam and the climate-forecasting project in Indonesia.

The next level of adoption is *Nf*, in which there has been uptake by initial users and some uptake by ultimate users. Five projects had outputs in this category. For example, in the PNG farmer evaluation and multiplication of sweetpotato varieties project, the distributed varieties were making a major contribution to improved food security and livelihoods. However, a survey revealed that there had been little spread of the improved varieties to more remote locations.

The highest level of adoption, *NF* (use by initial and final users), was achieved in at least some of the components of four of the projects. For example, in the smallholder cocoa production project in PNG, widespread adoption of integrated pest and disease management (IPDM) has demonstrated benefits, including improved yields and crop sustainability, that have transformed the PNG cocoa industry and resulted in further adoption by farmers in a number of other countries, including Solomon Islands.

Table 3. Current levels of adoption of key project outputs

Project	New technology/practical approach	Scientific knowledge	Knowledge, models for policy
Poverty alleviation and food security through improving sweetpotato–pig systems in Papua, Indonesia	*Nf*—Small survey interviewing two groups of farmers reported almost 100% adoption of at least one new sweetpotato variety. Only 20% of farmers more than 5 km from the project site had not heard of or adopted the new varieties. *Nf*—Most farmers fed at least one project diet to pigs, although only 10% fed more than one project diet. *N*—Adoption of the pig confinement system by farmers was limited, although some adopted it for younger pigs.		
Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices	*NF*—The PNG cocoa industry is transforming in response to the incursion of cocoa pod borer and market pressures for commercialisation. Widespread adoption of integrated pest and disease management (IPDM) by farmers underpins this transformation. *NF*—Translation of the IPDM training manual into Bahasa Indonesia, Vietnamese and Fijian Pidgin facilitated its use in other ACIAR projects. IPDM has now been adopted as the official recommendation for cocoa farmers in a number of countries, including Solomon Islands.		*NF*—New projects (including projects funded by ACIAR and the World Bank) have adopted the approach developed in this project to promote IPDM. IPDM training for farmers is now widespread in PNG, and has been used by provincial and local governments, the Cocoa Board, non-government organisations and the World Bank.

continued ...

Table 3. (continued)

Project	New technology/practical approach	Scientific knowledge	Knowledge, models for policy
Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality	*Nf*—Quality assurance program contributed to an increase in the volume of higher grades of coffee and an increase in certification and the volume of certified coffee. *Nf*—Farm training and extension staff continue to use four of the training modules (agronomy, improved coffee processing, nursery production, pest and disease control) developed by this project. However, the marketing and the household budgeting modules are not being used.	*Nf*—Linking collaborative marketing groups to exporters has increased the volume of certified coffee. Standardising processing activities (where farmers are unable to sell cherry) has improved the quality of the parchment dramatically.	*Nf*—The project played a significant role in shaping the Coffee Industry Corporation (CIC) Strategic Plan 2008–18. Increased awareness, training and education on quality and centralised wet-processing mills contributed to increased and consistent production of high-quality coffee.

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Table 3. (continued)

Project	New technology/practical approach	Scientific knowledge	Knowledge, models for policy
Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying	*O*—There was no uptake of the radial scanning technologies by next or final users in China or Vietnam. In Australia, radial scanning has been applied to some extent, including by the Cooperative Research Centre for Forestry (adoption level *N* to *Nf*). *NF*—Adoption of peeled-veneer production from eucalypts in China has been considerable and has led to the rapid development of veneer production systems. Similar changes have taken place in Vietnam but on a smaller scale (mainly because of Vietnam's smaller eucalypt plantation area). *N*—The rapid development of the eucalypt veneer industry in China and Vietnam has prevented widespread adoption of outputs relating to sawing methods. In Australia, adoption has been restricted to the modelling of sawmill performance and is unlikely to be significant until a suitable resource is developed. *NF*—Adoption of sawn-wood drying methods is visible in China, where steam reconditioning is being applied in the later stages of drying as a standard practice. In Australia, there has been no adoption other than in small industrial experiments (adoption level *O*).		

continued ...

Table 3. (continued)

Project	New technology/practical approach	Scientific knowledge	Knowledge, models for policy
Feeding village poultry in Solomon Islands	*Nf*—Information pamphlets on feeding village layers were provided to around 4,000 farmers. Distributed information on the poultry feeding method is likely to reach about 30% of Solomon Islands village farmers in the next 2–3 years. Poultry feeding systems fact sheets developed during the project were also distributed to African, Caribbean and Pacific island countries.		*NF*—Policies on poultry farming in suburban areas adopted by the city council in Honiara and major provincial towns drew on advice from the Ministry of Agriculture and Livestock (MAL) on best practice poultry farming obtained during the project. The Ministry of Health is now advocating the confinement of poultry using the Kastom Gaden Association and MAL village poultry farming model.
Seasonal climate forecasting for better irrigation system management in Lombok	*Nf*—FlowCast is used extensively by Indonesian Bureau of Meteorology staff as a research and training tool and to provide forecasts of rainfall and the onset of the monsoon and drought in eastern Indonesia. The outputs from FlowCast are disseminated to next and final users through monthly bulletins. *N*—The integrated quantity and quality model is not being used as intended (as a decision-support tool for water allocation and cropping decisions) due to lack of institutional capacity and the fact that it was only developed towards the end of the project, leaving little time to promote its use. However, general recommendations from the model are being used in decision-making.		*N*—There has been limited use by initial users, although general outputs from the model are often applied in decision-making. *O*—Staff in Lombok received little training in the use of the HowLeaky software, and it is currently not being used in Indonesia.

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Table 3. (continued)

Project	New technology/practical approach	Scientific knowledge	Knowledge, models for policy
Farmer evaluation and multiplication of sweetpotato varieties on the north coast of Papua New Guinea	*Nf*—Introduced varieties are widespread and farmers make deliberate choices about which varieties to keep. The distributed varieties are making a major contribution to improved food security and livelihoods. However, a survey revealed that there had been little spread of the improved National Agricultural Research Institute (NARI) varieties to more remote locations. *Nf* to *NF*—Participants had great enthusiasm for the dissemination technique, as it engaged farmers in research and selection and allowed decision-making to remain with them. Each community expressed satisfaction with its involvement in the project, and farmers were able to explain how they had benefited and why they chose the particular varieties they now farmed.	*NF*—The project improved understanding of farmers' criteria for the adoption of sweetpotato varieties. Farmers were selecting and seeking varieties not purely on yield but on a range of criteria, including taste, the speed at which the plant matures and the size of the storage roots. It was also made clear that farmers value choice.	

Note: Level of uptake is summarised as high, medium, low or none using the following abbreviations:

NF Demonstrated and considerable use of results by the initial and final users

Nf Demonstrated and considerable use of results by the initial users but only minimal uptake by the final users

N Some use of results by the initial users but no uptake by the final users

O No uptake by either initial or final users.

Factors contributing to the adoption of project outputs

Many factors always underlie particular adoption outcomes. They can be summarised as follows:

- Knowledge
  - Do the final or ultimate users *know* about the project outputs?
  - Is there *continuity of staff* in organisations associated with adoption (leading to the ongoing transfer of knowledge)?
  - Are the outputs *complex* compared to the capacity of users to absorb them? (Do users have a sufficient knowledge base to support adoption?)
- Incentives
  - Do users have sufficient *incentives* to adopt the outputs?
  - Does adoption of the outputs increase *risk or uncertainty* for the users (thus reducing incentives to adopt)?
  - Is adoption either *compulsory* or indirectly *prohibited*? (Are there extreme forms of incentives or barriers?)
- Barriers
  - Do potential users face *capital or infrastructure constraints*, limiting their ability to fund the adoption of the outputs?
  - Do potential users of the outputs face *cultural or social constraints* on adoption?

Table 4 summarises some of the major factors affecting adoption for the projects reported here.

Relatively high levels of adoption appear to have been driven by either strong economic incentives, such as improved production, incomes and employment, and greater choice, or by a mix of project outputs, such as improved food security and livelihoods (in the case of PNG) that allowed other economic incentives to emerge.

Relatively low levels of adoption resulted from different factors, including a failure to reach out to a wider group of users (particularly in remote areas), staff turnover resulting in institutional capacity problems, and cultural barriers. In some cases, infrastructure constraints limited the development of the industry and therefore adoption.

Table 4. Factors influencing adoption and impact—summary of key findings

Factor		Key findings
Knowledge	Do potential users know about the outputs?	*Poverty alleviation and food security in Papua, Indonesia*. Most farmers were aware of project activities and outputs but adoption was often limited because of distance from the project sites. The major factor affecting adoption and impact was therefore the lack of extension services involved directly in the project and a failure to promote contact between project farmers and non-project farmers. *PNG cocoa production*. The adoption of integrated pest and disease management (IPDM) has been widespread, particularly following the incursion of cocoa pod borer (CPB). Although farmers were initially reluctant to change their foraging strategies, the incursion forced them to choose between implementing IPDM options and losing their crops. Many even reported improved yields compared to pre-CPB times. *Plantation-grown eucalypt sawn wood*. The eucalypt peeled-veneer industry in China and Vietnam and associated plywood mills have become a major source of employment. *Village poultry in Solomon Islands*. Major outputs have been adopted, particularly at the policy level. The city council in Honiara drew on advice on best-practice poultry farming obtained during the project to frame policy. The Ministry of Health is now advocating the confinement of poultry using the village poultry farming model advanced in the project. *Farmer evaluation and multiplication of sweetpotato varieties in PNG*. The adoption of new varieties has contributed to improved food production and security and livelihoods. Adoption has largely been led by women, who understand the role of sweetpotato in the garden system and make planting decisions. However, adoption in more remote locations and among inland communities has been limited, despite farmers being aware of the project.
	Is there continuity of staff in organisations associated with adoption?	*Plantation-grown eucalypt sawn wood*. Research staff originally involved in the project are now engaged in research at the China Eucalypt Research Centre and other institutions associated with adoption. *Village poultry in Solomon Islands*. Staff involved in ACIAR projects are still active in the poultry sector, reflecting the impact of the training they received during the project . Some have become effective trainers of poultry farmers. *Climate forecasting in Indonesia*. Staff from the Water Planning and Infrastructure Department in eastern Indonesia were trained in the use of the integrated quantity and quality model. However, this investment has not produced the desired outcome, particularly because many staff are no longer working in this area.
	Are outputs complex in comparison with the capability of the users?	*Climate forecasting in Indonesia*. The technical outputs from the project were complex and not intended for direct use by farmers. However, the project has produced general recommendations on the impact of different climate types on water availability during each growing season and the implications for cropping patterns. Routine information on seasonal climate outlooks and the drought situation in eastern Indonesia is also disseminated to next and final users (farmers) through monthly bulletins.

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Table 4. (continued)

Factor		Key findings
Incentives	Are there sufficient incentives to adopt the outputs?	*Poverty alleviation and food security in Papua, Indonesia*. The adoption of a pig confinement system could reduce the quantities of sweetpotato required for efficient pig production. *PNG cocoa production*. Farmers adopting IPDM have benefited by intensifying cocoa production and freeing surplus land for other food and cash crops. This has led to higher production and more diversified income sources. The adoption of IPDM has also benefited commercial activity through the sale of inputs and increased supply of cocoa beans. *PNG coffee industry*. The adoption of a quality-assurance system could provide some economic benefits for individual organisations, including wet mills, dry mills and exporters, by minimising wastage and the proportion of product that fails to conform to customers' requirements. *Plantation-grown eucalypt sawn wood*. The development of the eucalypt peeled-veneer industry offers a range of economic incentives for tree growers, commercial enterprises and individual farmers. These include a greater demand for logs and higher prices than would otherwise be paid. *Farmer evaluation and multiplication of sweetpotato varieties in PNG*. The economic incentives driving the project included increased food production, improved livelihoods and greater choice.
	Does adoption increase risk or uncertainty?	This did not appear to be a major issue in the projects covered in this report.
	Is adoption compulsory or effectively prohibited?	*Cocoa production in PNG*. While adoption was not compulsory, farmers were forced by the CPB incursion to choose between implementing IPDM options or losing their crops and finding alternative livelihoods. This led to a widespread acknowledgment of the benefits of IPDM, particularly in effectively managing CPB losses. CPB was therefore a catalyst in the adoption of IPDM.
Barriers	Do potential users face capital or infrastructure constraints?	*Village poultry in Solomon Islands*. Poor infrastructure (including an underdeveloped road network, unreliable inter-island transport, high transport costs, lack of trained staff to deliver training programs and lack of financial support to support training) limit adoption and the development of the smallholder and semi-commercial poultry industry.
	Are there cultural or social barriers to adoption?	*PNG coffee industry*. The project recommended that training programs encourage farmers to save a greater proportion of the income generated from the sale of coffee and to develop and manage their household budgets. However, within the prevailing social system in PNG, this can be difficult because related family members (*wantok*) are still able to call upon any readily accessible funds.

Lessons

The results from the adoption studies reported here provide a number of lessons for ACIAR-funded projects.

The importance of involving local partners and agencies

In the poverty alleviation and food security project in Indonesia and Vietnam, a major lesson was the failure of the project team to adequately involve local agencies that were responsible for the extension of information and technology to farmers. This limited adoption to some extent. Closely related to this was a failure to understand adequately how farmers obtain information and the sources of that information. Such an understanding could help increase outreach and the adoption of outputs in future projects.

In the smallholder cocoa production project in PNG, it was similarly considered essential to engage with in-country partners to build support for the project and also to minimise failures due to cultural, ethnic, linguistic and social differences. The study notes the importance of consultation with all relevant stakeholders, including farmers, the private sector and non-government organisations (NGOs), especially during the project design phase.

Incorporating flexibility and adaptability into projects

In the smallholder cocoa production project in PNG, a key lesson was the importance of considering alternative models of extension, as one model does not suit every village. Early consultation would help to identify the most appropriate methods. Incorporating flexibility in the project design was also noted as being essential to accommodate unexpected changes. In the same project, a start-up workshop identified exotic pest and disease threats to the PNG cocoa industry, including cocoa pod borer. Awareness of this pest was important in the rapid response and adaptation of IPDM recommendations following its appearance.

Understanding the role and importance of women

In the farmer evaluation and multiplication of sweetpotato varieties in PNG project, it was observed that sweetpotato production and use were dominated by females, from planting through to food preparation. The adoption of sweetpotato varieties was also largely led by women, who understand the role of sweetpotato in the garden system and make planting decisions. The study therefore recommends that future extension efforts continue to pay considerable attention to involving women in the evaluation and dissemination of improved varieties.

Similarly, in the smallholder cocoa production project in PNG, the diversity of land tenure systems in the country can cause problems when implementing 'top down' extension activities. Even though women are important in both making and implementing management decisions, they are often excluded from traditional extension campaigns. Consulting women during the project design and extension phases could therefore prove beneficial, particularly when adoption is driven by their active involvement.

The importance of ongoing research and engagement

In the village poultry project in Solomon Islands, a key lesson was the need to develop a continuing project to maintain the momentum that was developed in the first project and to keep stimulating the development of the poultry sector. All the partners are also keen to continue to develop a feed manufacturing industry in Solomon Islands to reduce the huge cost of importing livestock feed, particularly pig and poultry feed. Thus, even if the original project outputs are successfully adopted, there may be opportunities for continuous improvement through ongoing research, engagement and extension projects.

Complexity

In the climate-forecasting project in Indonesia, the study identifies a range of problems and issues that limits the success of agricultural research in developing countries. They include a lack of funding, a paucity of data, low institutional capacity, limited social capital and the low priority placed on research. Moreover, developing and implementing new projects that involve the development of complex technical outputs, such as decision-support models, is often difficult in developing countries. Addressing some of these issues requires significant expertise and commitment, particularly at the local level. Substantial effort by research and collaborating organisations after project completion is also required to maintain the sustainability of project outcomes. While these problems should not deter agencies from investing in similar projects (as the benefits are potentially very large), continued support and funding may be needed to ensure sustainability and the realisation of a project's full potential if the use of the outputs requires significant changes in the knowledge and skills of the potential users.

Collaboration and partnerships

In the village poultry project in Solomon Islands, a major lesson was the importance of ongoing collaboration between partner organisations. For example, the South Australian Research and Development Institute continues to advise Kastom Gaden Association, Ministry of Agriculture and Livestock and Solomon Islands College of Higher Education staff on technical poultry matters as they arise. The advice can be particularly useful when technical staff from the agencies run demonstration trials and train poultry farmers in the future. The adoption study also identified other partners, such as the Solomon Island Development Trust and World Vision, that could assist in disseminating the original fact sheets more widely in Solomon Islands.

The climate-forecasting project in Indonesia was conducted in collaboration with many other agencies. The initial commitment by all agencies was very strong, and, in some cases, remained strong over the course of the project. However, there were significant changes in some institutions and staff, which affected the sustainability of the research. For example, considerable training was provided in the development and use of the integrated quantity and quality model within the Department of Public Works in Indonesia, but staff moved on and there is no current departmental capacity to continue this work.

Time frames for adoption

In the plantation-grown eucalypt sawn-wood project, the study notes that the development of a viable multiproduct processing industry will take considerable time and further research. There is still a need to develop sawmills that can process large-diameter eucalypts. This industry may not emerge for many years because of the cost of the processing technologies and the time lag in growing large-diameter eucalypts. These factors need to be accounted for when assessing the potential adoption profile.

In the farmer evaluation and multiplication of sweetpotato varieties in PNG project, it was not obvious which varieties, if any, would ultimately be adopted, even though the project had generated many varieties and a high level of enthusiasm and engagement at the farm level. The farmers had to determine which varieties had the characteristics that best suited their needs. It took a number of years before it was clear which varieties were preferred and being kept. It is important to understand that the adoption lag may be extended, as some farmer experimentation after a project may be needed before the project outputs are truly adopted. In addition, early indications of which varieties are likely to be widely adopted may be misleading.

Recognition of external constraints

It is important to understand external constraints and global changes that affect the relevance of the research. In the smallholder cocoa production project in PNG, it was observed that the international cocoa trade is volatile and subject to sudden changes in production, particularly in the politically unstable West African region. Global cocoa production is also significantly affected in the medium term by climate change. Furthermore, global market requirements are changing as consumers demand certified products. These issues, which are outside the immediate scope or control of the project, could significantly limit the project's economic impact.

The climate-forecasting project in Indonesia was conducted in the aftermath of the Bali bombings. Travel restrictions imposed through Department of Foreign Affairs and Trade advisory channels and a strict embargo on travel to Indonesia by the Queensland Government for the first 2 years of the project caused significant delays in project implementation. Other problems included the need to sign new contracts with different agencies during the project as a result of machinery of government changes in Queensland, affecting collaboration and project implementation. Unanticipated geopolitical issues therefore also have the potential to hinder the timely implementation and success of a project.

Poverty alleviation and food security through improving sweetpotato–pig systems in Papua, Indonesia (AH/1998/054)

Colin Cargill

Project number	AH/1998/054
Project title	Poverty alleviation and food security through improving sweetpotato–pig systems in Papua, Indonesia
Collaborating institutions	International: International Potato Center—East and Southeast Asia and the Pacific (CIP-ESEAP) Australia: South Australian Research and Development Institute (SARDI), Roseworthy Campus, University of Adelaide Indonesia: Balai Penelitian Tanaman Kacang-kacangan dan Umbi-umbuan Malang (Indonesian Legumes and Tuber Crops Research Institute—ILETRI), Malang, Java; Balai Penelitian Ternak (Indonesian Animal Production Research Institute—Balitnak), Bogor, Java; Balai Pengkajian Teknologi Pertanian Papua (Papua Assessment Institute for Agricultural Technology), Sentani, Papua; Dinas Peternakan Kabupaten Jayawijaya (Jayawijaya Regency Livestock Office—Disnak Jayawijaya), Wamena, Papua; Fakultas Kedoktoran Hewan (Veterinary Faculty), University of Udayana, Denpasar, Bali
Project leaders	CIP-ESEAP: Dr Dai Peters (2001–03) SARDI: Dr Colin Cargill, (2003–08) CIP-ESEAP: Dr Sukendra (Liem) Mahalaya (Indonesian Project Manager, 2002–08)
Project duration	1 January 2001 – 31 December 2008
Funding	Total $2,367,335 (ACIAR contribution $1,481,230)
Countries involved	Indonesia, Vietnam and Australia
Commodities involved	Pigs, sweetpotato
Related project	AH/2007/106

Motivation for the project and what it aimed to achieve

Food shortages and malnutrition were identified as major problems in the mountain areas of Papua province of Indonesia, where the dominant agricultural activities are the cultivation of sweetpotato and the production of pigs. The high levels of poverty in the highlands and people's dependence on the sweetpotato–pig system were the main justifications for developing the project.

Although sweetpotato is the main food for both people and pigs, it contributes only marginally to farm income. By contrast, pork has the potential to provide animal protein for people while at the same time increasing household incomes and reducing poverty.

The overall objectives of the project were the alleviation of poverty and the improvement of food security in Papua province by increasing production of consistently high-yielding, nutritious crops of sweetpotato and improving pig production efficiency. The original objectives were to:

- assess, characterise and analyse the existing human–pig production systems in Papua province within the overall household economy in order to understand the various types of system, their relative importance, and their major constraints
- improve sweetpotato production and stable food and feed supply, with an emphasis on selection for dual-purpose and forage feed varieties, drought- and frost-resistant varieties for pig feed in Papua province and Vietnam, and vitamin A–rich varieties for humans in Papua province
- enhance productivity and the efficiency of pig growth by nutritional improvement with locally appropriate technology and disease management using various levels of confinement acceptable to the local farmers in the Baliem Valley of Papua province
- improve the efficiency of indigenous, integrated pig-raising systems oriented to subsistence farming in Papua province.

These objectives were subsequently modified and expanded but maintained the overall objectives of poverty alleviation and the improvement of food security in Papua province through increased production of sweetpotato and greater pig production efficiency. Activities in Vietnam were confined to sweetpotato breeding and were completed during the first phase of the project.

The project was initiated by the International Potato Center and followed its work in collecting and identifying varieties of sweetpotato cultivated by the Dani people, who are the main tribe in the Jayawijaya Regency and Baliem Valley of Papua province. Several organisations, including SARDI, ILETRI, Balitnak and Jayawijaya Regency Livestock Office, were invited to a workshop in 1998 in Wamena, the main centre in the Baliem Valley, to scope and develop the project. Other organisations that joined the project between 2001 and 2008 included the Papua Assessment Institute for Agricultural Technology and the Veterinary Faculty of the University of Udayana, Denpasar, Bali.

The project commenced in 2001 and was completed in 2008 after five extensions. The ACIAR contribution over the 8 years was $1,481,230. CIP-ESEAP, the commissioned organisation, contributed $629,875. Other collaborators contributed $256,230.

Dr Dai Peters (CIP-ESEAP) was the initial project leader until she resigned from the centre in 2003. Dr Colin Cargill (SARDI) was seconded to the centre to lead the project.

The project began with diagnostic studies designed to characterise sweetpotato cultivation and pig production. Once the data had been analysed, constraints were identified and a series of research activities designed. The project team used a participatory approach to design experiments and invited Dani farmers to participate at all levels. Farmers were included in the planning process and were paid for their time and labour, provided they followed procedures agreed between farmers and the project team.

The greatest research effort went into breeding new clones of sweetpotato with higher protein and energy content and greater drought resistance, and into improving sweetpotato-based diets for pigs, along with modifications to housing and management to improve production efficiency. In the final 2 years of the project, the main activities involved farmer training programs using a farmer-to-farmer training model and training technicians employed by World Vision Indonesia and Oxfam to support networks of local farmers.

Creep box to provide warmth for baby pigs to reduce pre-weaning mortalities (Photo: C. Cargill)

Outputs—what the project produced

This project produced technical and capacity outputs.

Technical

The major technical outputs produced by the project were:

- five new clones of sweetpotato—three for humans and two for pigs
- several successful modified diets for pigs
- modified pig housing
- pig foraging using *lalekens* (small paddocks) planted with high-protein pastures
- a modified boar–sow management system to increase production
- parasite controls based on modified confinement and housing systems and regular feeding of betel nut or papaya fruit.

Three new clones of sweetpotato developed for human consumption were registered and named by the Indonesian President (Papua Solossa, Papua Pattipi and Papua Sawentar), and released in 2007. Two new clones and one local clone were also registered and released nationally for pig feed.

The initial changes made to pig husbandry and nutrition were to feed pigs regularly (twice daily) and to adjust the quantity of feed so that it was approximately 10% of body weight. These changes increased pig growth rates by up to three times those recorded using traditional practices. Another key change was to cook sweetpotato roots and vines to increase digestibility. However, the most sustainable diets were based on ensilaged roots and vines supplemented with either fish offal or golden snails. Ensilaged material was also supplemented with either high-protein pasture or foliage from fodder trees. The most successful diet (Wamena #9) contained 31% cooked sweetpotato vines, 20% cooked sweetpotato roots, 33% ensilaged sweetpotato roots and vines, 11% cooked banana trunk and 5% golden snails. The ensilaged material contained 85% sweetpotato roots, 15% sweetpotato vines or pasture or tree foliage and a small amount of salt, and was fermented for 14 days. Healthy, parasite-free pigs fed these diets grew by 250–300 g/day, compared with less than 18–48 g/day with traditional husbandry, and the time to reach sale weight was reduced by 30–50%. Calculations based on the cost of ingredients and labour and the sale price for pigs produced a benefit:cost ratio of between 2.5:1 and 5.0:1. Neither tofu waste nor rice bran proved to be a sustainable feed source, as supplies would need to be imported into the valley or the production base expanded. Snails, which are readily produced in small ponds and easily harvested, proved more sustainable than fish offal.

The most important pig health problems detected were internal parasites, the ingestion of toxic plants, and three important zoonotic diseases (cysticercosis, toxoplasmosis and trichinosis). The results indicated the need to modify husbandry techniques to limit the effects of parasites and toxic plants on health and welfare and increase the sustainability of pig production.

Confining pigs in houses overnight and in fenced areas (*lalekens*) reduced their parasite burden and prevented access to toxic plants. It also enabled foraging on high-protein pastures to further supplement the pigs' diet. The most successful confinement system was based on eight equal-sized pasture plots and moving pigs when 50% of the leaf material had been eaten. During drier months, farmers used cut-and-carry to augment the supply of pasture. The most efficient housing model was constructed from timber and had a thatched roof. These buildings were 3–4 °C cooler in the hottest part of the day and 3 °C warmer at night. The final management change introduced was to provide post-weaning boar contact for sows to increase productivity.

Capacity

The major capacity-building outputs produced by the project were:

- training scientists employed in the project
- training village farmers in modified production techniques
- training farmers to train other farmers
- training technical staff for local NGOs (World Vision Indonesia and Oxfam).

Capacity building was an important part of the project. All regional scientists involved in the project received at least one training opportunity in Indonesia, and one was assisted to complete a master of science degree. The members of the project team also worked closely with scientists from two major government institutions (ILETRI in Malang and Balitnak in Bogor) and scientists and researchers from the University of Udayana in Denpasar and the University of Papua in Manokwari, West Papua province.

Participating farmers were included in all project team meetings and visited all project sites annually. Around 70% of the farmers were taken to another part of Indonesia (Bali, North Sumatra and West Java provinces) to observe pig production and visit regional farmer training institutions.

Training materials were developed by the project team and were translated into Huburi (the Dani language), Bahasa Indonesia and English. However, it was subsequently found that if farmers could not read Bahasa Indonesia they could not read Huburi. The manual was designed to transfer knowledge and to be used as a training document that could be adapted and used in other parts of eastern Indonesia. The manual introduces techniques for improving sweetpotato cultivation and seed production, identifying pests and diseases of sweetpotato, developing products for human nutrition after harvest, preparing modified balanced diets and feeding regimes for pigs, and planning, building and managing a modified pig confinement system following the concepts developed by the farmers and the project team. The booklet and posters are now being revised and edited to include new information from a current project nearing completion.[1]

A group of farmers who had worked with the project for 3–7 years were trained as trainers for a farmer-to-farmer training program that was completed in 2008. Training was also provided to field staff from World Vision Indonesia and Oxfam to enable them to work with their own farmer networks in villages in other locations in the Baliem Valley.

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1 AH/2007/106—*Improvement and sustainability of sweetpotato–pig production systems to support livelihoods in highland Papua and West Papua, Indonesia*

Adoption—how the project outputs are being used

Two groups of farmers who had not had direct contact with the project team were interviewed for a small survey in 2013.

Based on this small sample, there appears to have been widespread adoption of the new varieties of sweetpotato. Almost 100% of respondents were growing at least one new variety. Only 20% farmers about 5 km from a project site had not heard of or adopted the new varieties. This indicates that getting famers to adopt new varieties of sweetpotato will be relatively easy.

However, the situation with pig production was quite different. Although there appeared to be little difference in knowledge about the project activities between farmers who lived within 2 km of a project site and those about 5 km away, understanding and adoption were lower in the more distant group, indicating the importance of farmer-to-farmer interaction and visual contact in enabling information spread and adoption. While few farmers had adopted the pig confinement system for all their pigs, most had adopted it for younger pigs and allowed only older pigs to run free. The main reason for limited or non-adoption was that farmers felt that they did not grow enough sweetpotato to feed all their pigs when the animals were confined. This suggests that the project team failed to convey to farmers that by supplementing pig diets with high-protein pasture and fodder trees, and storing pig feed as silage, they could reduce the quantities of sweetpotato required for pig production in a confinement system. In fact, the project data demonstrate that similar (or lower) quantities of sweetpotato are needed to feed pigs adequately in a confinement system compared with a non-confinement system.

Adoption of modified diets was higher: most farmers interviewed were feeding at least one project diet, and all cooked most of the sweetpotato that they fed to pigs. This was in stark contrast to the results of an initial survey in 2002, in which almost 100% of farmers said that they fed pigs uncooked sweetpotato roots and vines. However, in the 2013 survey, only 10% of farmers fed more than one project diet, and laziness was the main reason they gave for not adopting silage-making as a practice. This suggests that they did not understand that although silage-making requires considerable effort over a short period, it reduces the annual labour input required for feeding pigs.

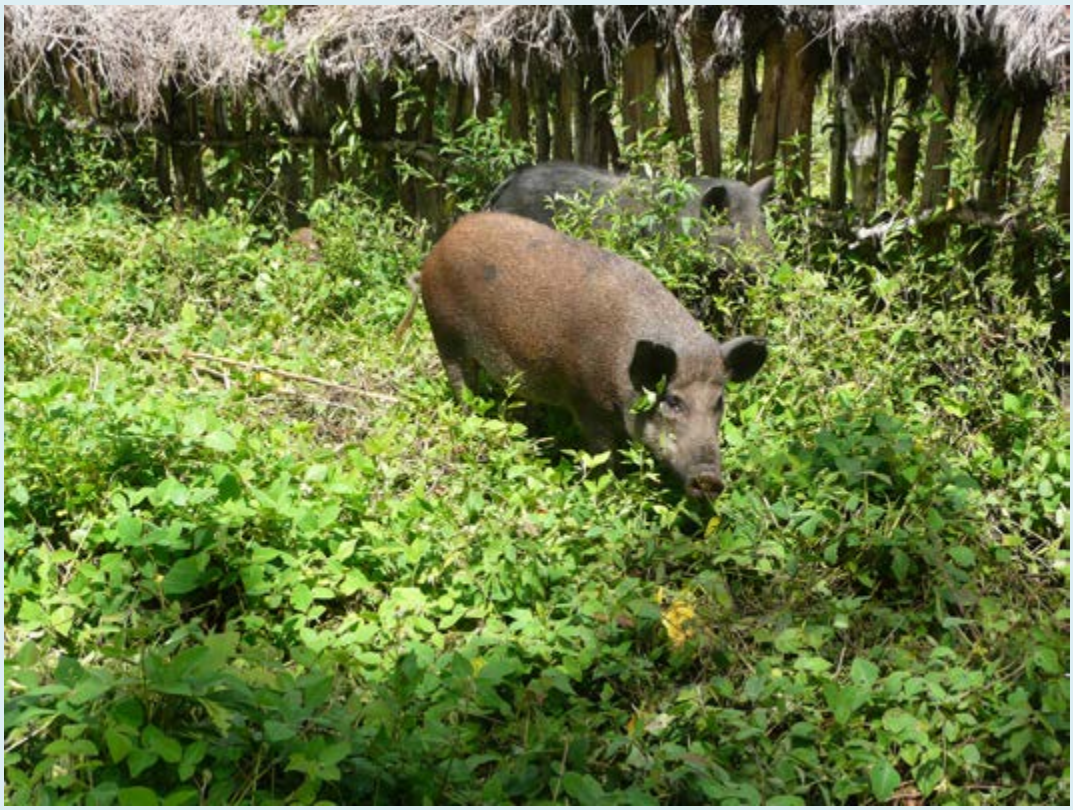
In summary, the major reasons for lack of adoption appeared to be:

- lack of contact between non-project farmers and the farmers and staff involved in the project
- lack of understanding of the concepts involved in using the pig confinement system to improve pig production
- farmers' perceptions that improved diets for pigs required greater inputs of labour
- lack of willingness (or laziness) on the part of non-project farmers to devote extra time and energy to manage pigs in a confinement system
- insufficient land for increasing sweetpotato production for pigs.

Fortunately, the final phase of a current project[2] creates an opportunity to initiate more extensive farmer training programs using practical working models established by this project in collaboration with local farmers. This could be used to deliver farmer-to-farmer training programs and to build capacity in local agencies responsible for delivering agricultural and animal production extension programs. Local extension agencies were not involved in the first project, but provincial and local extension agencies, along with World Vision Indonesia, were invited to join the current project from its inception.

The adoption of improved pig production technology was also limited by the lack of a well-developed market chain. Most pigs are sold direct to purchasers who need pigs to meet social obligations or through an informal live market that operates next to the Wamena City Markets. Although a small 'wet' market has developed during the past 3–4 years, the development of a strong market chain is limited by a lack of road transport in the Baliem Valley. Currently, all goods must be airfreighted in and out of the valley, making exports of product unsustainable and denying farmers access to the larger markets in coastal population centres.

2 AH/2007/106—*Improvement and sustainability of sweetpotato–pig production systems to support livelihoods in highland Papua and West Papua, Indonesia*



Pigs foraging high-protein pasture in a *laleken* (small fenced paddock) (Photo: C. Cargill)

Impact—the difference the project has made or is expected to make

Based on recent surveys and an impact study by Mahalaya[3] (2010), the project affected sweetpotato production by introducing new cultivars with higher yields and by improving crop production efficiency. In Mahalaya's study, increased sweetpotato production was also matched by a reduction in income earned from selling various natural resources from forest areas, suggesting a decrease in natural resource dependence. This could have long-term effects in reducing forest degradation.

The project also had a positive effect by increasing the ownership of primary farm equipment and other goods, such as radios, motorcycles and mobile phones. There was a decrease in ownership of hunting equipment.

One of the greatest potential community impacts of the project appears to be in education. According to Mahalaya (2010), the percentage of teenage and older children either completing or continuing secondary education was significantly higher among the project farmers' families than in a cohort of farmers who had not had direct contact with the project. Several of the older children of project farmers were attending tertiary and post-secondary educational institutions, compared with none from the non-project cohort. This suggests that families recognise the value of education and will leave children in school if they have sufficient funds to cover the cost of education.

Although adoption of the modified pig confinement system across the community was low, it reached 50% in one area where classical swine fever had caused significant mortalities in village pigs. The reason for the high adoption rate appeared to be that no pigs owned by the two project farmers in the area died from the disease. It was assumed that their pigs were confined and were not free to mix with infected pigs. The project has now had a significant impact on the control of classical swine fever in these communities, where most farmers now use the modified confinement system.

The estimated financial impact of project outcomes has also been assessed. Based on the cost of diet alone, the increased profit to be gained from feeding the project diets from weaning to 60 kg liveweight (324 days) was estimated to be 0.7–1.0 million rupiah per pig (currently A$70 to $100), based on a pig sale price of 1.5–3.0 million rupiah. However, over the past 3 years, the sale price for a 60-kg pig has increased from 2.5 million to 4.5 million rupiah. Based on these figures, a farmer with one sow who invests in building a pig house and *lalekens* will recover costs and make a profit within 3 years.

3 Mahalaya S. 2010. Impact evaluation of agricultural research in Papua, Indonesia using the sustainable livelihood framework. PhD thesis, University of Adelaide.

Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices (ASEM/2003/015)

David Guest

Project number	ASEM/2003/015
Project title	Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices
Collaborating institutions	Australia: University of Sydney PNG: Papua New Guinea Cocoa Coconut Institute Limited (CCI); PNG University of Technology (Unitech)
Project leaders	Australia: Professor David Guest PNG: Dr John Konam
Project duration	1 January 2005 – 31 May 2009
Funding	$1,510,382 total ($549,120 ACIAR contribution)
Countries involved	Papua New Guinea, Australia
Commodity involved	Cocoa
Related projects	ASEM/2002/014, PHT/2000/102

Motivation for the project and what it aimed to achieve

Cocoa is PNG's third most important agricultural export, after coffee and palm oil. The annual production of 48,000 tonnes contributed K250 million or 20% of national agricultural revenue in 2010–11 (Anon. 2006; Simatab 2007; ICCO 2013). Cocoa is seen as a potential driver of development because of its high productivity and suitability for smallholder farmers. At least a million people in coastal areas of PNG depend on cocoa farming as their primary source of income.

Most farms are less than 5 ha and produce yields of 300–400 kg dry beans per hectare per year (Curry et al. 2007). Low yields reflect low levels of management inputs, a lack of understanding of pests and diseases, and the absence of advice on management. Over 82% of farmers identified *Phytophthora* black pod, canker and vascular-streak dieback as the most important constraints on cocoa production (Omuru et al. 2001). Curry et al. (2007) found that up to 74% of trees were affected by canker in East New Britain province, yet over 95% of farmers had no knowledge of pest and disease management.

While the ability of cocoa to provide continuous, albeit small, incomes for PNG farmers suits their semi-subsistence livelihood, intensification has the potential to significantly improve incomes and standards of living. Because pests and diseases were identified as a major barrier to successful intensification, this project aimed to develop and disseminate options for integrated pest and disease management (IPDM) using a participatory approach to the research and transfer of technologies.

The first phase of the project included consultation with stakeholders through workshops, discussions and farmer surveys, followed by preliminary trials of management options. The main constraints on yield improvements were lack of knowledge, low levels of skill, low investment, high disease losses, theft, the availability of labour and inadequate record-keeping and financial literacy.

Anton Kamuso (Cocoa Coconut Institute, Kerevat) addressing integrated pest and disease management (IPDM) farmers in Bitagalup village, East New Britain province (Photo: Rosalie Daniel)

Outputs—what the project produced

This project produced technical and capacity outputs.

Technical

The technical outputs included:

- development of IPDM options and adaptation to cocoa pod borer (CPB)

  An IPDM package was optimised for PNG smallholder farmers. A range of options was included in the IPDM so farmers from different social and economic backgrounds could select those inputs and activities that best suited their situation, priorities and ability. The options were based on four levels of input, from low (current level—the farmer visits only to harvest) through to intensive management options requiring more time and the purchase of more tools and chemicals (Daniel et al. 2011).

- economic analysis of IPDM options

  Several economic analyses were completed to demonstrate the returns to increased investment. The most comprehensive report was by Joachim Lummani, socioeconomist at CCI (Lummani 2009). Lummani's analysis showed net incomes of K1,774, K2,305, K2,508 and K2,952 for options 1–4, respectively, when cocoa prices were K4/kg dry bean. While the incomes varied with price, IPDM remained profitable even at the lowest price estimate of K2/kg.

  In areas where CPB is present, no cocoa would be harvested without some sort of intervention. The regular pruning, harvesting and sanitation activities incorporated in IPDM level 2 management achieve excellent control of this pest.

Cocoa pods freshly harvested from IPDM farmer Elmah Maxwell's farm near Arawa, Autonomous Region of Bougainville (Photo: Rosalie Daniel)

Capacity

A stakeholder workshop with 300 participants was held at the start of the project. This led to an increase in the participants' understanding of:

- current farming practices
- constraints on production—knowledge, skills, low investment, high disease incidence, theft, the availability of labour, inaccurate record-keeping
- main pest and disease problems—*Phytophthora*, pink disease, vascular-streak dieback, longicorn beetles, mirids and CPB
- industry priorities—yield, quality, extension, land, market access
- IPDM options
- the implementation of on-farm participatory trials.

An IPDM training manual, covering all aspects of cocoa management, including pruning, was produced and translated into English, Pidgin, Bahasa Indonesia and Vietnamese for use in other projects. The manual was revised and updated in 2011 to include recommendations for CPB management. More than 10,000 copies have been distributed. In at least one region, the absence of other funding has led to sales of the manual, which supports local training efforts.

Paul N'nelau (Cocoa Coconut Institute, Buka) demonstrating seedling grafting in the cocoa nursery (Photo: Rosalie Daniel)

More than 132 farmers and extension staff participated in IPDM training in East New Britain province under this project, and a further 350 farmers were trained in IPDM during the follow-up CPB project. In Madang province, more than the expected number of model farmers were trained. In the Autonomous Region of Bougainville, more than 1,000 farmers and extension staff have been trained in IPDM. These farmers train others and foster the adoption of IPDM improvements in other cocoa blocks in their villages. IPDM demonstration blocks are used to display IPDM options to other farmers. They visually demonstrate the difference between the options and allow farmers to discuss the costs and benefits of each option with the farmer who implemented them.

Senior CCI scientific staff (including Saul-Maora, Epaina, Yinil and Gende) trained CCI extension staff to assist in the rollout of IPDM. In many cases, trained farmers became extension staff (for example, Joe Tomo and Elmah Maxwell in Bougainville), and extension staff (such as John Daigu) became private-sector consultants.

Final-year agriculture students were trained in cocoa management on the site established at the Unitech campus in Lae under this project. Some students also established IPDM plots in their villages as part of their practical work requirements.

The project has demonstrated the importance of thorough consultation with stakeholders in framing the project, developing monitoring and review processes to use through the project, and retaining flexibility to be able to respond to changes in the external environment during the project.

Adoption—how the project outputs are being used

The project encouraged the adoption of management options using participatory action research—an approach based on participatory training and research in the cocoa block. Plots demonstrating each of the four IPDM options were established with participating model farmers at Kareeba, Bitagalip and Tokiala in East New Britain province; Galeg, Waden and Kaul 2 in Madang province; and Malasang, Tinputz and Arawa in Bougainville. The selected model farmers in each village were shown how to apply each of the inputs required for each option by CCI staff and extension officers. Extension officers were trained while participating in the establishment of demonstration plots. Surveys conducted by project staff showed that farmers' initial knowledge was generally acquired by observation or from farmer-to-farmer exchanges, which shows the limited exposure to extension agents and new information that the farmers experienced. The fact that information is often disseminated among farmers highlights the benefits of using a participatory on-farm approach to extend information.

Village meetings held during the initial farmer surveys were used to introduce and discuss cocoa IPDM. Potential model farmers emerged from these meetings and were eventually selected after further explanation of the responsibilities associated with the role. Model farmers were asked if they would be willing to establish and maintain demonstration blocks, with the assistance of CCI and ACIAR. IPDM was passed on to farmers who 'learned by doing'. In return for training, model farmers agreed to train other farmers—in many cases, 12 others (in which case, those taught became 'disciples').

Because of their training and outside contacts, model farmers often assumed a role of 'village extensionist', and, in some cases, gained employment with cocoa traders and service providers or with CCI.

Paul N'nelau (Cocoa Coconut Instiute, Buka) discussing integrated pest and disease management (IPDM) options with cocoa farmers from Tinputz, Autonomous Region of Bougainville (Photo: Rosalie Daniel)

Impact—the difference the project has made or is expected to make

The project has realised benefits at all levels of the community. Smallholder cocoa farmers have benefited from higher production and income diversification by intensifying cocoa production and freeing surplus land for other food and cash crops. Intensification also reduces the incentive for clearing rainforests to increase the area of cocoa planted.

Cocoa-based villages have benefited from improved organisation and access to services through the establishment of cooperatives, community development and development programs.

The adoption of IPDM has also benefited commercial activity through the sale of inputs and the increased supply of cocoa beans.

It is interesting to speculate about the positive effect of CPB on the adoption of IPDM. Early in the project, early adopters of IPDM were hard to recruit, but those who joined became 'disciples' who actively promoted the technology. The CPB incursion left farmers with no choice, and non-adopters abandoned cocoa farming entirely, resulting in a very pessimistic outlook for the industry and communities that depend on cocoa. Now that IPDM has been shown to manage CPB losses effectively, cocoa farming is once again becoming popular; for example, in the areas of East New Britain province devastated by the original CPB incursion and management effort. In this sense, the incursion was a significant driver for the adoption of IPDM.

The global cocoa market is responding to consumer demand for certified products, traceability and niche products. PNG has always enjoyed a reputation for fine-flavoured cocoa, but certification and niche marketing require farmers to keep auditable records and to become more 'professional' in their approach to cocoa farming. Adopting IPDM is a good strategy for professional farmers, as it improves their understanding of the cocoa cropping cycle, appropriate management interventions, investment in future returns and consistent production.

Because of the low skills base of smallholder cocoa farmers, adopting a more businesslike approach to cocoa farming has many challenges. There are many reasons why a village- or community-based approach to those challenges makes sense, as training activities and the investment in tools, equipment and inputs can be shared. Cocoa quality can be monitored and maintained if communities use a central fermentary, which also makes marketing easier. Relationships with service providers, non-government organisations and private-sector stakeholders, including cocoa buyers, are easier to build and manage at the community level. The establishment of village cooperatives could also generate the critical mass and facilities needed to attract and organise training and advice in health, education and business skills in these often remote cocoa-growing communities.

Finally, it could be argued that increasing productivity and improving livelihoods in cocoa-farming communities benefit Australia by reducing PNG's dependence on aid and consolidating regional security. Australian chocolate companies could also benefit through greater confidence in the supply of high-quality cocoa, which supports their efforts in certification and niche marketing. Increased chocolate production benefits the Australian economy because other ingredients—sugar and milk—are produced here.

PNG project leader John Konam (CCI, Kerevat) contemplating the potential benefits of cocoa farming to rural communities throughout the Pacific. (Photo: Rosalie Daniel)

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Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality (ASEM/2004/042)

Peter Batt

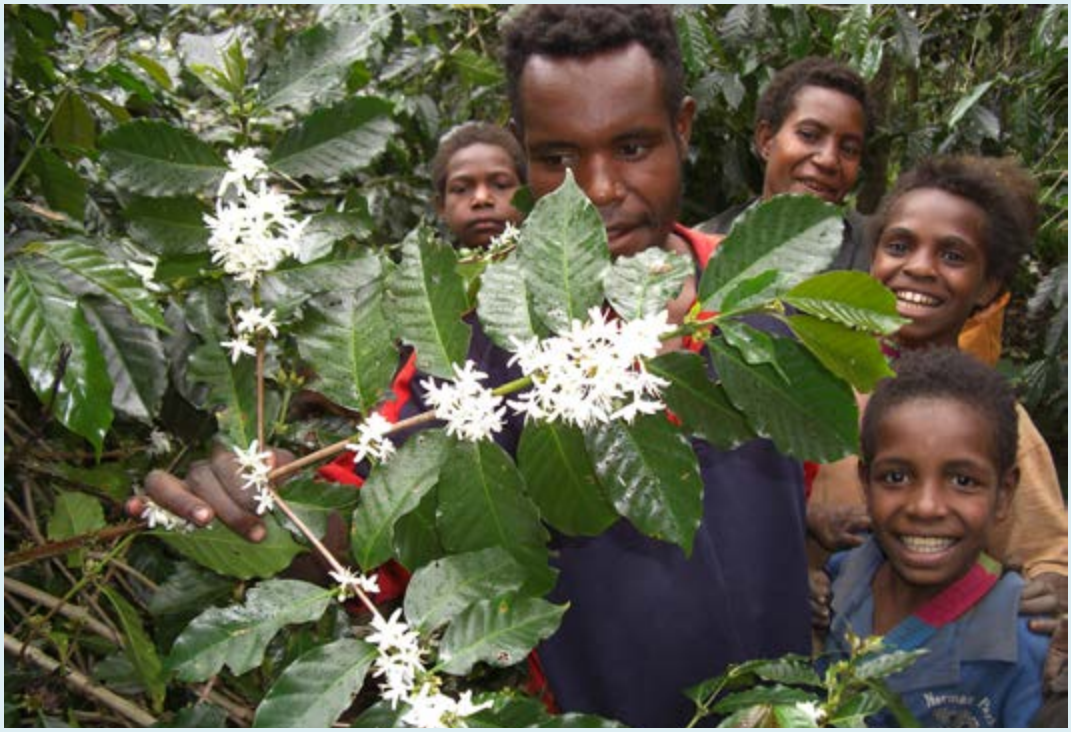
Project number	ASEM/2004/042
Project title	Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality
Collaborating institutions	Australia: Curtin University, Perth PNG: Coffee Industry Corporation, Goroka
Project leaders	Australia: Professor Peter J. Batt PNG: Mr Kessy Kufinale
Project duration	1 April 2005 – 30 September 2008
Funding	$923,092 total ($541,502 ACIAR contribution)
Countries involved	Papua New Guinea, Australia
Commodity involved	Coffee
Related projects	EFS/1987/034, PHT/2004/017

Motivation for the project and what it aimed to achieve

Coffee is the second most important agricultural export crop in PNG. The coffee industry earns an average of K340 million per year, which is 43% of agricultural exports, 10% of all exports and 5% of the nation's gross domestic product (GDP). More than 397,000 rural households cultivate coffee and more than 20,000 people are actively involved in the downstream processing and marketing of the crop.

In PNG, coffee is produced by three groups: smallholders, block-holders and plantations. Over time, the contribution by the last two groups (often called the 'estate' sector) has fallen to around 15% of total production. The decline in the estate sector, which was largely responsible for establishing PNG's reputation in the market as a producer of some of the world's best coffee, has resulted in a general perception among the buyers that the quality of PNG coffee has fallen. Consequently, the price of PNG coffee has fallen compared with the world price.

The smallholder sector generally produces fair average quality coffee (Y grade), which is consistently discounted against the New York 'C' price. The main complaint from buyers is inconsistency in quality from season to season and from shipment to shipment. In 2002, in response to market needs, the Coffee Industry Corporation (CIC) implemented an eight-point plan to improve the overall quality of PNG coffee. However, one of the major obstacles was the failure of the current marketing system to give the right price signals



A family in Eastern Highlands province inspects coffee blossom—a sign of things to come (Photo: Nuigini Coffee Tea and Spice)

to growers in the form of different prices for different qualities of parchment. The situation was further aggravated by poor production practices, poor on-farm processing and the marketing system, in which most smallholders sell their parchment coffee to roadside buyers at various buying points along the main roads.

In an effort to improve quality and to provide growers with better prices, a number of collaborative marketing programs have been introduced by both the private sector and CIC.

As the future of the PNG coffee industry is very much dependent on the smallholder sector, the price benefits to growers participating in these alternative marketing schemes needed to be quantified. At the time, there was a need to know how much the growers were benefiting financially and how much improvements in quality were affecting their livelihoods. There was also a need to identify the extent to which the initiators of the alternative schemes were benefiting and whether the benefits were being shared equitably.

Furthermore, if there was to be any significant improvement in the quality of PNG smallholder coffee, there was a need to replicate successful collaborative production and marketing arrangements. It was important to identify the variables that facilitated the formation and the ongoing development of those arrangements and the various factors that might bring about their demise and dissolution.

Outputs—what the project produced

The project produced technical, capacity and policy outputs.

Technical

The main technical outputs included an increased understanding of:

- the major constraints affecting the PNG coffee industry
- the need for a holistic system-based approach to improve rural livelihoods
- the need for collaborative marketing groups and to link those groups to exporters
- the key factors sustaining or causing the demise of the collaborative marketing groups
- the value of personal viability training in the World Bank's Participatory Rural Appraisal and Planning Process farm extension model
- the price differentials between cherry and parchment
- formal accreditation under a third-party certified quality-assurance program
- the share of the free-on-board (FOB) Lae price that goes to smallholder coffee farmers
- the need to standardise the methods of processing cherry to improve parchment quality
- the need for structured tasting to facilitate the improvement of coffee quality
- opportunities to establish community wet mills to improve parchment quality.

A generic hazard analysis and critical control point (HACCP)–based quality-assurance system was also developed.

Capacity

Capacity outputs included the development of five training modules and the increased knowledge and skills of those who attended the training activities. The training modules covered agronomy, improved coffee processing, nursery production, pest and disease control, and marketing.

The main training activities were a 3-day introductory course on quality management and an interactive workshop for the participants from selected collaborative marketing groups to develop a generic HACCP-based quality management system. Overall, 7 growers, 23 extension agencies and 1 other industry participant attended.

Policy

At the policy level, there was an increased awareness of the need to:

- revise quality standards to focus on cup quality in the specialty coffee market
- regulate cherry marketing
- discourage smallholder coffee farmers from direct marketing
- discourage smallholder coffee farmers from operating wet mills
- discourage the introduction of a mandatory generic HACCP-based quality-assurance system.

A participating group of coffee farmers in Chimbu province discusses the conversion rates from cherry to parchment (Photo: Peter Batt)

Adoption—how the project outputs are being used

The most immediate and significant change to the coffee industry since the end of this project has been the presence of the World Bank's Productive Partnerships in Agriculture Project (PPAP). That project is focused on improving smallholder livelihoods by improving productivity, quality and linkages between smallholder farmers and exporters.

Like this ACIAR project, the PPAP seeks to support partnerships with traders, processors, exporters, farmer groups and the organisations supporting them in order to train farmers in more productive and remunerative farm management practices and to link them to markets. Activities will improve the quality of PNG coffee and increase the proportion of differentiated coffees that are exported, resulting in higher prices for smallholder farmers and better incentives to invest in their farms. Differentiation can include better quality, geographical indications or the adoption of sustainable farming practices.

Through an integrated holistic approach, training is being delivered to smallholder farmers on coffee agronomy, rehabilitation, harvesting and processing, and on financial management at the household and group levels. Most of the Coffee Credit Guarantee Scheme cooperative groups that were present at the time this project was undertaken have now been aggregated under one of three provincial cooperatives (one each in Eastern Highlands, Chimbu and Western Highlands provinces), which trade collectively under the name Agra Apo Kange. All three cooperatives trade directly with PNG Coffee Exports, which, as an integral part of the PPAP, has employed nine field operatives to engage with these collaborative marketing groups at the village level.

In supporting collaborative marketing groups, the PPAP has recognised the importance of personal viability training and introduced it as an essential prerequisite for many of the same reasons that it was introduced by this project over 5 years previously. However, where the PPAP differs most markedly from this project is its lack of any market training. Presumably, this aspect has been dropped because of the direct linkages that have been established between the collaborative marketing groups and the six exporters participating in the PPAP.

Because the PPAP seeks to add value to smallholder coffee, community-based quality-assurance systems are being introduced in each of the collaborative marketing groups. The choice of system is very much dependent on the market to which the coffee is being consigned.

Those producers aligned with the Agra Apo Kange (and PNG Coffee Exports) are seeking accreditation under 4C, while those groups associated with Monpi are pursuing certification under the Utz Certified or Rainforest Alliance schemes. Those groups trading through Coffee Connections continue to seek accreditation under Fairtrade and as organic producers.

Common elements of these quality assurance systems include environmental management (soil conservation, shade and minimising the pollution of waterways), fair trade and equity (no child or forced labour, the right to bargain and free choice) and occupational health and safety considerations. Under the PPAP, training is being given on environmental management, chemical application and storage, and the use of protective equipment.

The PPAP has also recognised that the poor condition of the roads is a major impediment to market access and has included a significant cash component for road repair. The PPAP is providing pulpers, knapsack sprayers, pruning saws and secateurs, and soft inputs such as fertilisers and chemicals, to participating farmer groups.

To improve the quality of PNG coffee, this project raised the possibility of smallholder farmer groups investing in community wet mills. As reported by the PPAP, this initiative is gaining momentum. Because each of the groups operates under an accredited quality-assurance system, traceability demands that accurate records be maintained. Collectively, the groups have also established a revolving credit fund, providing farmers with an opportunity to borrow funds to purchase chemicals and fertilisers and to employ labour to prune and rehabilitate coffee trees.

Hand-sorting green bean for the specialty market at Madan plantation in Western Highlands province (Photo: Peter Batt)

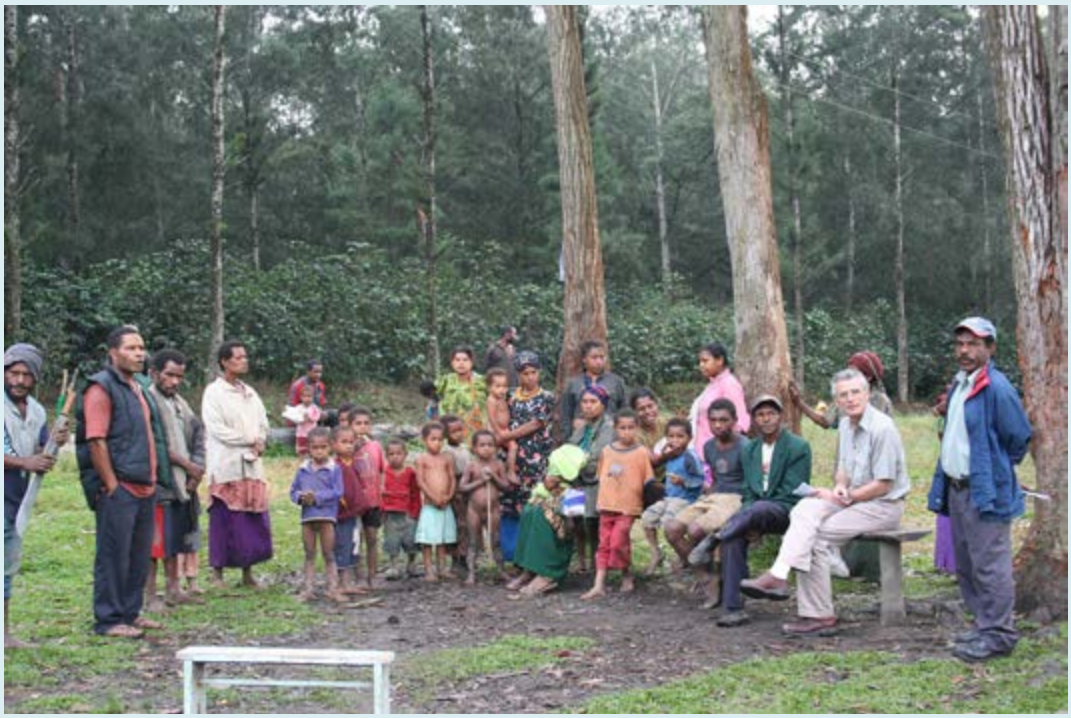
Impact—the difference the project has made or is expected to make

This project has had impacts at the industry, community and grower levels.

Industry impacts

Despite advice to the contrary at the time, it is now abundantly clear that this project played a significant role in shaping the CIC Strategic Plan 2008–18. Under Pillar 1 (increased and consistent production of high-quality coffee), the project contributed directly to:

- an increase in the volume of higher grades
- an increase in certification and the volume of certified coffee through industry training, grower mobilisation and the facilitation of supply-chain linkages
- the development of a generic HACCP-based quality-assurance program
- training and education on quality
- centralised wet-processing mills
- a review of the grading system
- mandatory price differentials.



A group discussion in Western Highlands province to clarify project expectations (Photo: Peter Batt)

At the time, the project did not support CIC efforts to encourage direct marketing by growers, preferring instead to link collaborative marketing groups with exporters who not only had the relationships with customers, but also the experience to manage the futures market and currency exchange rates. On a more positive note, while relationships between CIC and the exporters continue to be tested, the emergence of the PPAP and its associated funding has forced the exporters to engage with smallholder coffee farmers.

CIC acknowledges that this project provided a benchline study, outlining what the industry already knew but had yet to document. By linking collaborative marketing groups to exporters, not only has the volume of certified specialty coffee increased, but the quality of the parchment has dramatically improved through the adoption of standardised processing practices (where farmers are unable to sell cherry).

PNG Coffee Exports acknowledges that its relationships with growers have improved as a result of its participation in this project. To improve livelihoods, it recognises that a more holistic approach is needed to address the various impediments that affect the farmers' ability to increase productivity and to improve quality.

Community impacts

Under the Smallholder Support Services Pilot Project promoted by the Asian Development Bank, the formation of groups has forced smallholder coffee producers to come together to access the support services delivered by CIC through the Farm Extension and Training division. Strong and cohesive groups are also more attractive to the exporters because they provide a means of securing a regular and reliable supply of coffee and, with appropriate training, of securing more consistent quality coffee more cost-effectively. Where there is a high level of trust, several of the Agra Apo Kange groups are actively exploring the opportunity to establish community wet mills.

Strong, cohesive groups also provide the foundation for group certification, which is an integral and cost-effective part of the quality-assurance systems that are currently being promoted to shift more PNG Y-grade coffee to the specialty market. Under each of these systems, not only do the individual households benefit from increased income as a result of increased productivity and superior quality, but the community also benefits from premium payments. The premiums can be used to improve infrastructure (such as running water or roads), to provide consumables for schools or community medical centres, to collectively purchase production inputs, such as pulpers, pruning saws and secateurs, and, in some instances, to establish community wet mills.

Grower impacts

At the individual grower level, household incomes have improved as a result of increased productivity and higher prices (from the improvement in quality). CIC Lae reports that the cup quality of the coffee from the collaborative marketing groups has improved as a result of more standardised processing at the farm level. However, the quality of the coffee produced by smallholder farmers continues to be inconsistent.

Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying (FST/2001/021)

Russell Washusen

Project number	FST/2001/021
Project title	Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying
Collaborating institutions	Australia: Commonwealth Scientific and Industrial Research Organisation (CSIRO); Forests NSW; Queensland Department of Forestry and Fisheries China: China Eucalypt Research Centre (CERC); Guangxi Forest Research Institute (GFRI); Guangxi Eco-Engineering College Vietnam: Vietnamese Academy of Forest Science (VAFS)
Project leaders	Australia: Dr Russell Washusen China: Mr Peng Yan Vietnam: Mr Nguyen Quang Trung
Project duration	1 July 2005 – 30 June 2009
Funding	$1,385,694 total ($519,932 ACIAR contribution)
Countries involved	China, Vietnam, Australia
Commodities involved	Sawn wood, peeled veneer
Related project	FST/1999/095

Motivation for the project and what it aimed to achieve

Historically, the hardwood sawn timber and veneer processing industries in China, Vietnam and Australia have been important industries, supplying domestic and export building material, timber for high-quality furniture, and other decorative timbers. Processing plants have traditionally been supplied with logs from natural forests; however, in each of the three countries, natural forest log supplies have been increasingly restricted because of overcutting, tree clearing for agriculture and the allocation of many remaining forests to conservation reserves.

When this project was proposed, it was thought that an alternative source of logs might become available from a substantial area of newly developed eucalypt plantations. The plantations had been established on cleared farmland, and most were intended for relatively low-value pulpwood production. Processing these resources into high-value sawn wood and veneer could increase the value of plantations and become a new regional industry with flow-on benefits to local communities.

Compared with naturally grown logs, young plantation-grown eucalypts pose a number of challenges for processors of solid wood. Wood quality or mill output may be poor because of any combination of the plantation logs' smaller diameter, more and larger branch-related defects, the presence of tension wood, high and variable longitudinal growth stresses, and poor drying characteristics.

Processing systems in China and Vietnam were too poorly developed to cope with these characteristics. In Australia, where processing technologies were well advanced, processing plantation-grown eucalypts was very uncommon and restricted to small experiments conducted by research agencies and occasionally by processors.

The primary objectives of this project were:

- to improve sawn-wood and peeled-veneer quality and processing techniques for a range of eucalypt species grown in China, Vietnam and Australia
- for tension wood, for which improvements in wood drying are not possible, to apply tension-wood diagnostic techniques to identify some silvicultural and site factors associated with tension-wood formation
- to develop standardised research methods and improve the skills of research and industry staff.

The partners in the project were CSIRO, CERC and VAFS. CERC and VAFS have collaborated with CSIRO in the past in developing tree-improvement programs with the support of ACIAR. In the important tree-growing province of Guangxi, China, an informal partnership with another closely related ACIAR project[1] extended the collaboration to GFRI, the Dongmen Forest Farm and Liuzhou Eco-Engineering College.

1 FST/1999/095—*Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: genetics and silviculture*

Outputs—what the project produced

This project produced technical and capacity outputs.

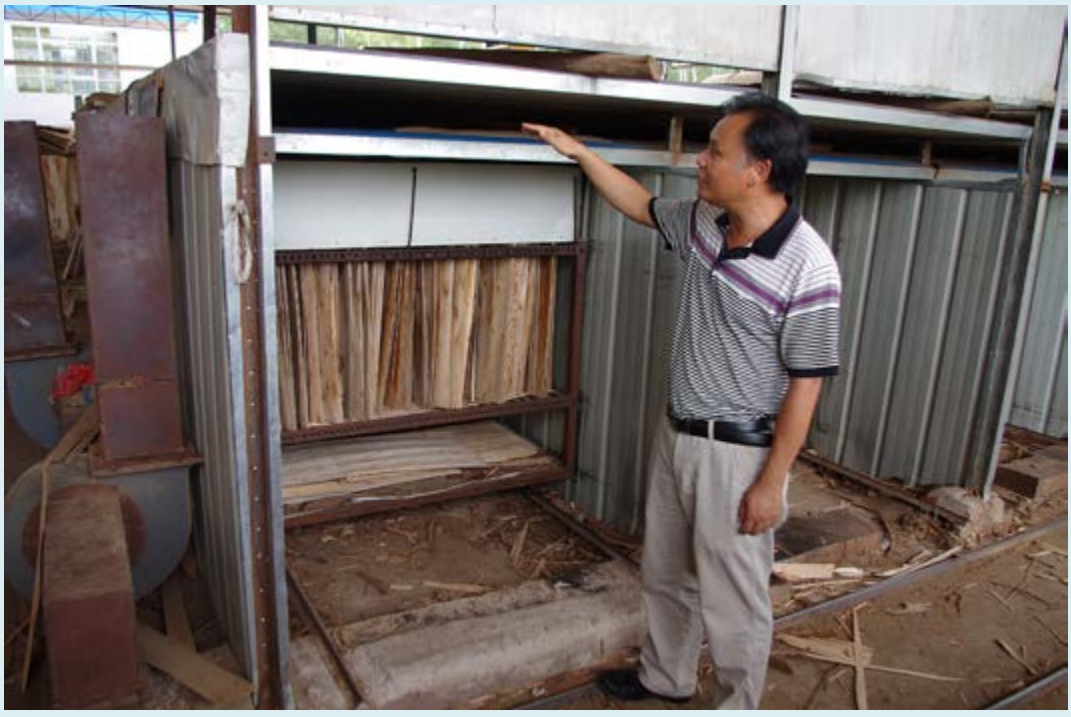
Technical

Radial scanning technologies and core sampling protocols developed at CSIRO to detect tension wood were further tested in a *Eucalyptus globulus* silvicultural trial. Timing of thinning, thinning intensity and the application of fertiliser all affected tension-wood formation, indicating that further work is needed to refine silvicultural strategies to minimise this problem.

Peeled-veneer production was identified as a good processing option for eucalypt logs under 20 cm in diameter. Improvements in mill-door log values of as much as US$50/m^3 over pulp log values were possible.

Modelling of log quality indicators produced grading strategies for unpruned small-diameter eucalypts that could be used to value logs or segregate them for different processing options, and log quality indicators for clonal selection in tree-improvement programs.

Pruning simulation models showed that mechanical pruning improved sawlog and peeler log values. Veneer log values could be increased by up to US$60/m^3, based on export-grade veneer prices.



Veneer dryer at Dongmen Forest Farm (Photo: Russell Washusen)

Improvements in peeled-veneer production and sawn-wood drying methods were realised through the application of veneer dryers, and through air- and kiln-drying and steam reconditioning of sawn wood.

In China and Vietnam, log rotation during sawing reduced losses in board volume due to end splitting, improved sawing accuracy and made growth-ring alignment more accurate to improve sawn-board drying characteristics and recovery.

In Australia, linear sawmills using symmetrical sawing methods demonstrated the application of high-throughput, low-cost sawing systems (in symmetrical sawing, multiple saws and chippers operate simultaneously on all sides of the log). Log length was increased, losses due to end splitting were reduced, and board deflection was contained to allow efficient board handling.

Existing modelling tools were further developed and applied to compare sawmilling costs for modern conventional reciprocating eucalypt sawmills and linear sawmills. For a given resource, there were substantial reductions in sawmilling costs in linear mills, allowing the mills to pay growers more for logs and potentially improving returns to both sawmills and growers. In one scenario, modelled log values were approximately US$100/$m^3$ greater for the linear sawmill.

Dried boards at Liuzhou Eco-Engineering College (Photo: Russell Washusen)

Capacity

Key research staff from CERC and VAFS were trained in sawmilling and wood-drying techniques for eucalypts at Timber Training Creswick in Australia. Technical discussions about sawn-wood and veneer processing techniques with Chinese and Vietnamese processors also aided the development of processing strategies in China and Vietnam.

All projects were conducted with a planned set of research methodologies to produce standard procedures for all projects in the program and for future research.

Adoption—how the project outputs are being used

Capacity utilisation

Approximately 20 research staff involved in the project are now engaged directly in wood processing, silviculture and clonal selection programs in China and Vietnam using outputs from the project. In China, GFRI is planning the application of the near infra-red radial scanning technology, and the Liuzhou Eco-Engineering College's Wood Processing Research Institute is continuing to develop drying and steam-reconditioning treatments for processing sawn wood. In Vietnam, VAFS has installed a new kiln with capacity for steam reconditioning, and testing and development of sawlog plantations using the project outputs.

Radial scanning for tension wood

There has been no take-up of the radial scanning technologies by next or final users in China and Vietnam because access to SilviScan-2 (an automated non-destructive system for estimating wood quality) has been restricted. CSIRO and the Cooperative Research Centre for Forestry in Australia have developed a near infra-red spectroscopy calibration for SilviScan data that improves access. The calibration is inexpensive and can now be applied in China and Vietnam.

Veneer production

The emergence of a major eucalypt veneer processing industry in China coincided with this project. The industry processes around 60% of the wood harvested from the country's estimated 3.6 million hectares (Mha) of eucalypt forests and has adopted some of the project outputs. In veneer mills associated with GFRI and the project, veneer processing methods have improved, face-grade veneer is now a target product, a new high-temperature veneer dryer has been constructed, and log and veneer conveyors have been installed. These improvements have allowed an expansion of production and given the mills a competitive advantage in the industry. Because of strong competition among an estimated 5,000 processors, this type of technology is likely to be adopted rapidly by other mills.

CERC has arranged for its network of growers in Yunnan and Sichuan provinces to prune trees so that it can assess improvements in the value and quality of logs used to produce both defect-free veneer (face-grade veneer) and sawn timber.

In Vietnam, similar changes have taken place but on a smaller scale than in China. This is because the eucalypt plantation area in Vietnam is only about 600,000 ha, and some of the resource is exported to veneer producers in China.

Sawing and drying sawn wood

Competition for logs in the veneer industry has limited the adoption of project outputs related to sawing and wood drying at the final-user stage. At the age of harvest for peeled veneer (5–6 years), sawing is a poor option because the diameter of the logs is too small. Older and larger diameter logs produce better product.

In China, CERC and GFRI have directed research into large-diameter sawlogs. GFRI aims to continue to develop research skills in a proposed project that will employ specialists in sawmilling and wood drying, and funding has already been secured for a wood-testing laboratory. At the next- and final-user stages, the commercial sawmill attached to the Liuzhou Eco-Engineering College now applies steam reconditioning in the later stages of drying as standard practice.

The situation in Vietnam is similar to that in China. A scarcity of domestically grown eucalypt sawlogs has increased demand for imported logs. Resource variation has also been identified as an impediment to processing sawn wood. Research is now directed to overcoming these problems by developing plantations in Vietnam to produce large-diameter eucalypts suitable for sawmilling. Drying eucalypt wood is a major difficulty in Vietnam, so VAFS has developed the capacity to apply steam during drying on a commercial scale. It continues to work with processors to develop wood-drying methods for eucalypts. VAFS also has plans to purchase a laboratory-scale drying system equipped with steam reconditioning. The system can be used for testing and developing drying schedules for commercial application.

At the final-user stage, the Pisico sawmill in Quy Nhon has now introduced air-drying techniques into processing of both eucalypt and acacia sawn wood.

Impact—the difference the project has made or is expected to make

There is evidence that the project influenced final users in the veneer and sawmilling industries in China and Vietnam.

While the eucalypt sawmilling industry has changed little, the eucalypt peeled-veneer industry in both countries and the associated plywood mills are major sources of employment in rural and regional areas close to the plantations. The many small-scale mills in Guangxi are particularly important because of the poverty in the rural community noted during project development, and because the province has about 40% of all eucalypt plantations in China. Tree growers, including government forest farms (in China), commercial enterprises and individual farmers, also benefit from greater demand for logs and higher prices than would otherwise be the case.

Similar benefits to rural communities are expected from the future development of large-diameter eucalypts for sawn-wood production. A greater reliance on ‘homegrown’ eucalypts for sawn wood will also improve the trade balances of both countries.

However, the expansion of veneer production has revealed skills shortages in all sectors of the eucalypt-plantation industry that are hindering development in some areas, including in research.

Plantation and industry development has a climate-change benefit, as carbon is a major component of wood. The large area of eucalypt plantations already established in China (3.6 Mha) makes up a significant carbon store. In Vietnam, the area of planted to eucalypts is smaller (0.6 Mha), but areas planted to acacias bring the total plantation area to around 1.0 Mha. Solid wood products from sawn wood and veneers that have a long life, such as those used for furniture and flooring, add to carbon storage capacity.

The need to ameliorate soil, water and land degradation caused by overclearing of native vegetation was also a contributing factor in plantation development. The 4.7 Mha of eucalypt and acacia plantations that have now been established in the two countries has helped significantly.

Demand for solid wood and wood fibre, and the development of world-class processing systems, are expected to contribute to increased demand and plantation area in the future.

Feeding village poultry in Solomon Islands (LPS/2003/054)

Phil Glatz

Project number	LPS/2003/054
Project title	Feeding village poultry in Solomon Islands
Collaborating institutions	Australia: South Australian Research and Development Institute (SARDI) Solomon Islands: Ministry of Agriculture and Livestock (MAL); Kastom Gaden Association (KGA); Solomon Islands College of Higher Education (SICHE)
Project leader	Dr P.C. Glatz, SARDI
Project duration	1 January 2005 – 31 October 2008
Funding	$655,055 total ($523,159 ACIAR contribution)
Countries involved	Solomon Islands
Commodities involved	Poultry
Related projects	ASEM/2005/094, ASEM/2010/053, LPS/2001/077, LPS/2006/149

Motivation for the project and what it aimed to achieve

The aim of this project was to develop poultry diets based on local feedstuffs and test them in village-reared layer and meat birds. This required staff training and the establishment of research facilities to enable sound scientific evaluation of the poultry rations. The project interacted closely with farmers and farmer groups to communicate the value of local rations and disseminate research findings. This required the training of provincial extension agents, non-govnernment organisiation (NGO) staff and farmer leaders in effective communication strategies and poultry management; demonstration trials on farms and at farmer schools and rural training centres; and the production and distribution of fact sheets to service providers and village farmers.

Use of local resources

The use of local feed ingredients to develop cost-effective diets for poultry in the Pacific island countries was a high priority for the South Pacific Commission, and the Solomon Islands village poultry project was driven by the high cost of imported poultry feeds. The smallholder egg and chicken-meat sector could also benefit financially from improved production methods, and farmers were demanding such information from service providers. Improving poultry production is an effective way to increase income and improve household nutrition, and greater use of local feedstuffs was seen as the best option for doing so.

Reducing poverty

Solomon Islands smallholders operate independently from the commercial layer and broiler industry. They produce about 210,000 birds per year, selling eggs and live birds in local markets. The sale of chickens is one of the major sources of income for traditional smallholder farmers, and an estimated 21,000 families (about 40% of the rural population) currently produce eggs and live birds. Birds are fed household food scraps and other locally available feedstuffs. About 85% of the Solomon Islands population live in rural regions with poor access for transport to urban areas.

Improving the productivity of village poultry systems could have a significant impact on national production and the wellbeing of rural communities, where an average of 30% of infants are underweight due to poor nutrition. The regular addition of eggs, chicken meat and more green leafy vegetables in family diets has the potential to reduce infant malnutrition.

Developing rations for poultry

A wide variety of locally available feeds, such as root crops, fruit, forages, bush plants and vines, could be used more effectively. Farmers are introducing new crops with higher nutritional value for poultry (sorghum, mungbean, pigeonpea, sunflower, amaranth and others). Planting material for many of these crops is available through the Solomon Islands Planting Material Network, a national farmers' network producing open-pollinated seed.

This project aimed to identify effective rations for village birds based on the variety of potential feeds available and to educate farmers on feeding management. These initiatives were planned to support the promotion by KGA and MAL of village poultry farming as a means of increasing income and the protein component in villagers' diet. Women, in particular, are often responsible for keeping and selling village chickens, making an important contribution to income for essential family needs.

Partner roles

KGA, in collaboration with MAL, ran demonstration and extension activities in the villages. SARDI Pig and Poultry Production Institute coordinated the project, building on its experiences in establishing a feed-testing facility for the smallholder broiler sector in Papua New Guinea (PNG) in other ACIAR projects.[1] The objective was to encourage smallholder farmers to use more suitable rations for their birds and stimulate an increase in the number of village layers, increasing income and the consumption of eggs and meat by village families. When the project began, there were no research facilities in Solomon Islands for testing poultry diet formulations. The establishment of such a facility at SICHE was seen as essential for the evaluation of the production performance of local village layers and to build the country's poultry research capacity.

1 LPS/2001/077—*Poultry feeding systems in PNG*; ASEM/2005/094—*Improving the profitability of village broiler production in PNG*.

Village farmer with project leader Phil Glatz, preparing to feed chickens (Photo: Tony Jansen)

Outputs—what the project produced

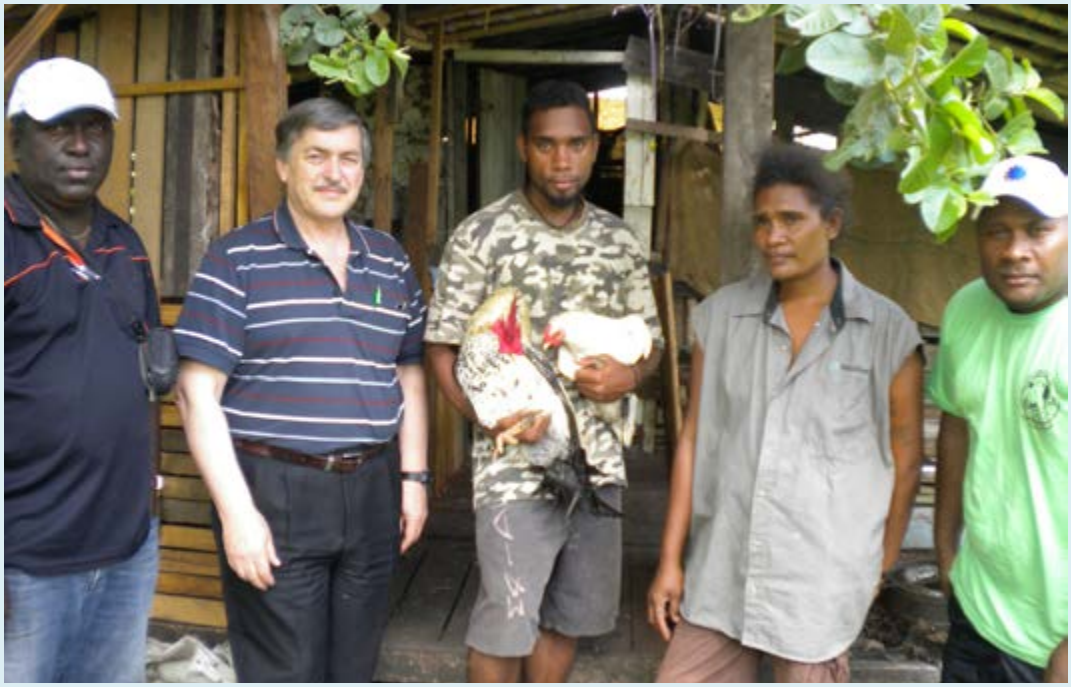
This project produced capacity, technical and policy outputs.

Capacity

The three main capacity outputs were the development of poultry research and demonstration infrastructure, the training of Solomon Islands village farmers and technical and academic staff, and ongoing collaboration between service providers in Solomon Islands and with the National Agricultural Research Institute (NARI) in PNG.

Infrastructure

The project involved the construction of a poultry research facility at SICHE, run in collaboration with MAL. The facility comprised a poultry shed with 16 pens that enabled replicated feeding trials to evaluate rations based on local feed ingredients. The feed resources used to develop the rations were those recommended by a village poultry farmers' research advisory committee established by KGA. In addition, a poultry facility to demonstrate best-practice village poultry farming was constructed at KGA headquarters at Burns Creek in Honiara. The facility was used to train village farmers while they were undertaking training on how to establish a smallholder village poultry business.



Barneabus Keqa (MAL), Phil Glatz (SARDI), Joshua Gregory (village farmer), Lottie Gregory (village farmer) and Michael Qwanafiam (KGA) inspecting village poultry (Photo: Phil Glatz)

Staff and farmer training

SARDI staff designed specific training programs for MAL, SICHE and KGA staff to assist them to run poultry feeding trials and demonstration and training programs for village poultry farms. Joseph Wahanui (SICHE lecturer) and Hilda Karani (KGA technician) did on-the-job training at SARDI in 2005. The training included working with SARDI staff carrying out daily husbandry activities associated with a feed trial, assisting with bird dissections, preparing samples for storage and visiting commercial farms where an on-farm research trial was being conducted. In addition, Thecla Vapusi (KGA village farmers' network coordinator) was trained on site in Solomon Islands by SARDI staff. Both Hilda and Thecla learned how to run demonstration trials at KGA and the importance of good record-keeping. This training improved their skills in training village farmers who participated in the attachment programs at KGA. Joseph Wahanui learned the scientific methodology required to set up and run feeding trials and was responsible for the research and development conducted at the SICHE facility. He also provided considerable support to MAL and KGA staff, as well as teaching SICHE students best-practice village poultry farming. A John Allwright Fellowship was awarded to Barney Keqa (MAL) to examine the genetic traits of village poultry in Solomon Islands as part of a masters degree at the University of New England. He has also developed significant knowledge in monogastric and ruminant nutrition. Since being awarded his masters, he has been appointed Director of the Livestock Section in MAL.

SARDI developed fact sheets on village poultry feeding to assist KGA and MAL to run farmer workshops on improved poultry feeding and management with village farmers in the Guadalcanal, Makira, Malaita and Western provinces. KGA hosted farmer attachment programs (1–6 months duration) at the Burns Creek demonstration poultry facility. When the participants returned to their home villages, most of them put into practice the poultry feeding and housing and business-management skills that they had learned.

Ongoing collaboration

The participation of MAL and KGA in the project has helped key people in each organisation maintain collaborative links, including in the development of a 5-year European Union livelihoods project run by NARI in PNG. Outputs from poultry projects in PNG[2] are being implemented in Solomon Islands and Vanuatu.

Technical

The major technical outputs produced by this project and associated ACIAR poultry projects were pamphlets demonstrating how to feed village birds and fact sheets and video on how to feed meat birds using a concentrate ration developed in PNG.

Information pamphlets on feeding village layers

The technical information produced by the project was obtained by running four feeding trials at SICHE. Information was initially obtained on current feeding practices used by village farmers. A survey showed that most farmers thought chickens were easy to care for and a good enterprise to provide cash and extra food for the family. Others were interested in poultry farming and had tried keeping birds, but faced a

2 LPS/2001/077; ASEM/2005/094—*Improving the profitability of village broiler production in PNG*

shortage of village chickens and a lack of available information and training on local chicken management and local feed ingredients. The village poultry farmers' research advisory committee was formed after the survey to advise the research team on the feed ingredients farmers had available to use in poultry rations.

Following the survey, experiments at the SICHE research facility evaluated the performance of village chickens on diets made from local feed ingredients compared to an imported commercial ration. The local diets included various combinations of sorghum, pigeonpea, pigeonpea leaves, fresh coconut and cassava, pawpaw fruit and leaves, corn, mungbean and fishmeal. The results showed that the local rations were more economical than costly, imported commercial feed.

SARDI, in collaboration with KGA, MAL and SICHE, developed one-page information leaflets on best-practice feeding methods for village poultry. The pamphlets include pictures of the feed ingredients and information on how they are prepared, the amounts of each ingredient to include in the diet (based on using a half-coconut as a volume measure), and how the diet is mixed and fed to birds. Fact sheets were distributed to farmers by MAL, SICHE and KGA.

Information pamphlets on feeding village meat birds

The method used to feed meat birds using a concentrate diet mixed with sweetpotato or cassava is being demonstrated to village farmers in Solomon Islands by PNG's NARI as part of a project funded by the European Union (EU) ('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' project). The meat-bird feeding method, fact sheets and video were developed in PNG by NARI in collaboration with SARDI.

Policy

Policies adopted by the city council in Honiara and major provincial towns on poultry farming in suburban areas drew on advice from MAL on best-practice poultry farming obtained during the project. The Ministry of Health in Solomon Islands is now advocating the confinement of poultry using the KGA and MAL village poultry farming model.

Adoption—how the project outputs are being used

The major outputs from the project were the development of poultry research and demonstration infrastructure; the training of Solomon Islands village farmers and technical and academic staff; collaboration between service providers in Solomon Islands; and pamphlets demonstrating how to feed village birds.

Infrastructure

The poultry research facility at SICHE and a village poultry demonstration unit at KGA continue to be used for training. Each year, 185 students are taught poultry production at SICHE and are involved in hands-on training with birds housed in the research facility. A poultry breeding facility constructed at SICHE to support the research is being used as a temporary classroom, pending the construction of new classrooms.

The breeding facility will then return to its original role of providing birds for the research facility. Since the completion of the project, no research trials have been conducted by MAL or SICHE due to lack of funds. At KGA, the poultry demonstration facility continues to be used for farmer attachment training.

Staff and farmer training

Hearly Aleve (MAL) and Joseph Wahanui (SICHE) attended an Australian Agency for International Development (AusAID)-funded Pacific islands poultry workshop run by SARDI in Sydney in 2010 in association with the Australian Poultry Science Symposium. Hearly and Joseph picked up the latest information on poultry health and production issues in the Pacific from Australian experts in the field.

KGA indicates it trained about 1,000 village poultry farmers from the completion of the project to July 2012. Information on poultry diets developed and demonstrated during the project continues to be provided to farmers. MAL has trained 500 village poultry farmers in association with the Seventh Day Adventist Church and World Vision. Therefore, about 1,500 village poultry farmers out of an estimated population of 21,000 in Solomon Islands have received training on how to prepare poultry diets from the project.

The geography of Solomon Islands constrains the training of village farmers, who are spread sparsely across the 992 islands in the archipelago, making it difficult to communicate with them and to bring them together for training. Solomon Islands has a poor road network, unreliable inter-island transport, high transport costs, a lack of trained staff to deliver training programs and a lack of financial support and interest by donor organisations to support training and the development of the smallholder and semi-commercial poultry industries. Nevertheless, the village poultry market is very lucrative for farmers, particularly in urban areas. The Chinese community in Solomon Islands has a high demand for village poultry and will pay SI$80 for a bird fed on local feed, which is equivalent to the price paid for commercial meat chickens that are fed on imported feed. This is driving the demand for information on village poultry diets developed in the project.

Ongoing collaboration

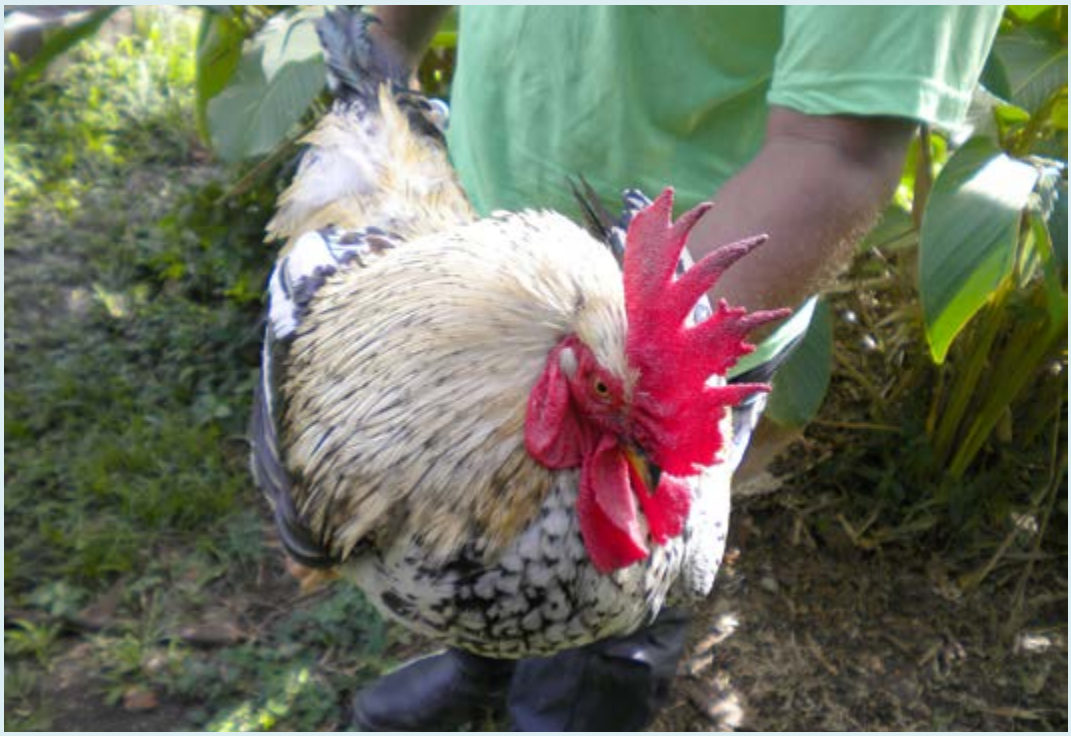
SARDI's ongoing collaboration with the Solomon Islands staff after the project was completed involved organising an AusAID-funded workshop on poultry production for Solomon Islands, Tonga, PNG and East Timor staff in Sydney in 2010. In addition, SARDI has continued advise KGA, MAL and SICHE staff on technical matters as they arise. With MAL and KGA, NARI staff from PNG have developed a 5-year EU project that is demonstrating meat-bird feeding methods to villagers, along with other sustainable livestock and agricultural systems. The broiler feeding methods were developed in ACIAR projects in PNG managed by SARDI.

The Solomon Islands Development Trust, which is committed to improving livelihoods in Solomon Islands, has a large network of village farmers. The trust has indicated its interest in working with MAL and KGA to include information on the poultry diets in its livelihood program.

Information pamphlets on feeding village layers

KGA has provided details of the village layer feeding method to about 4,000 farmers in its distribution network. It reports that the number of new network members is growing by 5% a year. The Solomon Islands Development Trust is proposing to collaborate with MAL and KGA to also distribute details of the village poultry feeding method to 3,000 villages in the trust's independent network.

Taking into account MAL's outreach activities, it is likely that information on the poultry feeding method will reach about 30% of Solomon Islands village farmers in the next 2–3 years. These activities are being augmented by the EU project in Solomon Islands run by NARI, which is demonstrating the meat-bird feeding method developed in ACIAR PNG poultry projects to 300 village farmers. Fact sheets on the poultry feeding systems, developed in the ACIAR poultry projects, are being distributed to African, Caribbean and Pacific island countries through an article requested by the Technical Centre for Agricultural and Rural Cooperation. The article is raising awareness of developments in poultry feeding systems in developing countries. This has implications for policy formulation, implementation and priority setting for poultry industry development in those countries.



Prized rooster at Lottie Gregory's village poultry farm near Honiara (Photo: Phil Glatz)

Impact—the difference the project has made or is expected to make

This project has had impacts in research, training and collaboration, and for farmers at the village level.

Development of poultry research and demonstration infrastructure

The development of the poultry research and demonstration facility continues to have impacts in Solomon Islands. While training has continued, the research has not, despite MAL staff wishing to further examine the role of local dietary ingredients in the production of commercial hybrids and local chickens. However, there is a strong demand for using the research facility to teach poultry production to students at SICHE. The poultry rations that were developed in the project are included in the teaching program for students and for the village farmers involved in training programs run by KGA and MAL. The demonstration facility at KGA is used to teach best-practice poultry farming to village farmers who are on training attachments. It will be further enhanced with the building of a facility to provide different strains of village poultry under a restocking program to three project sites in the EU project: Aruligho in Guadalcanal province; Hunda and Kena Islands in Western Province; and Buma in Malaita province. A link has been made with the ACIAR poultry project to use local feed resources to feed village chickens and to demonstrate the meat-bird feeding system developed in PNG to village farmers.

Training of Solomon Islands village farmers and technical and academic staff

Staff involved in the ACIAR project remain active in the poultry sector, reflecting the impact of the training they received during the project. Joseph Wahanui (SICHE) has returned to his village to establish a poultry business. Barney Keqa (MAL Director of Livestock) is developing a strategic livestock plan for MAL in collaboration with the World Bank's Solomon Islands Rural Development Program. The World Bank program aims to improve local infrastructure, agricultural services, service delivery and rural business development. MAL has undertaken to build a research and development facility for pigs, poultry and cattle and to expand research and extension capability to meet the needs of the expanding livestock sector in Solomon Islands. Barney is drawing on his experience in establishing the research facility at SICHE during the ACIAR project and his academic training to support him in the development of the strategic plan. He has submitted two papers from his masters thesis to an international poultry journal.

Hearly Aleve (MAL), who attended the AusAID-funded Pacific islands poultry workshop run by SARDI in Sydney in 2010, has been actively involved in running para-vet courses for livestock staff in Solomon Islands. He imparts information on the village chicken feeding system established in the ACIAR project to the trainees as part of his holistic approach to training para-vet staff. For KGA female technical staff members Hilda Karani and Thecla Vapusi, the impact of the training has been substantial. They have learned how to run demonstration trials and the importance of good record-keeping, and have become very confident and effective trainers of poultry farmers.

Collaboration between service providers in Solomon Islands and with other countries

The ACIAR poultry project established a good partnership between MAL, KGA and SICHE, which had previously worked independently. There has been an additional impact in the strengthening of the partnership of Solomon Islands partners with NARI in PNG and the Vanuatu Department of Agriculture and Rural Development. There will be a substantial spillover of project outputs into Solomon Islands that is likely to have an impact on village farmers' profits in the next 5 years.

Use of village poultry diets

There has been a significant impact on rates of egg production reported by farmers who have used the village poultry diets developed during the project. When village birds are fed a balanced diet made from local ingredients, they can double egg production compared to that of scavenging birds.

Ethnic groups in Solomon Islands are driving the demand for village chicken meat and eggs. The meat-chicken sector is also expanding, and 400,000 birds are being distributed to poultry farmers servicing the major towns. In the next 2–3 years, the project technology is forecast to penetrate about 30% of the market. On this basis, it could be assumed (based on cost–benefit calculations in PNG) that the benefit:cost ratio of the ACIAR project research, development and extension in Solomon Islands will be about 15:1.

Seasonal climate forecasting for better irrigation system management in Lombok (SMCN/2002/033)

Yahya Abawi

Project number	SMCN/2002/033
Project title	Seasonal climate forecasting for better irrigation system management in Lombok
Collaborating institutions	Australia: Queensland Climate Change Centre of Excellence Indonesia: Badan Meteorologi Klimate dan Geofisika (BMKG) Indonesia; Balai Pengkajian Teknologi Pertanian; Department of Agriculture (Dinas Pertanian-NTB); Dinas Perkerjaan Umum (Department of Public Works); University of Mataram
Project leaders	Australia: Dr Yahya Abawi Indonesia: Ir Ismail Yasin
Project duration	1 January 2004 – 31 December 2008
Funding	$1,677,571 total ($863,203 ACIAR contribution)
Countries involved	Indonesia, Australia
Commodities involved	Rice, pulses, soybean
Related projects	LWR2/1996/215, SMCN/1999/005

Motivation for the project and what it aimed to achieve

Climate variability and climate change have a wide range of impacts in the Asian region, including threats to food and water security, extreme weather and impacts on human health. The situation is exacerbated by a lack of national capacity for climate monitoring and forecasting; low levels of awareness among decision-makers; the subsistence nature of farming; low levels of educational attainment; limited institutional capacity; and a lack of effective policy responses.

Indonesia depends on agriculture as its primary means for support and sustenance, and more than 70% of the population is engaged in the industry. Climatic extremes (droughts and floods) affect all levels of the community, but the poor are most vulnerable. More than 90% of droughts in Indonesia have been linked to El Niño events that delay the onset of the monsoon, resulting in a shorter rainy season and widespread crop failures. On the island of Lombok, which has little water-storage capacity to mitigate variable streamflows, the many smallholder farmers rely on rivers to provide water for their crops. Rainfall and streamflow are usually sufficient to grow the first rice crop, but the southern and eastern regions of Lombok often face severe water shortages during the second and third cropping periods, particularly in El Niño years. Forecasts of rainfall and streamflow are therefore important in managing crop production on the island to maximise cropping opportunities in good seasons and to minimise adverse socioeconomic and other impacts of droughts.

The main aim of this project was to evaluate the utility of seasonal climate forecasting in water and crop management to improve ultimate yield, develop institutional and human capacity in seasonal climate forecasting, and raise awareness of climate variability and climate-change impacts among decision-makers, researchers and policymakers.

Rice is grown for its social value as well as its economic value (Photo: Yahya Abawi)

Outputs—what the project produced

To achieve the aims of the project, a number of interrelated decision-support tools for climate forecasting, water allocation and cropping decisions were developed in collaboration with various government agencies at the national and provincial levels. Although the tools were developed as stand-alone outputs, the output from each is used as input for other modules.

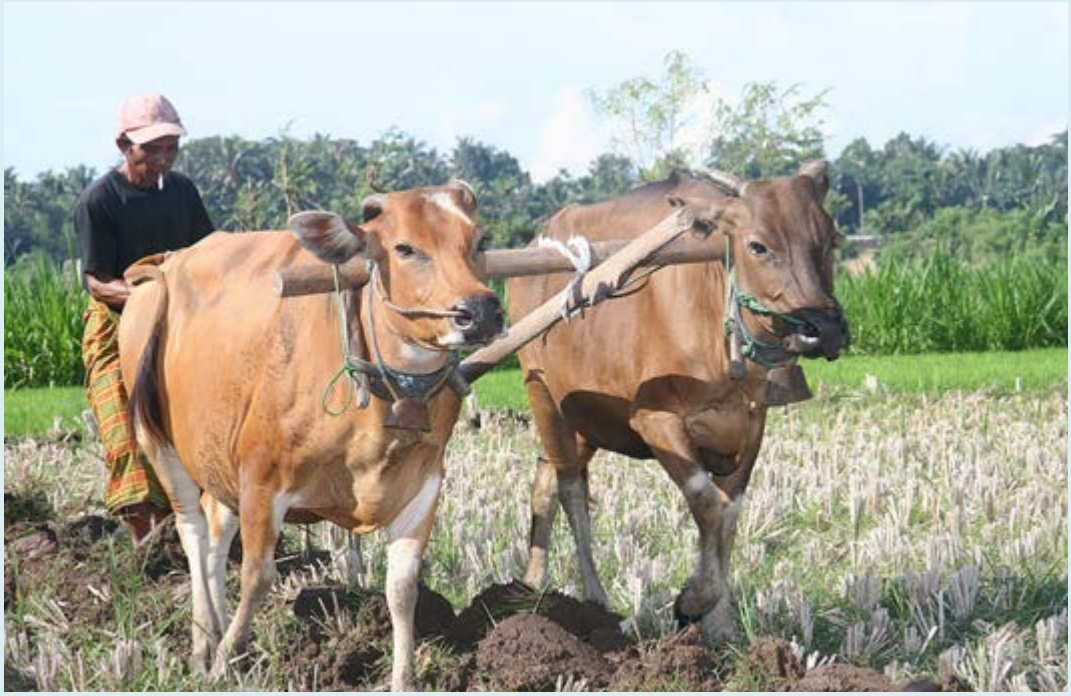
The main outputs included four decision-support tools—FlowCast, CropOptimiser, an integrated quantity and quality model (IQQM) and HowLeaky—and a comprehensive database of daily and monthly climate and hydrological data extending back to 1950 and covering more than 30 stations across Lombok. In addition, a number of intermediate outputs and methodologies in data synthesis and hydrological modelling techniques were developed and now provide significant capacity for further surface water and groundwater studies for scientists in Indonesia and Australia. Some of these products have been used in other studies, such as the Pacific Island Climate Prediction Project, which included climate adaptation studies covering human health, water, renewable energy and agriculture.

Hand-harvesting high-quality rice to reduce losses (Photo: Yahya Abawi)

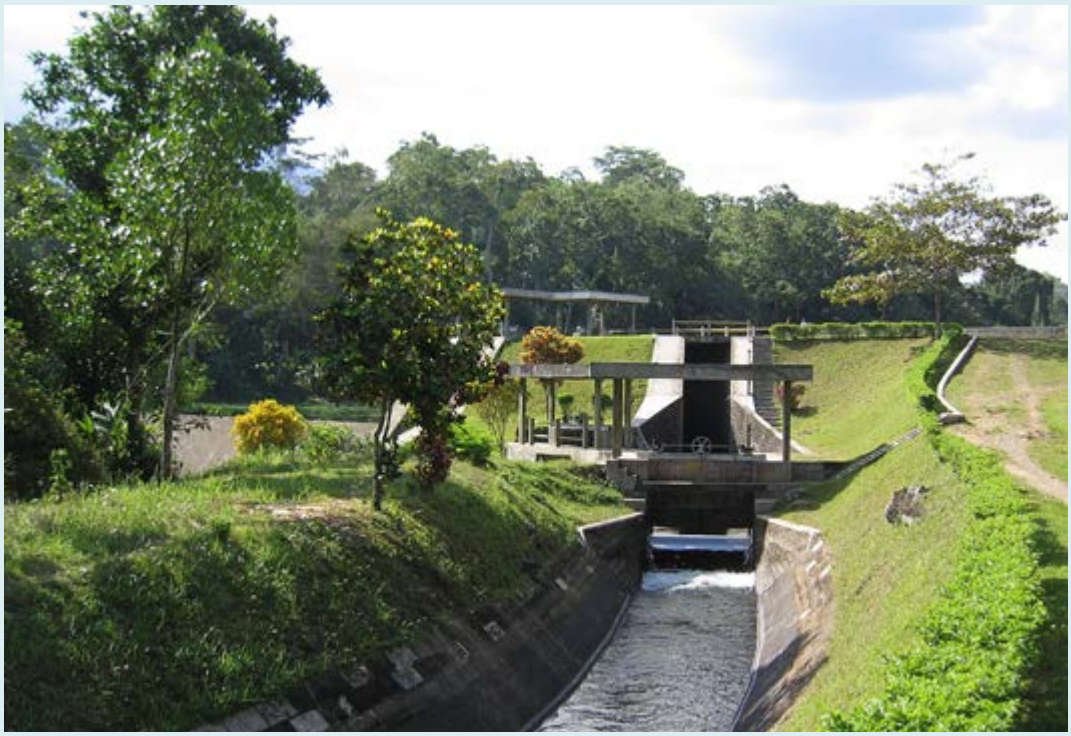
Technical

FlowCast was developed to generate probabilistic forecasts of rainfall and streamflow at local and regional scales. It has been designed for scientists, water managers and agricultural decision-makers who have extensive background knowledge of climate and its drivers. FlowCast provides spatial analysis capabilities, enabling the Indonesian Meteorological Agency, BMKG (Badan Meteorologi Klimate dan Geofisika), to provide forecasts of rainfall, streamflow, the onset of the monsoon and the drought situation. Inputs include a range of 'predictors', such as sea-surface temperature anomalies or the Southern Oscillation Index, and 'predictands', such as rainfall, temperature or streamflow data. FlowCast is interactive and includes a range of custom-designed user-input tools. It can be used to generate forecasts in the local Bahasa language.

CropOptimiser was developed to optimise regional cropping choices and patterns for different seasonal, climatic, agronomic and social conditions. It aids regional-level agricultural planning by providing cropping recommendations that can be disseminated through government officials and community leaders to the farm level. At the regional level, strategists can geographically optimise cropping choices and areas based on the likely water availability, as determined from climate forecasts and IQQM output. CropOptimiser uses a linear programming approach to maximise profit, subject to physical and social constraints for defined cropping seasons and climate forecasts. Regional inputs include available land area, soil types, rainfall and irrigation system diversion time-series data. Crop characteristics are defined by potential yield, water demand, a soil productivity index, growing costs and prices.



Traditional farming methods are used in conjunction with climate forecasts issued by the Indonesian Bureau of Meteorology (BMKG) to plan water allocations (Photo: Yahya Abawi)



Irrigation network in Lombok (Photo: Yahya Abawi)

IQQM is a hydrological model used for planning and evaluating water resource–management policies at the river-basin scale. Used extensively in Australia, the IQQM was configured for the river systems in Lombok, covering an irrigation area of 64,000 ha from the Jangkok system in the north-west to Jerowaru in the south-east. The model was calibrated using limited observed daily irrigation diversion data to simulate at least 50 years of daily streamflow and irrigation diversions. The output from the IQQM is used in FlowCast and CropOptimiser to evaluate the impacts of climate on water allocation and cropping decisions.

HowLeaky is a point-scale water-balance model used to explore the implications of alternative land uses for water balance, run-off, erosion and drainage. HowLeaky was used to verify experimental results from a related ACIAR project[1] to determine the potential benefit of capturing run-off from the first-season crop in raised-bed systems in southern Lombok, where water is limited, and storing it in small dams (*embungs*) for the supplementary irrigation of second-season crops.

Capacity

This project has built significant human resource and organisational capacity in Indonesia for research related to climate, agriculture and water management, and has formed an extensive network of organisations in Australia, South-East Asia and Indonesia. The Research Centre for Water Resources and

1 SMCN/1999/005—*Improved soil management of rainfed Vertisols in Nusa Tenggara*

Agroclimate (Pusat Penelitian Sumberdaya Air dan Agroklimate—Puslisda) at the University of Mataram was formed in 2009, and staff engaged in the ACIAR project transferred to the centre. Puslisda is active in promoting the outcomes of the ACIAR project to the community and has attracted significant research funding from national and international organisations (such as Kementerian Riset dan Teknologi, Dikans, the Australian Agency for International Development and Fauna & Flora International). The project has also developed significant leadership capacity in Indonesia through successful degree completions by two PhD students and one masters student and the awarding of an Australian Academy of Technological Sciences and Engineering Crawford Fund Scholarship.

Adoption—how the project outputs are being used

The decision-support models are complex and not intended for direct use by the final users (farmers). However, the project has produced general recommendations on the impacts of different climate types (El Niño, normal, La Niña) on water availability during each growing season and their implications for cropping patterns. The main users of the project outputs are the many government agencies that provide recommendations to farmers. This approach was taken because an early survey in Lombok found that 70% of farmers had never had schooling and that most of them take advice from the government on which crop to grow.

FlowCast is used extensively by the BMKG as a research and training tool and to provide forecasts of rainfall, the onset of monsoon and drought conditions in West Nusa Tenggara (WNT). The BMKG office in Lombok produces a monthly bulletin (*Analisis Curah Hujan*) for 56 stations, with forecasts of below-normal, normal and above-normal rainfall for the next 3 months. In addition, drought analyses (Analisis Tingkat Kekeringan Di Nusa Tenggara Barat) are produced in a monthly bulletin (*Agroklimate—NTB*) and distributed to all government agencies in WNT.

This information is used by agencies to plan the next growing season. The forecasts of rainfall, general cropping recommendations and local inputs are used by the water and agriculture departments to determine water allocation and crop production strategies and to produce an atlas (*Tanam Kalender*—Crop Calendar) for the region. Crop Calendar describes the schedule for planting certain types of plants in the area for a year, from soil preparation and planting to harvesting. The acreage and choice of crops are based on seasonal climate forecasting produced by BMKG. Other agencies involved in these decisions include the University of Mataram and the WNT Department of Agriculture.

The Department of Agriculture also conducts drought seminars involving extension officers from various government agencies. The workshops are normally held every 3 months, but more often during drought.

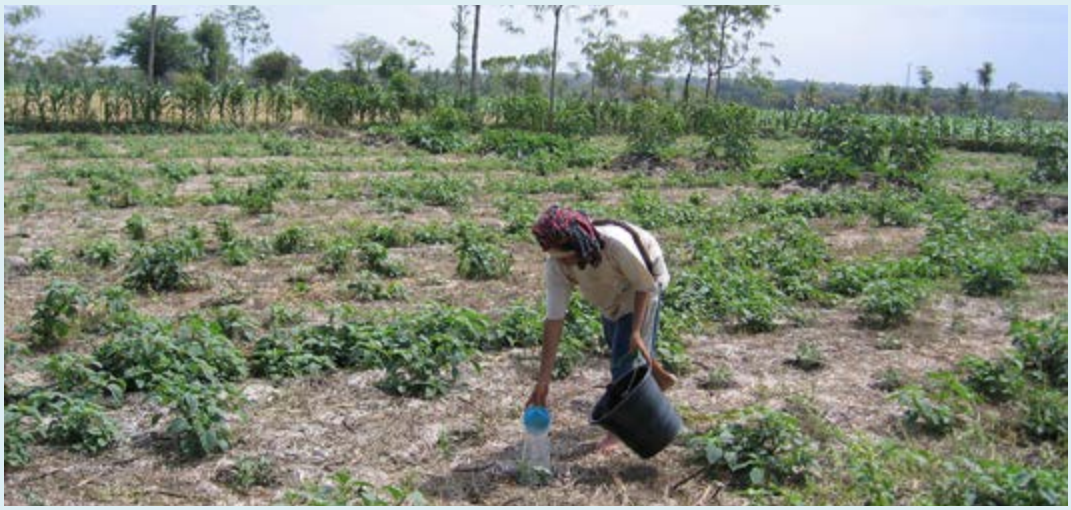
Although most information produced from the project is distributed to final users through research and extension officers, some large cooperatives seek information directly from BMKG and the University of Mataram and have also engaged independent consultants to provide climate forecasts for them.

Impact—the difference the project has made or is expected to make

Since the start of the project, awareness of climate variability and climate change has increased significantly among researchers, policymakers, farmers and the general public. Climate forecasts are now routinely used in all aspects of planning and environmental management across Indonesia. This is evidenced by the number of centres that have been established to do research with climatic applications in different sectors, including research by Puslisda at the University of Mataram. However, it is difficult to quantify the direct impact of the project at the final-user level, as farms are typically less than 0.1 ha and crop production depends on many other factors as well as climate.

The future impact of the project is likely to be significant as the information from the project and other related research is progressively used in drought management, water allocation and crop management decisions across the region. WNT is one of six corridors identified for food production in the Indonesian Master Plan for Economic Development Acceleration (MP3EI) program. Under the master plan, WNT is to reach a rice production target of 2 million tonnes (Mt)/year by 2015. Production increased from 1.3 Mt/year in 2005 to 1.7 Mt/year in 2011. Improved water and crop management strategies are vital if the 2 Mt/year target is to be achieved.

Notwithstanding the positive impacts of the project to date, there is a real risk that the use of this information may have negative social and economic impacts. Forecasts are inherently probabilistic and subject to misinterpretation by novice users, and some of the Indonesian staff trained as part of the project have moved on. The decision-support software developed has not been maintained or updated, which is a problem because of rapid changes in computer technology since 2009. There is a real and emerging need to conduct further training activities across Indonesia and to upgrade existing software to ensure that the full potential of this research is realised.



Limited water availability during El Niño events forces farmers to hand-water crops in southern Lombok (Photo: Yahya Abawi)

Farmer evaluation and multiplication of sweetpotato varieties on the north coast of Papua New Guinea (SMCN/2003/010)

Ian Grant, Elick Guaf and Francisca Yagama

Project number	SMCN/2003/010
Project title	Farmer evaluation and multiplication of sweetpotato varieties on the north coast of Papua New Guinea
Collaborating institutions	Australia: World Vision Australia; Queensland Department of Primary Industries and Fisheries; Australian National University PNG: National Agricultural Research Institute (NARI); World Vision (PNG) Trust; Division of Agriculture Livestock and Fisheries, Madang province
Project leader	Dr Sally Henderson, World Vision Project Coordinator, World Vision (PNG) Trust
Project duration	1 April 2004 – 30 October 2008
Funding	$1,179,331 total (ACIAR contribution $48,998; AusAID contribution A$881,603)
Country involved	Papua New Guinea
Commodity involved	Sweetpotato
Related projects	CS1/1984/033, CS1/1988/012, CS1/1992/702, LWR2/1991/001/ LWR2/1996/162, LWR2/2000/060

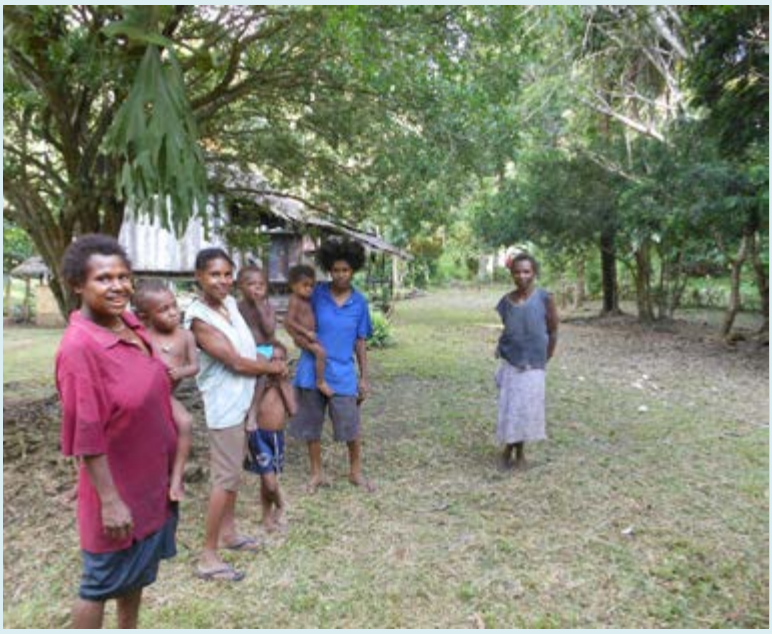
Motivation for the project and what it aimed to achieve

This project addressed the need for food security in six districts of Madang province, Papua New Guinea (PNG), where populations are growing fast and are vulnerable to natural disasters. Implemented by World Vision in collaboration with PNG's National Agricultural Research Institute (NARI), the project aimed to improve the production of sweetpotato, which is the most important food for more than 60% of the population and is commonly planted across diverse agroecological zones. Average crop yields are low in the area, and there was potential for improvement using selected NARI varieties maintained at the Lowland Agricultural Experiment Station, Kerevat, which produce yields up to double those of locally grown varieties. The NARI varieties have the potential to help families cope with the effects of intensified production.

Working with other World Vision rural development initiatives, community groups and individual farmers in the Madang area, the project involved first selecting varieties from farmers' fields for evaluation by NARI and then multiplying 14 varieties (plus two local varieties as checks) for evaluation in trials on farmers' land under the supervision of field extension technicians and later by farmers.[1] An investigation into farmers' criteria for selecting sweetpotato varieties was an important component of the study. The trials provided the necessary information to disseminate appropriate sweetpotato varieties throughout the northern coast of PNG.

In practice, the project operated only in the lowlands of Madang province (below 600 m above sea level) in Madang, Raikos, Usino/ Bundi, Bogia and Sumkar districts. It was the first of its kind in PNG to have worked extensively with villages at such a large scale.

1 Details of the varieties are in NARI n.d.



When Valeria (closest to camera) moved to Aronis village, she planted sweetpotato into a kunai grass area, to shade out weeds and produce a quick crop.

Outputs—what the project produced

The outputs of the project were:

- the identification of farmers' criteria for adopting sweetpotato varieties
- promising sweetpotato varieties from NARI trials
- the evaluation of a dissemination technique that uses farmers as multipliers and evaluators of planting material.

The mean yield for all 16 varieties evaluated was about 5.7 t/ha. The best mean yield was from the SI85 variety at Usino in the second series of technician-controlled on-farm trials (17.4 t/ha). These results were below expectations. In this environment, one would expect mean root yield of about 12–14 t/ha and a maximum of 30–40 t/ha. When the project was reviewed by Dr Grahame Jackson in 2007, he suggested that the planting material was carrying a high load of viruses, reducing yields.

Although sweetpotato was perceived to be a secondary garden food in the farming systems in the Madang lowlands, it was increasingly recognised, particularly by women, as playing a valuable food-security role by filling a 4-month hunger period outside the cropping periods for traditional indigenous foods (taro and yam).

The adoption of sweetpotato in the Madang lowlands appears to be largely led by women, who understand its role in the garden system and make planting decisions. Therefore, it is important that future extension efforts continue to involve women in the evaluation and distribution of improved varieties.

The project found that farmers were selecting and seeking varieties not purely on yield but on a range of criteria. The original project objective was to identify the best varieties for food security, but the farmers just wanted the 'best' varieties—and they wanted to define 'best'. They based their definition variously on taste, the speed at which the plant matures, or the size of the storage roots. Their priorities might change over time, but it was clear almost immediately that farmers value choice.

The project has helped develop both choice and diversity in farmers' gardens. Allowing the process and thought behind farmers' decision-making to occur is perhaps even more important than their final decisions. Because sweetpotato production is dominated by females from planting to food preparation, women have the power and ability to decide. In the future, higher yielding varieties to bolster food security will already be in the farmers' gardens as a result of the project.

Participation and interest were high because farmers are natural researchers who enjoy their knowledge and understanding of each variety as much as the benefits each gives. While the benefits of some varieties were good, there were additional benefits in being part of a research project that brought attention back to the farmer.

Early indications show that farmers are reluctant to drop any of the 16 varieties from their gardens in the near future, although some varieties may be preferred to others. This would probably not have been the case if 30 varieties been distributed.

Adoption—how the project outputs are being used

This adoption study aimed to determine whether any of the 14 selected sweetpotato varieties distributed to communities were still present and to understand why particular varieties had been selected and how they were being used. A secondary aim was to identify changes in the use of sweetpotato and the drivers of those changes.

It was found that the introduced varieties were widespread, that farmers had made deliberate choices about which varieties they kept, and that the NARI varieties were making a major contribution to improved food security and livelihoods.

The study covered 15 villages, each of which had its own preferred variety. Sweetpotato is now the most common food in daily household diets, taking over from yam and taro. After the analysis of the most preferred varieties in the Bogia, Madang, Rai Coast, Sumkar and Usino Bundi Gama districts, DOY2 stood out (Table 5).

Table 5. Sweetpotato varieties present in each site visited

District	Names of villages	Preferred varieties
Madang	Erima, Barum and Panim	SI85, SI108, FV2, FV1, FV2, K9, L43, DOY2, K142, L942
Sumkar	Aronis, Pepaur, Murukanam and Karkar Island	L43, DOY2, FV2, Kinabakap, RAB36, K142, B11, MAS2, L781, L46, FV1, K9, SI85, SI108, L942
Bogia	Bari, Apengan, Nubia and Iku	FV1, FV2, K9, L43, SI85, DOY2, RAB36
Usino Bundi Gama	Sankiang, Yakumbu and Waput	DOY2, L942, L46, RAB36, B11, Kinabakap, L43, FV1, MAS2
Rai Coast	Bibi	L46, RAB36, DOY2 and FV1

DOY2 is greatly preferred because of its good yield and because its vigorous growth prevents weeds from growing in the gardens. It is also one of the early-maturing varieties.

The two local Madang varieties (FV1 and FV2) were the second most preferred, followed by RAB36 and L43, which have orange flesh and are preferred by most families, especially the children. The fourth most preferred varieties were L942, SI85 and K9, which are mainly grown for marketing because of their high yield and good storage-root size. These were followed by MAS2, K142, L46 and Kinabakap, then B11, and the least preferred variety, L781.

Farmers reported that sweetpotato was of increasing importance in their gardening systems, providing food for local consumption, income from sales and, to a lesser extent, food for livestock production. One key driver for this trend was a change in the climate from the usual seasonal dry period to year-round

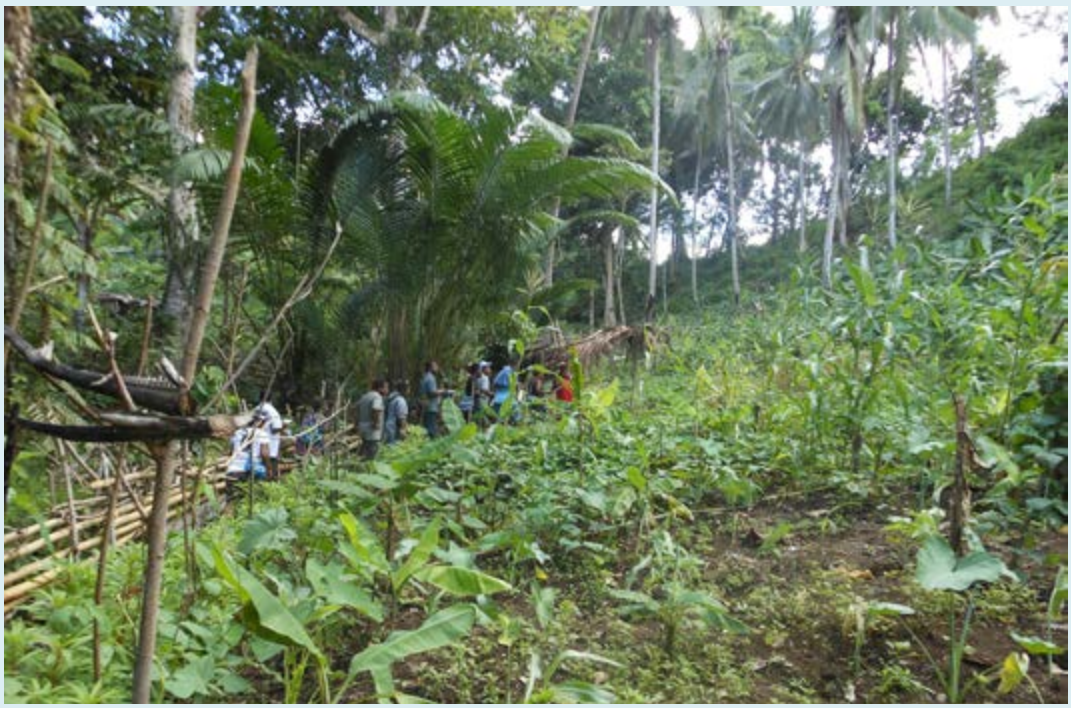
rainfall (at times excessive). Farmers commented that their preferred staple crops (taro and yam) provide less reliable yields under continuous rainfall. This may be because of an increase in pests and diseases. Sweetpotato is thus becoming more of a year-round crop with continuous cropping.

Pests and diseases of sweetpotato were noted at a number of locations, but farmers commented that most were not that important during the wet season, provided crops were harvested when ready. The survey team found little evidence of virus infection of sweetpotato, apart from in crops that were under stress (for example, in low-vigour crops growing in coastal sands).

Betel nut production and marketing are now major economic activities in the province. A disease outbreak in betel nut trees in Markham Valley has reduced competition and increased prices. The crop is both marketed locally and sold to buyers from the highland provinces. In turn, sweetpotato is imported into the province and is available in the main markets. According to Omot et al. (2010), the highland varieties are preferred over local varieties. A number of farmers have planted them, but their taste and yield are not satisfactory.[2]

Serious sweetpotato farming appears to be concentrated in mid-altitudinal areas and in more remote locations above 600 m. Most sweetpotato sold in markets along the northern coast appears to have been grown in mid-altitudinal areas. Coastal communities are more reliant on cash incomes from betel nut, timber, pig, coconut and cocoa production (sweetpotato is grown for home consumption or to feed to pigs).

2 Sweetpotato varieties yielding well at high altitude will not usually yield well at low altitude, as low soil temperature is critical for storage root bulking.



Visit to sweetpotato garden in Aronis village by project survey team (Photo: Ian Grant)

Almost all communities surveyed grew sweetpotato for home consumption and for income, and the introduced NARI varieties were selected to meet those two needs. Commercial planting for large-scale sales to urban markets and to institutions was expanding in some areas. The two Solomon Islands varieties (especially SI85) were being used to develop markets in competition with imported highland varieties.

The survey showed that there has been little spread of the improved NARI varieties to the more remote locations, even though communities there had heard about the project. There is demand in the inland communities for improved planting materials of *Dioscorea rotundata* yam, *D. esculenta* yam and sweetpotato.

Several communities complained that wild and local pigs regularly damage their sweetpotato gardens. Men were more phlegmatic than women about this, stating that the pigs were hungry and that it was understandable (pigs create wealth for the men, who also enjoy hunting wild pigs). Women said that they felt like giving up growing sweetpotato, as pigs attracted to gardens damaged not only their sweetpotato but also other crops. This also reflected the status of the crop as something that belonged to the women. Where sweetpotato is grown as a commercial crop (for example, in Erima), pigs are tethered or housed permanently.

Sweetpotato varieties on display during focus-group discussions in Nubia village (Photo: Ian Grant)

Impact—the difference the project has made or is expected to make

This project had impacts at the community level and on capacity and collaborations.

Community impacts

Because the project engaged farmers in research and selection, it generated a great deal of enthusiasm from participants. Each community visited expressed satisfaction with its involvement in the project, and farmers were able to explain how they had benefited and why they chose the particular varieties they now farmed.

The widespread adoption of the new varieties is bringing benefits to both food production and livelihoods. The availability of the varieties also appears to have aided communities as they adapt to changes in the climate.

Unlike the other traditional food crops, sweetpotato is not subject to any boundaries or restrictions on who should be eating what and when. This makes it the most easily accessible food crop available all year round for villagers of all ages. Recipes distributed during the project are still being used, and some people commented during focus-group discussions that this is improving the diets of children and adults. The recipes are also used to prepare food for church and school fundraising and to have food on hand for the Sabbath.

Capacity impacts

The project began by identifying key farmers in each district of the province. These farmers provided great support for the project and without their leadership nothing would have happened. Farmers actively participated in the training and reflected positively on the whole experience. They established a collective to market SI85 to local institutions and markets in Madang, set up a trade store, established women's groups, developed local recipes to improve nutrition and utilisation of the crop, and distributed material to relatives and friends. For some with a special interest in sweetpotato, the project has affirmed their knowledge and provided additional training on all aspects of production and marketing. Many recognised the value of the new varieties in responding to changes in the climate.

Most of the technicians employed in the project were relatively recent graduates, so the project gave them an opportunity to learn on the job. They expressed gratitude for the skills they learned during the project (sweetpotato production, disease recognition, project management, community mobilisation, data collection and analysis). Furthermore, the relationships developed with the communities are still very healthy.

For World Vision, this project opened up new areas for development as the area program was established and communities entered into partnerships to undertake further projects on water, sanitation and hygiene (WASH); adult literacy; early childhood education; livelihoods; children's nutrition; maternal and infant health; local governance capacity building; and youth music and arts. Trust built up during the project has been important for the expansion of the work in the province.

NARI, though Mr Elick Guaf, provided great support for the project and has continued to support agriculture in Madang province through local partnerships, especially for the distribution of planting material and technical training. Knowledge about which sweetpotato varieties farmers have adopted provides confidence to distribute the best varieties. Further varieties might also be tried, based on these results. The Department of Primary Industry officer based in Bogia was involved in the project while working for NARI and continues to support local farmers to try new crops and techniques.

Collaboration between service providers in PNG and with other countries

Local institutions provided great support for the project. They included the Cocoa Coconut Institute, the Division of Agriculture, Livestock and Fisheries in Madang province, and schools and churches. This network of collaborators shared in the work and also in the lessons learned—as demonstrated by the end-of-project workshop. During the survey, it was observed that a good level of cooperation and mutual support continued. NARI continues to work with Division of Agriculture, Livestock and Fisheries staff to distribute new varieties as part of a food security and climate-change project funded by the European Union.

Trends that multiplied the impact of the project

The impact of the project was increased because of farmers' increasing need for cash income that benefits women and children; the need to improve the diets of children; the specialisation of coastal communities away from sweetpotato production as an income earner; and the effects of climate change on staple crop production (both yam and taro are struggling with year-round rainfall). The presence of disease in coconut and banana crops may also bring further change.

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