Australian Agency for International Development

AusAID

PNG agricultural cluster evaluation

Evaluation No: 5 - March 1998

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This study was undertaken by external consultants and does not necessarily represent Australian government policy

Contents

List of figures

Abbreviations and Acronyms

ACIAR	Australian Centre for International Agricultural Research
ACLMP	Australian Contribution to the Land Mobilisation Project
CCRI	Cocoa and Coconut Research Institute, Keravat
CCEA	Cocoa and Coconut Extension Agency
CDA	Coffee Development Agency
CIC	Coffee Industry Corporation
CQIP	Cocoa Quality Improvement Project
CRI	Coffee Research Institute
CRIP	Coffee Research Institute Project
DAL	Department of Agriculture and Livestock
DEC	Department of Environment and Conservation
DPI	Division of Primary Industry
FIM	Forest Inventory Mapping (component of ACLMP)
FRRAP	Forestry Rapid Resource Appraisal Project
GIS	Geographic Information System
LUS	Land Use Section (of DAL)
MASP	Mapping Agricultural Systems Project
NFS	National Forest Service
PCR	Project Completion Report
PID	Project Implementation Document
PNGRIS	PNG Resource Information System
RRA	Rapid Resource Appraisal (of forest resources)

TAG	Technical Advisory Group
TFAP	Tropical Forest Action Plan
UPNG	University of Papua New Guinea

Common acronyms such as CSIRO, FAO etc have been excluded.

Currency Conversions

Average mid-rates for year against Australian $ and US $

Year	Australian dollars	US dollars	PNG Kina
1990	1.0000	0.7734	0.7386
1991	1.0000	0.7599	0.7232
1992	1.0000	0.6873	0.6630
1993	1.0000	0.6775	0.6627
1994	1.0000	0.7770	0.7858
1995	1.0000	0.7452	0.9537
1996	1.0000	0.7968	1.0511
1997 (August)	1.0000	0.7300	1.0276
1990	1.2930	1.0000	0.9550
1991	1.3160	1.0000	0.9517
1992	1.4550	1.0000	0.9647
1993	1.4760	1.0000	0.9782
1994	1.2870	1.0000	1.0113
1995	1.3420	1.0000	1.2798
1996	1.2550	1.0000	1.3191
1997 (August)	1.3605	1.0000	1.3707
1990	1.3539	1.0471	1.0000
1991	1.3828	1.0508	1.0000
1992	1.5082	1.0366	1.0000
1993	1.5089	1.0223	1.0000
1994	1.2726	0.9888	1.0000
1995	1.0486	0.7814	1.0000
1996	0.9514	0.7581	1.0000
1997 (August)	0.9926	0.7296	1.0000

Source: IMF International Financial Statistics and Commonwealth Bank

$ in this report refer to Australian dollars

Basic Project Data

Coffee Research Project

Executing Agency: Coffee Research Institute, Aiyura, Kainantu
Managing Contractor: Department of Agriculture and Rural Affairs, Victoria; and Overseas Projects Corporation of Victoria

	Planned	Actual
Technical Assistance (person months)		
Long-term advisers	84	na
Short-term advisers	3	na
Total	87	na
Project cost ($'000)		
AusAID costs	1150	1150
Local currency expenditure (est)	250	329
Total initial project cost	1400	1479
Project extension	732	2541
Total project cost	2132	4020
Key Dates:		
Appraisal mission	March 1987	
Appraisal report	September 1987	
Project commencement	May 1988	
Planned completion	May 1991	
Project completion		November 1992

Cocoa Quality Improvement Project

Executing Agency: Cocoa and Coconut Research Institute, Keravat, East New Britain

Managing Contractor: Queensland Department of Primary Industries/Hassall and Associates Pty Ltd

	Preparation	Phase II	Extension	Total
Technical Assistance ° (person-months)				
Long-term advisers		48	18	66
Short-term advisers	9	53	11	73
Total	9	101	29	139
Project costs ($'000)				
Budgeted				
AusAID costs	300	2681	840	3721
Estimated local costs	na	518	260	778
Total project cost	300	3199	1100	4499
Actual				
AusAID				3071
Local contribution (est)				607
Total project cost				3678
° budgeted - actual not available				
Key Dates				
Assistance request to AusAID	1986			
AusAID/Cocoa Board MOU	May 1988			
Project Design Document	April 1988			
Design mission	May-Sept 1989			
Project Implementation Report	April 1990			
Project start		July 1991		
Appraisal of research component		August 1994		
Volcanic eruption		September 1994		
Scheduled project completion		June 1995		
Extension component completion			December 1995	
Research component completion			June 1996	

PNG Resource Information System Project (2 and 3)

Executing Agency: Department of Agriculture and Livestock

Managing Contractor: CSIRO Division of Wildlife and Ecology/Landcare Research, New Zealand

	Planned	Actual
Technical Assistance (person-months)		
Long-term advisers	50	na
Short-term advisers	150	na
Total	200	na
Project Costs ($'000)		
AusAID costs	3745	2800
Estimated local contribution	na	na
Total project cost	na	na

Key Dates:

Project design document	March 1991
Start of PNGRIS II (Inception stage)	March 1992
Inception stage contract	May 1992
Appraisal	January 1993
Project implementation document	March 1993
Project start	June 1993
Project end	June 1995
Mid-term review	December 1994

PNG Forestry Rapid Resource Appraisal Project

Executing Agency: National Forest Service and Department of Environment and Conservation

Managing Contractor: CSIRO Division of Wildlife and Ecology/Landcare Research, New Zealand

	Planned	Actual
Technical Assistance (person-months)		
Long-term advisers	50	na
Short-term advisers	150	na
Total	200	na
Project Costs ($'000)		
AusAID costs	1747	1200
Estimated local costs	na	na
Total project costs	na	na

Key Dates:

Inception/design phase	November 1990 - February 1991
Project design document (draft)	March 1991
Appraisal (of draft PID)	January 1993
Project implementation document	March 1993
Project start	June 1993
Project end	June 1995
Mid-term review (by TAG)	December 1994

Summary

Four completed projects from AusAID's PNG renewable resources sector program were selected for a cluster ex-post evaluation:

- Cocoa Quality Improvement Project, Keravat, East New Britain province;
- Coffee Research Institute Project, Aiyura, Eastern Highlands province;
- PNG Resource Information System, Port Moresby and Lae, Morobe province; and
- Forestry Rapid Resource Appraisal, Port Moresby

Cluster evaluation, covering a group of projects within one sector or from the same country, allows common themes and issues to be highlighted. Significant cost savings in the evaluation process are also achieved, which may make it cost-effective to evaluate small projects which would probably not otherwise be post-evaluated.

This report presents the findings of a post-evaluation mission during August/September 1997. Assessment is made of the projects' sustainability, potential development impact and effectiveness in achieving their objectives.

The evaluation is based on a review of the project completion reports (PCRs), material in AusAID files, and discussions with staff members of AusAID's PNG desk in Canberra and the post in Port Moresby, the project implementing agencies and other in-country agencies. The evaluation was undertaken over a five-week period including one week planning the field mission and reviewing documents in AusAID's head office, followed by three weeks in the field with the preparation of field reports. A 'wrap-up' meeting was held in Port Moresby at the end of the field-work phase, attended by staff from several government agencies. The draft evaluation report was finalised in Australia and circulated for review by the implementing agencies and AusAID staff. Comments received were taken into consideration in finalising the report.

Cocoa Quality Improvement Project

Cocoa is a major cash crop in many lowland areas of PNG. In the mid-1980s, a number of problems were identified with the industry, including plant diseases and quality of the export product. In January 1987, the PNG government requested AusAID to provide assistance for a cocoa quality improvement project.

Objectives and Scope

The goal of the project was "to improve the quality of PNG cocoa in the export market through a program of assistance for research and extension". There were to be two main components:

(i) **applied research into fermentation and drying** at the Cocoa and Coconut Research Institute (CCRI) at Keravat, East New Britain, including: a laboratory for quality monitoring and research; a research program to develop a processing system to improve cocoa quality; and a processing system for laboratory assessment of the quality of small samples of cocoa; and

(ii) **extension, information and training**: to establish a support system for extension, information and training to assist the Cocoa Board and existing provincial extension services in improving cocoa quality.

At a meeting with industry in March 1994, a change in research direction was defined. AusAID was subsequently requested to fund an extension to the project. In addition to continuing cocoa extension, the project was redirected towards research on: (i) minibox fermentation and solar tent, open sun and hot air drying; (ii) assessment of genotype quality; (iii) microbiology of cocoa fermentation; and (iv) the influence of environmental factors and fermentation method on flavour characteristics.

Implementation Performance and Project Results

During the early years of the project, research concentrated on establishing the physical conditions affecting acidity in the cocoa bean. Although useful progress was made, cocoa exporters at the 1994 meeting advised that acidity was not a key factor affecting price. Subsequent breeding and evaluation work concentrated on increasing fat and reducing shell content. The laboratory and particularly the laboratory-scale fermenter have been instrumental in supporting the

cocoa breeding program and are expected to assist in the release of improved cocoa clones to the industry in future. The micro-fermentation system is a 'world first' and is expected to find international application.

During the latter years of the project, much of the research effort was placed on developing farm-level processing technology. The project further evaluated a minibox fermenter designed at CCRI during the 1980s, with a capacity of about 200 kg of wet bean, compared to the standard one-tonne commercial fermenter. A novel form of solar tent (drier) was designed and tested. In combination, the fermenter and drier are appropriate for use on smallholdings, with many growers indicating interest in the system. A total of 30 units have been tested on smallholdings in East New Britain and a further 6 on Buka Island (North Solomons Province). The trial units have consistently produced cocoa with quality equal or superior to conventional kiln-dried beans. A recent delegation of some 200 members of the Cocoa Growers Association from all cocoa-growing provinces is reported to have indicated enthusiasm for the technology to be extended to other provinces.

Plantations are also showing interest in solar drying and a large-scale drier has been partially completed at CCRI, Tavilo. This and other designs are expected to be assessed under an ACIAR (Australian Centre for International Agricultural Research) project which is due to start in 1998. While the project has had no specific involvement in establishing plantation-scale solar drying, it has provided a sound foundation on which to build.

Two mobile extension units were purchased under the project. These were used to provide information to cocoa growers, extension workers and inspectors in the main cocoa producing provinces, except for the project's 'home province' of East New Britain. One unit was deployed in October 1991, and the second in October 1995. Some 25 courses were conducted over a three-year period.

The mobile units were supported by a major program to produce extension materials. The component suffered a setback with the volcanic eruption which destroyed the Cocoa Board and extension offices together with much of the published material. AusAID approved replacement of this material rapidly. Extension publications

have been widely distributed to extension staff and cocoa growers. However, in the absence of any information on adoption rates, the overall impact of the extension component cannot be defined.

No attempt was made at the design stage or subsequently to assess the overall economic performance of the project. However, the quality improvement program was expected to generate an internal rate of return of 23 per cent. The revised breeding program should lead to improved cocoa clones being released over the next few years with increased fat and reduced shell content, resulting in direct financial gains to growers exceeding $1 million annually. The smallholder processing system developed under the project is estimated to be able to generate an internal rate of return of between 9 and 15 per cent. The latter figure includes a potential quality premium estimated at K80 per tonne, which may be realised when solar-dried cocoa exceeds perhaps 10 per cent of national production.

Conclusion

Overall, the project succeeded in meeting most of its objectives. The (revised) research component has resulted in systems which are expected to improve both plant breeding outcomes and smallholder processing of cocoa. Regular meetings with growers, processors and exporters are conducted, largely as a result of the project. Had this mechanism been in place at project inception, substantial time and resources could have been saved, through an earlier change in research direction.

The minibox fermenters and solar driers have the potential to revolutionise smallholder processing of cocoa. Growers are enthusiastic about the technology because it allows on-farm value adding and eliminates the need for firewood collection, which in many areas is seen as a substantial chore. Reduction in firewood demand will also lead to environmental benefits, and an improvement in cocoa quality due to elimination of smoke damage.

High-quality extension materials were produced under the project, and widely distributed largely through the medium of the first mobile extension unit. The research component has been institutionalised within CCRI and the recent establishment of the Cocoa and Coconut Extension Agency (CCEA) may allow many of the extension initiatives commenced under the project to be continued and the extension materials used. However, it would have been

beneficial if institutional aspects of the extension program had been considered during design, and mechanisms for sustainability developed during the project period.

Coffee Research Institute Project

Coffee is the leading export crop in PNG and the most important source of cash income for most highanders. About one quarter of the national population depend on coffee for at least part of their income.

Coffee rust was detected in the highlands in mid-1986. This fungal disease can cause severe yield reduction and has devastated the coffee industries in a number of other coffee growing countries. In PNG, control of the disease was believed to require development of a fungicide spray program in the short term. In the longer term, disease resistant varieties were seen as the solution. A project was formulated to accelerate research into major aspects of coffee rust prevention and control.

Objectives and Scope

AusAID fielded an appraisal mission within two months of receiving an official request from PNG and project staff commenced field-work 14 months later. A major component of the project was to develop safe, environmentally acceptable and cost-effective recommendations to control rust. This required development of an understanding of the epidemiology of coffee leaf rust under PNG highland conditions; an understanding of the effect of rust on the growth and yield of coffee; evaluation of fungicides and their application; and development of recommendations for rust control. It also required evaluation of spray technologies for chemical spraying of coffee plants affected by rust.

An imported rust-resistant variety had been selected at the Coffee Research Institute (CRI) prior to the project. The project was intended to provide CRI with knowledge of the techniques required for the rapid multiplication of rust resistant coffee lines through the development of micro-propagation technology. This involved evaluation and refinement of protocols for initiation, multiplication and root initiation of coffee; assessment of the potential for the micro-propagation of coffee planting material; and development of protocols for PNG conditions. Once the technology had been developed, a micro-propagation laboratory capable of producing

about one million coffee plants per year was constructed at Aiyura as an additional component. An intensive program to train graduate and technical staff to run the facility was undertaken.

Implementation performance and project results

The research components were completed successfully and the results were documented in a series of high-quality publications. The project made a significant contribution to capacity building and staff development at Aiyura. Formal training was provided for three scientists, two of whom are still working at CRI. The third has recently been retrenched because of financial problems within the Coffee Industry Corporation (CIC). CIC was established as the peak coffee industry body in 1991 and owns CRI. The quality of the research conducted by CRI has been enhanced by the project, a benefit which remains evident five years after project completion.

Rust is not a problem at altitudes above 2000 metres and does not pose as severe a threat to the coffee industry as was feared when the project was formulated. Hence the project findings have had less impact on the industry than if rust was a more serious problem in the main highland valleys. Nevertheless, the main research findings have been taken up by the industry. The research confirmed the need for good management and contributed to the core messages promoted by the Extension Services Division of CIC. It indicated that less frequent use of chemicals was needed for control than had been recommended when rust was first detected. The plantation sector has adopted this recommendation. Results on the epidemiology of rust under different climatic conditions have been incorporated into extension material on the disease.

The AusAID mid-term review recommended a number of short-term consultancies to develop action plans for potential outbreaks of coffee berry borer and coffee berry disease; and recommendations for controlling cicadas in plantation coffee. These action plans were developed. Research on cicada control in plantations was conducted and resulted in a series of recommendations to manage the pest.

Each of the main components has had some current or potential economic impact. The project was instrumental in reducing the spraying intensity for coffee rust on plantations and some coffee blocks in lower altitude areas from about six to three fungicide sprays annually. The spray technology program also recommended a

different nozzle to that normally used in backpack sprayers which reduced by some 50 per cent the volume of spray required for an given area. Using data from the CIC plantation cost-of-production surveys, it is estimated that growers made cost savings of about K2.6 million ($3.5 million) between 1988 and 1991 due to reduced spraying intensity.

Five years after project completion, the micro-propagation facility is substantially under-used and is deteriorating because insufficient funds are provided for maintenance and purchase of inputs. Capital and operating costs of the unit have been high, suggesting a net economic loss to PNG. Despite the problems experienced to date, the micro-propagation facility has the potential to yield long-term economic benefits through: (i) the rapid propagation of coffee seedlings in the case of a major outbreak of coffee berry disease or other serious disease; and (ii) reproducing plant material other than coffee. Despite CIC's current financial and management problems, the facility's capacity should be maintained for these reasons.

The recommended spray regime has not had any negative impact on the acceptability of PNG coffee and no problems with residues have been reported. The project's integrated pest management component has had a significant positive environmental impact. The recommendation from the project that plantations should minimise or eliminate insecticide sprays has been widely adopted and appears to have reduced the cicada problem. Some seminars were given to CIC and industry personnel on safe handling, application and disposal of pesticides and these messages have been incorporated into extension material produced by CIC. Despite this, limited field observation suggests that this has had little impact on the safe use of weedicide by smallholder growers.

Conclusion

Overall, the project succeeded in meeting most of its objectives. High quality research into coffee rust epidemiology, disease control and spray technology was undertaken. Where relevant, results were passed onto the sections of CDA and later CIC responsible for extension. The impact on smallholder practices has not been large because rust is not as severe a constraint as was feared at project implementation. The recommended spraying regime has been largely adopted by the plantation sector, with consequent cost savings and environmental benefits. The micro-propagation unit and rapid

multiplication technology have proved not to be needed by the industry. The unit is not being fully utilised, but has the capacity to propagate crops other than coffee. Overall, the project made a useful contribution to capacity development of CRI. Links between the research and extension arms of CIC deteriorated after project completion and this is threatening the effectiveness of both sections. CIC management is making efforts to resolve this problem.

PNG Resource Information System Project (Phases II & III)

Phase 1 of the Papua New Guinea Resource Information System (PNGRIS I) was intended to integrate and standardise existing information on the natural resources, current land use and population distribution in PNG. It was one of the first national-level resource information systems in the world. It was a valuable tool for planning, but the system lacked the capacity for computer mapping and was only installed in one section of one government department in PNG (Land Use Section of the Department of Agriculture and Livestock - DAL). By 1987, more data had become available and computer systems had evolved, with increasing power and affordability. This offered the potential to update and computerise the map outputs of PNGRIS and to make the system more widely available to government institutions. The project was formulated in 1991 and the inception phase commenced in early 1992.

Objectives and Scope

Project documents do not identify the purpose of the project. However, the objective of the project can be taken as "to improve efficiency and effectiveness in PNG government agencies in the planning and management of natural resource development". The main components were: (i) to upgrade and update PNGRIS for application as a landuse planning tool; (ii) to develop resource survey methods appropriate to catchment and project level assessments; (iii) to develop an upgraded system to assess land suitability for food and cash crops; (iv) to develop a comprehensive natural resource and landuse planning system at provincial level; and (v) to provide field and post-graduate training in the use of PNGRIS, computer systems and land evaluation.

Implementation Performance and Project Results

The project met its targets in a timely manner. This was facilitated by having a full-time project coordinator based in Port Moresby for 21 months. A computer mapping system was developed; additional population data from the 1990 census were added to the system; the upgraded PNGRIS was installed in a number of PNG institutions; and staff from a number of government agencies received formal training in the use of the upgraded PNGRIS. The system is now installed in 17 institutions in PNG, all in the public sector.

PNGRIS is now far more secure from an institutional perspective. About 150 staff have received some training in the use of PNGRIS and there are regular and competent users in five government institutions. The project has made a useful contribution to inter-agency coordination and collaboration, through the PNGRIS user groups and attendance at joint (overseas) training courses. It is being taught in the Department of Surveying at Unitech and will be included in the Forestry course there from 1998. The use of PNGRIS and other GIS systems is not yet being taught to agriculture students at Unitech or geography students at UPNG, though Unitech's Agriculture department is interested in introducing GIS modules when their courses are next restructured.

The uses of PNGRIS have been more varied than anticipated when the system was conceived, particularly since installation of the upgraded version in a number of institutions. It is rarely used by the private sector nor has the system been officially installed outside public sector agencies. This is unfortunate as it has considerable potential as a development tool for companies involved in activities such as road building and working with landowner communities associated with resource extraction.

The project investigated the technical aspects of producing a 1:250,000 scale application of PNGRIS with a map system. This was completed for Madang Province and a provincial resource information system was prepared combining information on the physical environment, forest, land use and population. It was concluded that the existing PNGRIS at a scale of 1:500,000 could meet most needs for overall provincial planning and that any further funding would be better used to generate project level applications at a scale of 1:50,000. The Madang Province Resource Information System is little used for planning in that province.

Another component was designed to develop resource survey methods appropriate to catchment and project level assessment at scales of 1:50,000 and 1:100,000. This was completed successfully for one catchment (the Upper Ramu Valley in the Eastern Highlands). This component provided the Land Use Section of DAL some capability to conduct resource surveys at the catchment or project level. The high cost of such undertakings will limit the extent to which PNG agencies can develop information systems at this scale without external assistance.

An FAO project had developed an automated land evaluation system for PNG, using in part information from PNGRIS I. The system was developed a little further under PNGRIS II/III and computer mapping output is now possible. The system, known as PNG ALES, is being used and developed further by one staff member in DAL's Land Use Section.

Following completion of PNGRIS II/III, a request was made for further technical support and training in PNGRIS. This was provided successfully under the Australian Contribution to the Land Mobilisation Project (ACLMP), which has resulted in further strengthening the capacity of staff in government agencies to use the resource information system.

The project documents do not attempt to identify the intended economic impacts of PNGRIS. The wide-range of present and potential uses suggest that the project will have a positive and long-term economic impact. At the least it has been a cost-effective way of providing for access to and use of the large volume of resource information which was previously inaccessible. Some of the applications of the system have the potential to reduce environment degradation, including formulation of conservation needs assessments and delineation of vulnerable locations.

Conclusion

The project succeeded in meeting most of its objectives. PNGRIS has now been installed in 17 public sector institutions. A large number of people have received formal training in using the system and it is being used regularly in four government agencies as well as in one department at Unitech. The system has been used for a wide

range of applications in development, planning and research. This represents a substantial change from the situation prior to the project, when PNGRIS usage was restricted to DAL.

Although many people have been trained in PNGRIS and many more are familiar with the program (and its sister programs Mapping Agricultural Systems – MASP, and Forest Inventory Mapping - FIM), it is far from robust. If one or two key users in the main PNGRIS sites leave, capacity will revert to a low level. The best chance for the continuing development and use of PNGRIS is the further incorporation of the system into undergraduate teaching at Unitech and UPNG.

Information systems in the late 20th century need to be dynamic. PNGRIS II/III recognised this and updated the original PNGRIS to make it more accessible and user-friendly. Since project completion, computer power has continued to expand exponentially and costs have declined. There is now a need to review PNGRIS and other PNG geographic information systems and to develop a coherent strategy to take them to a higher level and, in particular, to make them more relevant for provincial, catchment and local area planning.

Forestry Rapid Resource Appraisal Project (FRRAP)

Forest resources are one of PNG's major assets, generating close to K500 million annually in export revenues. The country's forests also yield a wide range of products used by rural dwellers. Unfortunately, the level of management of the national forest resource has been poor in recent years, as indicated by the Barnett Inquiry and the national forestry action plans of the early 1990s.

Objectives and Scope

The implicit objective of the project can be considered to have been: "improved forestry resource planning, management and use at national and provincial levels". Components and component objectives included: (i) Inception Phase (PNGRIS II) - interim resource assessment and preparation of project implementation document; (ii) Rapid resource appraisal – preparation of 1:500,000 scale forestry resource maps and transfer of information to PNGRIS; (iii) mapping of forests and other vegetation at 1:100,000 and

recompilation at 1:250,000; (iv) develop procedures for updating forest inventory; (v) addition of conservation needs assessment information to PNGRIS; and (vi) training, system installation and publication. A seventh component relating to forest resource assessment design was deemed to have been adequately covered by component (iii) and was deleted.

A subsequent component under the Australian Contribution to the Land Mobilisation Project developed a Forest Inventory Mapping database (FIM). This involved digitising the 1:100,000 scale FRRAP maps and updating land use and forestry status to 1996 using satellite image interpretation.

Implementation Performance and Project Results

Forest resource information was developed into a PNGRIS overlay by assigning forest types or a mix of types to the existing PNGRIS resource mapping units. A 1:500,000 scale set of forestry resource maps was produced. These subsequently were used as the basis for provincial plans and the national forest plan prepared by the Forest Authority in May 1996. A 1:1 million scale map of vegetation types was also produced in four sheets.

Forest mapping at 1:100,000 was the key component of FRRAP, involving the definition of forest type and other landuse boundaries on the base of the national 1:100,000 topographic maps and the 1975 aerial photography. The 280 maps were combined into 70 maps at 1:250,000 scale. The substantial volume of forestry resource information was prepared as hard copy and the maps were coded with the 20 main forest classes. This component formed the foundation (as intended) for the Forest Inventory Mapping project.

FIM was undertaken to provide an easily accessed forest inventory database with up-to-date information on area, forest areas and types, species distribution and, through a link to PNGRIS, on related natural resource and population data. FIM also provides information on existing concession areas and the extent of current logging.

The development of FIM represents the main impact of the project. It is presently being used to update the provincial management plans initially based on FRRAP. Eight plans have been completed and the remainder will be completed when adequate provincial data become available. The plans provide a useful basis for forest management in the provinces.

The project's resource inventory and the FIM will not of themselves have any impact on the level of management. However, if accompanied by: (i) a more serious effort to control logging; (ii) improved management of the forest resource in forest management areas; and (iii) promotion of sustainable development of the infrastructure associated with logging activities, the long term gains to the country will be immense.

Conclusion

The Forestry Rapid Resource Appraisal Project achieved virtually all of its output objectives and is classed as successful. Its outputs have been taken up in the Forest Inventory Mapping program, the main mapping tool used by the National Forest Service. New provincial forest management plans have been completed for eight provinces. The plans include improved assessment of risk categories and areas to be left unlogged.

Whether the improved planning results in significant change on the ground will depend on strengthening management and inspection at the provincial and project level. However, the project has at least provided the means to monitor production and to develop more sustainable logging practices.

Lessons Learned and General Issues

Several issues are highlighted by the projects evaluated. These are discussed in detail in the chapters on the individual projects. A number of general themes can be identified, based on the experience in two or more projects and conclusions drawn relating to natural resource sector project design and implementation in PNG. Several of these may also have relevance in other sectors in PNG or regionally.

Project Design and Flexibility

The two research projects highlight the benefits of flexibility in project planning. In both cases, but particularly for cocoa, major benefits resulted from research programs that were introduced midway through the project. At the same time, the need to change direction in the cocoa research program suggests that detailed consultation with exporters would have been beneficial during the design or early implementation phases.

The ability to adjust research (and other) programs in the light of new knowledge is highly desirable.

Regular review of research programs and progress should include consultation with all relevant sectors of the industry intended to benefit from the research.

Research - Extension Linkages and Information Availability

Applied research must reach the people in a position to use it if project impact is to be maximised. In the agricultural sector and particularly for smallholders, extension is usually the major mechanism linking research and the farmer. CRI and Coffee Development Agency staff made efforts to develop the research/ extension linkage but, in part because of changes in staff and organisation structure, the linkages weakened after the end of the project. The cocoa quality project did maintain close ties to extension but these were not institutionalised.

Research project designs should give detailed consideration to the research-extension-farmer linkage and ensure as far as possible that two-way communication links are developed and institutionalised.

Access to both PNGRIS and RRA/FIM is restricted. Their data should be considered as a public good and access to people and organisations in a position to use them effectively should not be limited. Consideration could be given to lifting the ban by the PNGRIS users group on access to PNGRIS by resource development companies, consultants and research institutes.

Baseline and Monitoring Studies

The complexities of smallholder production systems have been appreciated by development specialists for many years. Neither research project attempted to analyse smallholder systems or how the research and development programs would affect them.

Research projects (and other rural development projects) should endeavour to understand smallholder farming systems, the likely constraints to technology adoption and the effect of their research findings on the systems. Data could be collected using participatory or rapid rural appraisal techniques and include information that can be used for impact assessment.

Project Management, Recording and Reporting

None of the four projects in the cluster evaluation reported on: (i) project costs by component, category and year; (ii) local costs or resource inputs; (iii) adviser/consultant person-month inputs; (iv) training courses conducted; or (v) financial/economic impact.

Some of this information may have been recorded but is not readily available. More likely, much was not recorded and/or analysed. Numbers (i) and (ii) are necessary data for project financial and economic analysis and (iii) may be required to assess cost-effectiveness, particularly for technical assistance projects. Training course summaries are an invaluable aid both to trainers in the same sector and to evaluators responsible for assessing training program effectiveness.

Adequate recording and reporting of costs and other resource inputs should be required for AusAID projects.

Training course reports should be prepared on all (non-institutionalised) training activities. These could include the course outline, attendance by gender and self-evaluation. Training course impact evaluations should be undertaken on selected courses some time after completion.

Project completion reports should be seen as key project documents and not simply as the final project output. Detailed review of PCRs by Evaluation Section should be undertaken prior to their final acceptance by AusAID.

The logical framework has been one of the key tools in the design and management of AusAID projects for the last 20 years. It is consequently of concern that only one of the four projects (CQIP) produced a logframe that was of much value for evaluation. It may be that at the time of design of the four projects (between 1987 and 1991), contractors were not sufficiently familiar with logframe requirements and/or did not consider the logframe to be important. However, the design and implementation documents were accepted by AusAID, possibly suggesting that desk officers were also not fully familiar, for example, with the hierarchy of objectives required by the logical framework.

Designers should carefully consider and differentiate their project's objectives at the output and purpose levels. The assumptions needed for the achievement of objectives at different levels and any risks facing the project should be identified.

Gender

Women are central to smallholder agriculture in PNG and in the region. The two research projects did not pay much attention to gender issues, though the cocoa project design did include some gender analysis and recommendations. Although PNG culture mitigates against interaction with and promotion of women to some degree, greater efforts could have been made to involve women in project activities (for example in the extension program). At least, women's roles in the agricultural system could have been defined and assessment made of how project activities and recommendations would affect them.

Rural research and development projects should make an effort to define women's roles in farming system and attempt to ensure that women participate in project benefits.

Institutional Strengthening

All four projects involved substantial staff training, both academic and on-the-job. PNGRIS in particular has included a major training program for the past 10 years. Overall, the training programs were effective and achieved a substantial positive impact. As would be expected, some trained staff have left or been retrenched due to financial problems, and in all cases the gains made under the project are at some risk. This highlights the need to take a long-term perspective of institutional strengthening projects with project or training support continuing over many years.

Where projects have capacity-building objectives, mechanisms to promote sustainability need to be considered. Options include training extra staff, and (perhaps preferably) arranging for training programs to continue after the end of project funding, using local resources or other donor-funded training programs.

Information Systems and Technology Projects

For two of the projects evaluated, the most important outputs were information systems. Much of the development and programming for the systems was undertaken in Australia. This was necessary because of the highly technical nature of the work and because both relied on the considerable prior experience of a number of key members of the project teams. To some degree, this has resulted in a lack of familiarity with the systems and a limited capacity to update and modify them in-country.

Even where it is necessary to conduct much of the work on highly technical projects in Australia, mechanisms should be explored to enhance local involvement, for example through the award of masters degree level scholarships in an appropriate discipline and location.

Both PNGRIS and RRA built upon an large body of prior work. It would be extremely expensive, and possibly not feasible, to collect such field information now. Their cost-effectiveness is thus likely to have been high compared to conducting new field-work, analysing and presenting the data.

Information systems projects which build on prior knowledge may have greater prospects for success than those which involve primary data collection.

Geographical information systems are being developed rapidly in PNG, as are the technologies available to access, process and present data. The best chance for long-term sustainability and development of such a tool is for GIS technology to be taught to undergraduates in natural science courses in local universities.

Tertiary institutions should be encouraged to include natural resource information system modules in undergraduate teaching for students in natural sciences and planning. This can promote institutional sustainability and assist in maximising the long-term use of and benefits from resource information systems projects.

Introduction

PNG Agriculture

Agriculture in PNG may conveniently be classed under three sub-sectors: subsistence food production, domestically marketed food, and export crops. In practice most villagers produce commodities for both subsistence and sale.

Subsistence food production is the most important sector in terms of volume and value. Most rural people in PNG (some 80 per cent of the population) continue to produce the bulk of their food supplies. Many crops are grown, with sweet potato being the most important on a national basis. Other staple crops include sago, banana, yams, taro, Chinese taro, cassava and maize. Pigs are important, especially in the highlands. Fishing is a major food source for many coastal and island communities.

PNG's agricultural systems are diverse, as are the environments in which they are practised. Land use intensity ranges from very-low to semi-permanent and permanent. Very-low and low intensity systems occur where cropping periods of between one and three years are followed by natural fallows lasting more than ten years. Throughout PNG, land use is being intensified in response to increasing population and demand for food. This is being achieved by: shortening the fallow period; increasing cropping periods; adoption of new crops, mainly of New World origin; adoption of high yielding cultivars of existing crops; and various soil fertility restoration practices, including composting, tree planting, rotation of grain legumes with root crops, and soil retention barriers.

The greatest land pressure occurs on small islands and in certain valleys and basins in the central highlands. In general, subsistence agriculture has maintained food supplies for the rural population because of the intensification techniques noted above. However, increasing intensity of land use is resulting in yield declines in some locations. There are indications that yield decline and environmental degradation will occur in more locations because some of the intensification techniques are once-off, in particular the adoption of

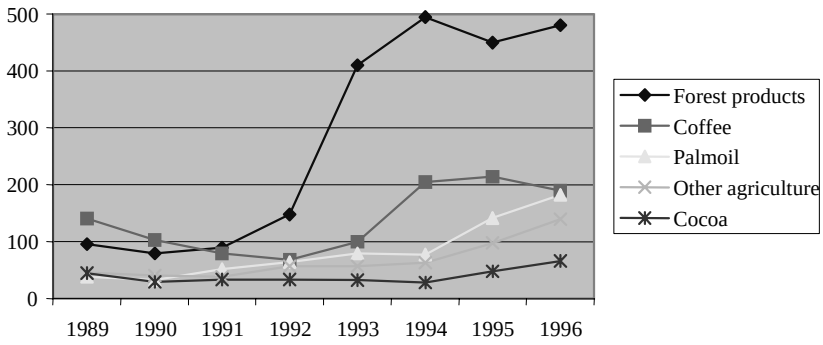
new crop species. At the same time, many areas of higher potential continue to be under-used. This is despite considerable population movement in recent decades, mainly informal movement to areas of higher production potential and to urban locations.

Domestically marketed food and betel nut also provide significant income. More than half of all rural households in PNG are involved in selling food. In recent years, this has been the most dynamic agricultural sub-sector and sales have increased steadily. Betel nut is the most important single item and the main source of cash income for rural villagers in parts of Gulf, Central, Morobe, Madang, East Sepik and other lowland provinces (see Map 1 on page iv). Other significant marketed food items include sweet potato, peanuts, banana, other root crops, traditional vegetables, introduced vegetables, fruits and nuts. Food sales are most important near the larger urban areas and in locations in the highlands provinces and Morobe Province with good access to main roads.

The main export cash crops are coffee, palm oil, copra/coconut oil and cocoa. Minor quantities of tea, rubber, pyrethrum and cardamom are also exported. The mean export value for export crops between 1989 and 1996 was K138 million for coffee, K84 million for palm oil, K44 million for copra/coconut oil and K40 million for cocoa. (Figure 2-1). Smallholders produce about 70 per cent of coffee, 35 per cent of palm oil, 75 per cent of copra and 65 per cent of cocoa (Appendix C, Table C-2). Production from the export tree crops has been static over the past eight years, apart from palm oil, production of which has increased steadily. Per capita real net agricultural market product has declined by 1.7 per cent per year since 1980 (Avei, 1997, p1-4).

Agricultural exports represent about 15 per cent by value of all exports, with gold, copper and timber each worth more than all agricultural exports combined (Bank of PNG 1997). Nevertheless, the export tree crops remain the most important source of cash income for the bulk of the rural population. The main coffee producing provinces are Western Highlands and Eastern Highlands, with smaller quantities grown in Chimbu, Morobe, East Sepik, Enga and other provinces (Figure 4-1).

Figure 2.1 - Primary product exports, PNG 1986 - 96 (K million)



About half of the cocoa is grown on the Gazelle Peninsula of East New Britain, with significant quantities also grown in parts of North Solomons, New Ireland, Madang and East Sepik provinces. Palm oil production is restricted to parts of West New Britain, Northern, Milne Bay and New Ireland provinces. Copra is grown in all lowland provinces, particularly in the Islands region.

Over the past 10 years, commercial exploitation of forests has assumed major importance. Round logs account for about 15 per cent of all exports and export taxes on logs provide 10 per cent of national government domestic revenues (Avei 1997, p1-5). The mean value of forest product exports, mainly round logs, over the period to 1989-92 was K100 million, increasing to an average of K450 million annually for the period 1993-96. PNG is the world's second largest exporter of tropical round logs, behind Sarawak in Malaysia.

AusAID Activities in the PNG Agriculture Sector

Since PNG's independence in 1975, Australia has provided budgetary assistance to support the country's economic and social development. Since the mid-1980s, part of this aid has taken the form of specific program and project assistance, reaching almost $200 million out of the $300 million PNG program in 1997/98. Direct budget support will be phased out by 2001, with the entire program comprising program and project support.

Australia's program is directed towards six priority sectors as indicated in Figure 2-2. Transport and communications account for almost one third of the total and education for one quarter. Renewable

resources projects accounted for 10 per cent of AusAID's project expenditure in 1996/97, behind law and justice, and health, both with 12 per cent.

Figure 2-2 AusAID's PNG program and project expenditure 1996/97

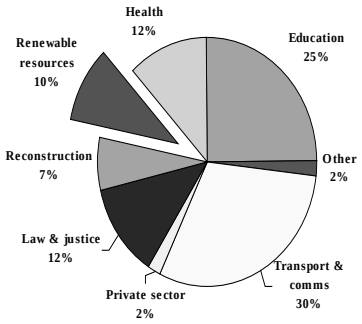
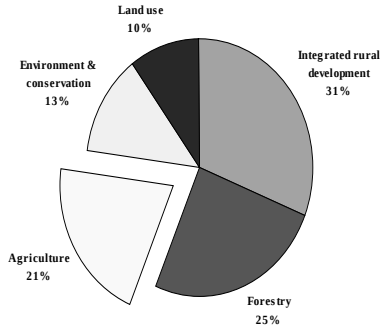


Figure 2-3 AusAID Expenditure on renewable resource activities in PNG 1996/97



The breakdown of expenditure between classes for the renewable resources sector is in Figure 2-3. Integrated rural development projects with 30 per cent were the largest group. This level is likely to decline as a number of projects conclude. It is unlikely that further integrated rural projects will be commenced due to a number of problems in the sector over recent years. This change in direction of AusAID's renewable resources program was one reason for excluding integrated rural projects from this cluster evaluation.

According to a recent '*Study of Effectiveness*' (AusAID 1997) "the vast majority of the people in PNG are dependent on agriculture for their livelihood. Development of the rural sector remains the greatest and most sustainable opportunity for employment for most people. As the rapidly growing population is predicted to exceed six or seven million by 2015, there will be increasing pressure on land for settlement and cultivation."

Evaluation Responsibilities and Acknowledgements

The evaluation was carried out by a team comprising:

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Implementing agencies, government departments and the AusAID post provided a high level of support. This support included the provision of transport, staff time and information and was greatly appreciated by the evaluation team. The AusAID post in Port Moresby was particularly helpful to the team and organised itineraries and meetings with great efficiency.

Cocoa Quality Improvement Project

Project Description

Cocoa is a major cash crop in many lowland areas of PNG and at the time of design was second only to coffee as a source of export revenue. In 1986, cocoa accounted for 20 per cent of crop exports and earned some K56 million in foreign exchange, compared to around K100 million for coffee. Some two-thirds of PNG cocoa production came from the smallholder sector.

Over the last decade, cocoa production has varied. A slump in 1994-95 was followed by high production and exports in 1996. Cocoa bean exports totalled 41,000 tonnes in 1996, valued at K66 million (see Figure 2-1), behind coffee (K190 million) and palm oil (K182 million).

Rationale

According to the design document (p3) "PNG's cocoa industry expanded rapidly in the 1960s but since then has deteriorated considerably. Land tenure problems, aging plants, poor management, inadequate extension services, disease outbreaks and insufficient research have contributed to the industry's problems... While cocoa is in many ways an ideal crop for the small-scale farmer with limited resources, it suffers greater losses from a number of serious pests and diseases than many other tropical crops. These pests and diseases are becoming an increasing problem in other major producing areas and present a constant threat in PNG". Quality was reported to be declining, threatening the position of PNG in the world market. The cocoa produced in PNG was nonetheless of high quality and commanded a premium.

The Cocoa and Coconut Research Institute (CCRI) at Keravat in East New Britain is responsible for research into cocoa production. It is a non-profit organisation, funded through: (i) a proportion of the K30 per tonne export levy; (ii) an annual government grant; and (iii) revenue from sales and consultancies. The design document indicates that although CCRI had "improved its research management and staffing, commissioned reviews and preliminary research and upgraded and expanded its research program, its limited resources meant that it required outside assistance to undertake all of the work necessary to support the rejuvenation of the industry."

Formulation

A request was made by the PNG government to AusAID in January 1987 for assistance in undertaking a cocoa quality improvement project. A more fully documented proposal was then prepared by the Cocoa Research Committee with assistance from Queensland Department of Primary Industry. The proposal outlined details of a research project to investigate the variables associated with the fermentation and drying of cocoa beans. Field review of the proposal was undertaken in March 1987 and a draft project design was prepared in Canberra. The design document was finalised after a further visit to Rabaul in November 1987.

The first phase of the project (detailed design) extended from May to September 1989. The project implementation report was completed in April 1990. Implementation commenced in July 1991.

Objectives and Scope

The project was to conduct research into the fermentation and drying of cocoa beans. The main focus was on a collaborative investigation by PNG and Australian researchers into the sensory, microbiological and chemical properties of cocoa beans and determination of the physical conditions which lead to the development of desired quality characteristics. Most of the work was to be undertaken in PNG.

The overall goal of the project was identified as "to improve the quality of PNG cocoa in the export market through a program of assistance for research and extension". The project was to include three components, with the following objectives and outputs:

1. Research – to improve cocoa quality through applied research into fermentation and drying;

- a fully-equipped laboratory with sensory evaluation and processing facilities and trained staff to allow sustainability for quality monitoring and research;
- a practical research program to develop a processing system which improves cocoa quality and is suitable for use by both smallholders and plantations; and
- a laboratory-scale processing system suitable for assessing the quality of small samples of experimental cocoa from breeding trials.

2. Extension, Information and Training – to establish a support system for extension, information and training to assist the Cocoa Board and the existing provincial extension services in improving cocoa quality;

- cocoa extension resource base and mobile extension unit;
- material and equipment for extension and training activities;
- an information system for recording field activities and extension planning; and
- training modules to cover the training needs of farmers, DPI and Cocoa Board staff and quality assessors.

3. Project Management – Australian inputs were planned to comprise 87 person months of long- and short-term adviser inputs over a period of 29 months for the research and four years for the extension component. Major material and equipment inputs were to include two vehicles including a mobile extension unit, equipment and staff housing at CCRI.

Local inputs were to comprise research and extension staff, land and office space at the Cocoa Board in Rabaul for the extension component and at CCRI for the research component.

Further technical assistance was requested by CCRI in May 1994 for the research component, resulting from a meeting between representatives of CCRI, government and industry interests in March 1994. Following the September 1994 volcanic eruption in Rabaul and the destruction of some of the extension materials, the extension and research components were extended to December 1995 and June 1996 respectively.

Project Cost

The design document indicated a total project cost of $3.9 million, of which Australian inputs were expected to cost $3.4 million. The implementation document reduced project cost by around 20 per cent to $3.2 million with local costs of $518,000 as shown in Appendix A, Table A-1. The project extension in 1994 budgeted additional costs of about $900,000.

Actual project cost is reported by the PCR as $3.4 million. No breakdown is provided by year or component or indication of: (i) whether the total includes local as well as Australian project costs; or (ii) whether it includes stage 1 (design) costs. Assuming the PCR figure covers Australian inputs only and does not include the cost of project design, total project cost was some $600,000 under budget.

Implementation Performance

Identification and Design

The identification process for the Cocoa Quality Improvement Project (CQIP) was protracted. From the time of the initial request for assistance in January 1984, five years elapsed before the preparation of the project design document and a further two years before implementation commenced. In practice, the protracted preparation period is considered to have contributed to a well thought-out design that reflected perceived priorities of the cocoa producers. The problem analysis (design document p6) and resulting project logframe are well developed and laid a sound foundation for the project.

Three aspects of design are considered to have been less than optimal: (i) insufficient consultation was undertaken with exporters, resulting in a research direction in the early project period that did not focus on key quality issues; (ii) the extension component was introduced in the PID with limited analysis and justification. It introduced a new approach to cocoa extension (through the Cocoa Board) with no institutional analysis or indication of how it could be institutionalised; and (iii) there is little discussion of monitoring and evaluation in the design documents. The PID (p5-10) states that "project benefit monitoring and evaluation will be undertaken in accordance with the normal periodic review schedule and reporting on PBME will be included in regular progress reports." In practice, the monthly reports give useful information on sub-component progress but none

on benefit monitoring. It would have been beneficial if the project design had been more specific in relation to what was to be measured and reported.

In May 1994, almost three years into implementation, the government requested AusAID to provide additional assistance. This was to cover "additional technical assistance, equipment, facilities and housing to permit completion of research activities that had been delayed or not addressed and the initiation of new directions in cocoa quality research" (CQIP Extension Appraisal Document, November 1994). A 24-month extension was approved for the research component and six months for the extension component to give a completion date of December 1995 for extension and June 1996 for research.

In addition to continuing the extension component, the project extension was to centre on research relating to: (i) minibox fermentation and solar, sun and hot air drying; (ii) assessment of genotype quality; (iii) microbiology of cocoa fermentation; and (iv) environmental effects and fermentation method on flavour characteristics. Overall cost of the extension was estimated at $695,000 foreign contribution and $210,000 in local costs.

The PCR (p27) reports that a second mobile extension unit was acquired in October 1995 and was deployed on Bougainville. This unit is not mentioned in the extension phase design document and there is no information on why it was purchased six weeks before the end of the extension component or of its subsequent use.

Technology Transfer and Adoption

It is difficult to assess the extent of technology transfer under the project since no survey or evaluation has been undertaken, for example of extension or training effectiveness. The widespread distribution of extension material to provincial divisions of primary industry is considered by CCRI to have had a positive impact and resulted in improved agronomic and other management practices. The head of the CCRI extension liaison section indicates that "the mobile units and the resource base established under the project have greatly enhanced [CCRI's] capacity to train extension officers and assist them with farmer demonstrations." Overall, the project is

considered to have made a major contribution to broadening the perspectives of CCRI and making it more responsive to industry needs.

The CCRI publications unit reports that almost 10,000 publications were distributed between January 1996 and August 1997. These have mainly been to DPI offices, extension agents and cocoa producers. A policy of charging for documents has been introduced recently, which is considered beneficial in terms of promoting sustainability and ensuring that documents distributed are used and valued.

Under the project, a total of about 1900 people were reported to have received training including 12 Cocoa Board inspectors, 100 provincial DPI trainers, 1330 farmers, 600 processors, 20 DPI extension officers/planners and 30 inspectors/assessors. No record is available of the results of this training in relation to skills development or application. However, the quality of the training materials is high and it is likely that much of the training was effective.

In relation to the minibox fermenters and solar driers, a rapid appraisal survey of four of the 30 trial units indicated a potentially major demand for the technology in East New Britain. The respondents stated that a high proportion of the growers in their villages wish to purchase the equipment, whether or not credit is available. The ability to purchase equipment without credit provision is likely to be greater in East New Britain than in other cocoa-growing provinces.

Organisation and Management

Project management was generally satisfactory under CQIP. Project reporting requirements were fulfilled. The extension, information and training (EIT) component was singled out for praise by the project extension appraisal which reported that: “the EIT resource materials are generally of superior quality in appearance and content and abundant [compared to Department of Agriculture and Livestock materials]. The training of Cocoa Board inspectors and provincial DPI officers at the CQIP resource base attached to the Cocoa Board office and during rounds by the mobile unit has been effective. Most provincial DPIs in cocoa growing areas have utilised the services

offered by CQIP to train their officers and assist with extension. [However] East New Britain DPI has not availed itself of training or materials available from the project" (PRT 1994 p10).

The volcanic eruption in September 1994 destroyed the Rabaul offices of the Cocoa Board and the adjacent cocoa extension resource base established under the project. Most extension materials were lost. The project responded to this by moving the extension base to the CCRI at Keravat. Lost materials were replaced rapidly following AusAID approval of the necessary additional expenditure.

The project logframe is clear, and substantially the best of the four projects in this cluster evaluation. However, it does not appear to have been used for project monitoring at the purpose level, since few of the required verifiable indicators have been measured, apart from those relating to construction and other physical outputs.

Project Completion

The project was completed in June 1996, giving a project duration of five years. This was one year longer than envisaged at design, following the project extension in 1994. A completion report was prepared at the end of the project. It contains a useful summary of the history of the project and outlines changes in the project direction following the meeting of government and industry personal in March 1994 and after the Rabaul eruption in September. However, no useable information is available on actual project costs and little attempt is made to assess the effectiveness of the research and extension programs.

Impact Assessment

Operational Performance

The operational performance of the main project components and sub-components is reviewed briefly in the following sections.

a. Research

Laboratory

A fully-equipped laboratory and sensory evaluation facility was developed under CQIP, and staff were trained in cocoa quality research. The laboratory is functioning satisfactorily, with a trained cocoa quality specialist and support staff, though the recent resignation of the PNG specialist who received the most training

under CQIP is unfortunate. The laboratory has demonstrated that it is possible to adjust the flavour of cocoa by modifying drying method and is continuing to test samples of cocoa produced under the CCRI breeding program and from the CQIP pilot solar driers.

Improved Farm-level Processing

The second research component was to develop a processing system that improves the quality of cocoa and is suitable for use by both smallholders and plantations. Research initially concentrated on ways to modify acidity. However, the program was discontinued in 1994 following advice from exporters that acidity was not a key determinant of cocoa price. Research was then redirected to other aspects of cocoa quality, particularly fat content.

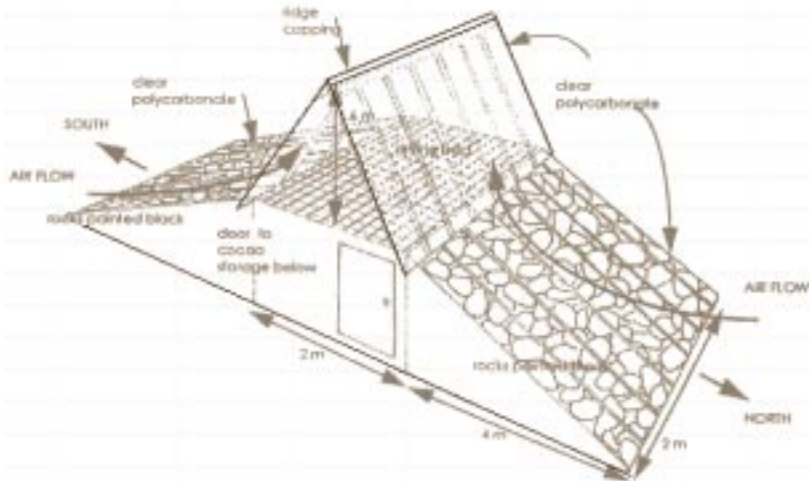
A major aspect of the project related to farm-level processing. There were two main aspects: miniboxes and solar drying. The miniboxes comprise timber boxes that ferment up to 200 kg of wet bean, compared with the conventional larger fermentation boxes that ferment about 1000 kg. These allow processing of smaller quantities of cocoa by individual growers, rather than growers being restricted to the sale or delivery of wet bean to a central facility. The technology was developed in the early 1980s, but was rejected by the Cocoa Board, perhaps due to the potential for an increase in the number of fermentaries.

The second aspect of the new processing system is the development of a solar drier (Figure 3-1). This has the potential to replace the kiln driers used by smallholders and plantations that rely on firewood (smallholders) or diesel (plantations) for heating.

Solar drying has the potential to transform cocoa processing by smallholders in PNG. The advantages of the system over conventional fermentation boxes and kiln driers for smallholders include:

- improved quality of fermentation due to the heavy duty fermentation boxes which retain temperature better than the traditional one-tonne boxes. The boxes are also easy to demount, maintain and clean and will last longer than traditional boxes;

Figure 3.1 Solar Drier



- elimination of the need for firewood, releasing labour from collecting timber and maintenance of the drying fire as well as saving on transport costs;
- better quality cocoa. The major quality problem with PNG smallholder cocoa is smoke damage that may occur during kiln drying if a heat pipe deteriorates. This problem does not occur with the solar driers. There is presently no price premium for cocoa produced from the experimental solar driers, but exporters have indicated that higher prices may be paid once sufficient solar-dried cocoa is produced; and
- increased returns from the sale of cocoa as growers can sell the processed dry bean rather than unprocessed wet bean. The small incremental labour cost for processing by the grower may give a significant financial reward, depending on the relative prices for wet and dry cocoa beans and recovery rate. If the technology is widely adopted, it should eventually result in greater returns to individual growers and hence greater equity within the industry.

Thirty trial mini-fermentation boxes and driers were established on smallholdings in ENB between January and May 1996. A further six were installed on Buka Island (North Solomons Province) during November 1996. The system has operated successfully, though the extent of usage has been variable according to Cocoa Board records.

The trial miniboxes and solar driers have been enthusiastically received by both male and female members of cocoa growing households. There is considerable interest in the new technology among cocoa growers in East New Britain and in the other cocoa growing provinces. Many cocoa growers have indicated that they would be prepared to purchase the new technology once it is approved by the Cocoa Board and is commercially available (probably at a cost exceeding K2000). Care will be needed to ensure that designs are strictly adhered to under commercial construction, based on the Cocoa Board's experience with heat kilns, where private builders economised on the quality of chimneys and heat pipes, resulting in rapid corrosion and resulting smoke problems.

The new technology developed under the CQIP has now been fully evaluated in East New Britain, but not elsewhere in PNG. The cocoa produced using miniboxes and solar driers is equal to or superior in quality to that from the conventional kiln driers. The next stage will be for the CCRI Board to endorse the new technique for cocoa fermentation and drying; for this to be submitted to the Cocoa Board for approval probably at the Board's meeting scheduled for September 1997; and for the miniboxes and solar driers to be constructed and marketed by a commercial builder.

Cocoa Board inspectors collect data on the production of cocoa from each fermentary. Data from 1996 indicate that the throughput solar drier in East New Britain averaged about 1350 kg of dry bean over the period for which they had been operating. Three of the fermentaries had processed 125 kg or less, while 13 processed more than 1300 kg. Four fermentary operators interviewed during post-evaluation had highly positive attitudes towards the boxes and driers. However, in addition to perceived operational benefits, their attitudes may be affected by the fact that the trial driers were donated to the growers, and that maintenance is carried out by the CCRI.

Plantations are also showing interest in solar drying and a pilot large-scale solar drier is being developed at the CCRI base at Tavilo. This and other designs will be tested and further developed under an ACIAR project starting in 1998. While the project has had no specific involvement in establishing plantation-scale solar drying, it has provided a sound foundation on which to build.

Laboratory-scale Processing

The third research component set up a laboratory-scale processing system capable of fermenting and drying small samples of wet beans to a standard equivalent to commercial processing. A technique has been developed which allows quality assessment on samples as small as one kilogram of wet bean. This is a major breakthrough as a research tool, allowing the quality of cocoa beans to be assessed early in the breeding program when pod supply is limited. Small-scale fermentation allows testing of a small number of beans (eg, from one tree) compared to production from many trees for conventional processing and testing. The system should thus contribute to the distribution of improved genetic material reaching production significantly earlier than in the absence of the project. Since the micro-fermenter allows more samples to be tested, some overall increase in productivity from the breeding program is also likely in the long term. The laboratory is currently testing about 15 samples per week from the CCRI breeding program and has the capacity to test up to double this number.

An important outcome of the CQIP has been to enhance the status of CCRI and the Institute's links with overseas institutions. For example, a paper presented at the International Cocoa Conference in Brazil in 1996 on the laboratory-scale processing system and the solar driers generated considerable interest. A number of inquiries have been made to CCRI on the solar driers from other PNG and overseas institutions, for example, the International Development Technology Centre at the University of Melbourne and the PNG Livestock Development Corporation. A senior staff member from the chocolate maker, Nestlé, has described the laboratory-scale processing system as a 'world first'.

b. Extension

Mobile Units

The extension component was to set up a mobile extension unit in order to provide information to cocoa growers, extension workers and cocoa inspectors in the main producing provinces. One unit was deployed in October 1991, and a second in October 1995. The units are fully-equipped Toyota Troop Carriers with camping gear, generator, television, video, pruning tools and extension materials. Each of the cocoa growing provinces was visited about three times,

except East New Britain which was reported by the PCR not to have received any inputs from the project. Currently one unit is on Buka Island and the second is said to be working in Madang and Morobe. Although both units are reported by CCRI to be used widely for extension and training, staff from the Cocoa and Coconut Extension Agency (CCEA) in Madang and the Division of Agriculture in Morobe province had no knowledge of the unit. This highlights the limited coordination between agencies in PNG.

Extension Materials

The project's extension component was to provide material and equipment for extension and training activities. This was successful and an large number of high quality and appropriate publications were generated. Some were produced under the CQIP and some were updated from earlier material produced by LAES and CCRI. The extension material included 11 posters, 14 plant pathology leaflets, 11 entomology leaflets and 11 other publications including booklets on various aspects of cocoa production. The component suffered a setback with the volcanic eruption which destroyed the Cocoa Board and extension offices together with much of the published material. AusAID approved replacement of this material rapidly. The extension material has been widely distributed to extension staff, cocoa growers and others in the industry.

Training

A series of training modules was developed under the extension component to cover the needs of cocoa growers, DAL, DPI, Cocoa Board staff and cocoa assessors. A total of 25 courses were conducted for growers, processors, DPI extension/planning staff, DPI trainers, inspectors and assessors over three years. According to the appraisal of the project extension dated November 1994, "East New Britain DPI has not availed itself of training or materials available from the project". This situation is reported by East New Britain DPI staff to have improved over the latter years of the project, and good relationships were developed with CCRI.

A fourth component: development of an information system for recording field activities and extension planning was not proceeded with. However, it was not formally deleted as a project component.

Overall, it is difficult to assess the impact of the extension component of the project. An impressive number of publications were produced and a large number of people attended training courses. It has to be assumed that this has had positive impact, though experience from other extension projects in PNG suggests that the impact on the industry may be limited.

Institutional Development

The project has had a number of positive outcomes in strengthening PNG institutions, particularly for CCRI. The Institute now has a laboratory with trained staff that is used to assess cocoa quality from both the breeding program and other projects, including the solar driers. CCRI staff believe that the laboratory is one of the best-equipped cocoa quality laboratories in a cocoa producing nation.

At appraisal, it was planned that cocoa extension was to be undertaken through the Cocoa Board. This has not occurred. There is no indication that the capacity of provincial Divisions of Primary Industry to conduct extension was enhanced through the project, and in fact the approach was modified when it became apparent that the extension component could not be conducted through provincial departments. However, there have been a number of positive institutional outcomes for extension. CCRI has set up an Extension Liaison Section, partly as a result of CQIP. The Section employs an officer in each of five cocoa growing provinces who are responsible for setting up demonstration plots and conducting training of extension staff.

In response to the lack of effective extension on cocoa, a new institution was set up in early 1997, the Cocoa and Coconut Extension Agency. The agency will have access to the extension material produced by the CQIP. This parallels experience in the coffee industry in the late 1980s, when the Coffee Development Agency was established to provide extension to smallholders. It will be important that CCEA learns from the CDA experience in relation to smallholder needs for technology, adoption rates and the factors affecting adoption.

Financial and Economic Impact

a. Financial Impact

The direct financial impact of the project on CCRI was significant. The project provided assets for the Institute, with a value of K120,000 for the extension component and additional inputs for research. CCRI Research Section expenditures averaged 80 per cent of budget over the project period, indicating motivation on the part of the Institute and the government to support the project.

The project has contributed to a number of potentially significant financial impacts on the cocoa industry. The development of the laboratory-scale fermentation system is expected to make a major contribution to the development of new clones of cocoa, which will assist the industry to survive and prosper under the tight world market situation which is expected to continue. The ability to measure bean quality in small samples should assist in overcoming two of the problems of PNG cocoa in the long term - high shell content and low fat, compared to the benchmark Ghanaian cocoa. Industry opinion is that a one per cent decrease in shell content will lead to a two per cent increase in price, while every one per cent increase in fat content (from the 55 per cent fat which is common for PNG cocoa) should result in an equivalent increase in export price. Several genotypes have been identified under the research program with fat contents of 60 per cent or greater.

b. Economic Impact

Partial assessment of project economics was undertaken in the project implementation document. It was based on the research program leading to a reduction in acidity and thus an increase in the proportion of premium grade cocoa from 10 per cent of national production to 85 per cent over an 11 year period. This was expected to result in an average export price increase of approximately 4 per cent and an internal rate of return of 23 per cent. No specific benefits were attributed to the extension component of the project. As discussed under the heading Project Description, the research program into breeding and production for reduced acidity was discontinued in 1994, and research has been on increasing fat and reducing shell content, while assessing resistance of strains to black pod, vascular streak and other diseases.

The benefits of the (revised) cocoa breeding program will mainly be seen by the plantation sector and in new areas developed by smallholders. If the plantation sector can reduce shell content by say 1 per cent and in addition, increase average fat content by 2 per cent, the export value of PNG cocoa could increase by some $800,000 per year. Benefits to the smallholder sector would take the incremental export value to well over $1 million annually. While not all of this potential gain can be attributed to the project, is does suggest that the overall genotype research program, including the project's contribution, should show a satisfactory return.

Of greater significance to the smallholder sector are the mini-fermentation boxes and solar drying technology developed under the project. Provided that the technology is approved by the CCRI board and by the Cocoa Board, it is expected that many smallholders will adopt the technology over the next five years. Project reports and a rapid appraisal survey of four pilot units conducted during the evaluation indicated substantial enthusiasm among the pilot group and other smallholders in East New Britain. From a smallholder's viewpoint, the main potential benefit is that the equipment allows on-farm fermenting and drying.

The CCRI economist has estimated the potential benefits of on-farm drying (Omuru 1997). These data have been reviewed and revised by the evaluation team, as summarised in Appendix B. Based on a current ex-farm price of K1441/tonne for dry beans, a conversion of wet to dry bean of 37.5 per cent and a wet bean farmgate price of K380 per tonne, the internal rate of return on investment in a small box fermenter and solar drier in East New Britain is estimated at 9 per cent. Other benefits recorded by smallholders include the reduced labour required by the solar driers, particularly relating to elimination of the need to collect firewood and dispose of ash.

In future it is possible that PNG solar dried cocoa will attract a premium price due to reduced smoke damage. Exporters consider that this would require a significant part of the crop (perhaps of the order of 10 per cent plus) to be solar dried. If solar-dried beans attract a premium of K80 per tonne, internal rate of return would increase to around 15 per cent. Smallholders in other provinces would probably benefit more than those in East New Britain, since the wet bean price is generally lower in mainland and other island provinces.

The extent to which these benefits are realised will depend on the level of adoption of the technology by smallholders. Assuming that the CCRI and Cocoa Boards approve use of the system in East New Britain (as is expected during their September 1997 meetings), adoption is likely to be quite rapid. CCRI anticipate that further trials will be required before the technology is released in other provinces where the rainfall pattern in relation to the main harvest period and grower practices differ from those of from East New Britain.

Environmental Impact

So far, the project has not had any significant environmental impact. However, widespread adoption of solar driers would have a positive environmental impact, in that it would reduce consumption of firewood. Some 750 kg of firewood is needed to dry 1000 kg of wet cocoa. Firewood is reported by villagers to be scarce in the most densely settled parts of the Gazelle Peninsula of East New Britain.

Some plantations have also expressed interest in adopting solar driers or combined solar/diesel units. They require a drier that will handle at least one tonne of wet beans per batch. If solar drying is adopted by plantations, it will reduce diesel use and thus have a positive environmental impact in relation to both fuel use and greenhouse gas emission.

The conventional and minibox fermentaries produce small volumes of effluent. For conventional fermentaries, Cocoa Board guidelines indicate that effluent should drain to a sump, from where it soaks away and is likely to be broken down before it reaches waterways. The minibox fermentaries would produce less effluent per unit and therefore should pose even less of a pollution threat.

Social and Gender Impact

In keeping with AusAID guidelines, the project was required to collect gender-specific baseline data. This was either not undertaken or not published. The project was intended to "increase opportunities for participation by women in the ownership of tree crops and fermentaries due to emphasis being given to women in the extension process" (PID p6-1). However, there is no indication of how this emphasis was to be achieved or whether it was realised in practice.

The main farm-level extension publication is entitled *Joseph grows cocoa* (CQIP 1991). Although Joseph's wife Lucy makes several appearances, the book is dominated by pictures of men and the interaction between Joseph and Mark, the agricultural officer. Given that women in many areas of PNG share much of the work on smallholdings with their husbands, a more prominent role for Lucy could be considered in future editions.

The project did not record information on, for example, training course attendance by gender. However, according to the PCR (p19) "Cocoa Board personnel and extension staff were trained in communication skills, with emphasis on the methods to be used in contacting women growers and others who had difficulty in understanding normal extension material. The mobile extension unit program was designed to enable participation by growers' families, including women and children". Overall, it is considered that the project missed an opportunity to assess women's roles in cocoa production and to promote women's development in PNG's rural economy.

The processing technology developed under the project has the potential to have a significant impact on women. On smallholdings where it is introduced, an average of perhaps half of the additional work involved in processing is likely to be undertaken by women, adding to a workload which may already be heavy. For growers who already process their beans using a traditional kiln, the workload for both men and women would decline due to the removal of the need to collect firewood. Overall, the impact on the female workload is likely to be positive.

There is little information available on the sharing of income within cocoa growing households. It is thus difficult to assess the implications of a move to on-farm processing, highlighting the need for a better understanding of village level cocoa production.

Occupational Health and Safety

The main area in which the project involved occupational health and safety issues was in the production of extension materials. *Joseph grows cocoa*, contains many references to necessary precautions when using chemicals, with cross-referencing to the section on the rules of chemical use. Gramoxone weedicide is probably the most dangerous chemical in common use on smallholdings and some specific

reference to it could be considered in future editions – though it may be better to retain the approach implied: that all chemicals are equally dangerous. Highlighting the danger of particular chemicals may lead to unintended consequences, as shown by high youth suicide rates from agricultural chemicals in at least one South Pacific country.

Sustainability

The sustainability of the project is mixed. The research component of the CQIP has been institutionalised in CCRI and operation of the cocoa quality research laboratory is included in the Institute's annual budgets for 1997 and 1998. The laboratory-scale processing system developed under the project has been adopted by the Institute. Evaluation of the miniboxes and solar driers is continuing at CCRI. Equipment provided by the project is being maintained and the recurrent costs are being met from core CCRI funding, although with more difficulty than when the CQIP was functioning.

Considerable effort was put into training local staff in all aspects of the project. Although the training was generally successful the continuity of work remains dependent on a limited number of trained staff, particularly since the recent resignation of the staff member who received most training under the project. Further loss of trained staff would threaten the sustainability of the benefits from the research component.

The extension component has proved less sustainable. The extension materials produced under the project is an ongoing resource, while the mobile extension units are reported to be functioning, though no information could be obtained on the mainland unit's activities during field visits to Madang and Morobe. The project is likely to have a continuing impact on extension through the recently formed Cocoa and Coconut Extension Agency, which will utilise some of the material produced under the project.

Lessons Learned and Key Issues

Conclusion

Overall, the project succeeded in meeting most of its objectives. The research component, as modified prior to the project extension, has resulted in systems which are expected to improve both plant breeding outcomes and smallholder processing of cocoa. A range of high-quality materials was produced under the extension component,

and widely distributed, largely through the use of a mobile extension unit. The research component has been institutionalised within CCRI and the recent establishment of the Cocoa and Coconut Extension Agency may allow many of the extension initiatives commenced under the project to be continued and the extension materials used.

The major potential project benefits for smallholders relate to the minibox fermentation and solar drying systems developed under the project. The extent of interest in the system from growers in all cocoa growing provinces suggests that widespread and rapid adoption is likely once the system is approved by the Cocoa Board. The CCRI intention to continue trials under a range of climatic and agronomic conditions is sound. It will be important to avoid the problems experienced by the plant breeding program with the premature release of black pod susceptible clones.

The broad objectives of the project were identified over a long period by industry and government. The targeted technologies for research (cocoa quality and improved cocoa clones) are appropriate for smallholders, who produce some 65 per cent of PNG's cocoa. Thus, ownership of the results has been retained by the PNG cocoa industry.

Key Issues and Lessons Learned

The project experience leads to a number of lessons:

a. Research Flexibility

Project research objectives changed substantially over the course of the project, particularly after the meeting held with industry in March 1994. A number of the positive outcomes of the project resulted from the discussions at that meeting which formed a model for further consultative meetings between commercial and research representatives. This highlights the benefits of industry consultation in research program definition and review. It also suggests that the research into acidity that had been the main focus of the project's research component to that time could probably have been terminated earlier (or possibly not commenced) had more industry consultation taken place during project design or early implementation.

Applied research project components should include adequate industry consultation in their design and implementation. Such consultation should include all sectors of the industry which may be affected by the research.

Research program flexibility is likely to be a key determinant of project impact and should be built into design.

b. Extension Program Design

The extension program was effective, but was not institutionalised. This has resulted in a loss of momentum after the end of the extension component in December 1995. The mobile unit approach seems to have been sound, but no review of extension effectiveness and impact was undertaken and it is not possible to quantify project outcomes. While the project identified institutionalisation as an issue, at least in the November 1994 appraisal of the CQIP extension, no formal attempt was made to place project extension activities in an appropriate agency. The development of the Cocoa and Coconut Extension Agency is a potentially promising development. However, it would have been beneficial if the project could have undertaken more analysis of the institutional framework of extension and taken active steps to achieve a sustainable approach.

Mobile extension units are an appropriate way of training extension officers on a national or regional basis. To be effective, they need to be complemented by conventional extension services.

Where projects include components which have weak institutional linkages, active steps to ensure their institutional survival after the end of project funding should be built into the project. Alternatively they should be recognised at the outset as having a limited life so that the most cost-effective solution can be implemented.

The proximity of the project components as well as formal liaison mechanisms contributed to the integration of research and extension. These were enhanced after the extension unit moved from Rabaul to CCRI at Keravat.

The combination of research and extension under one project can enhance the potential for research messages to reach the farmer. At the least, formal links between research and extension should be a prerequisite.

The project's extension component is reported to have developed good relationships with agricultural and extension staff in all provinces except those closest to the project, in East New Britain.

The reason for this has not been fully determined and East New Britain Department staff report that relationships with CCRI are excellent. However, it may highlight a common problem in development assistance projects – that highly-resourced projects may lead to jealousy, and possibly conflict with less well endowed parallel institutions or non-project sections within the same institution. While overcoming such problems can be difficult, in this case the provision of some support to and role for the East New Britain department staff may have pre-empted the problem. Given that the province is the major cocoa growing area in PNG, this might have made a useful positive impact.

Institutional analysis in development assistance project designs should examine the potential for jealousy and conflict to build up in relation to resource allocation. As far as possible, designs should include steps to eliminate or minimise this problem.

c. Adoption of small-scale processing and drying regime

Cocoa growers are enthusiastic about the potential of the minibox fermenters and solar driers. However, the technology must be approved by the Cocoa Board before it can be implemented. The farm-scale testing over 18 months undertaken in East New Britain and for about 9 months in North Solomons indicates that the system is able to at least meet and often exceed the quality output of traditional fermenting and drying systems. However, conditions over the period were exceptionally dry.

The CCRI and the Cocoa Board should review and approve the fermentation and drying technology developed under the project as soon as possible. However, adequate testing in provinces with climatic conditions different to East New Britain is required before the system is approved for implementation elsewhere in PNG.

Widespread adoption of the technology will require an increase in the inspection requirements placed on the Cocoa Board. Review may be merited of the inspection requirements for fermentaries, to determine if there are other methods that could maintain quality without involving regular inspection by government agencies. This could perhaps include a notification system by buyers where quality problems are identified for a particular fermentary.

d. Baseline and Monitoring Studies

Limited information is available on smallholder cocoa production and processing. In the case of CQIP, it would have been beneficial in relation to project design and implementation if, at least, a baseline and an impact survey had been undertaken. This could have been contracted to a local institution such as Unisearch (the consulting arm of UPNG) and would not have added greatly to project costs. This should have assisted in, for example, identifying the constraints to processing, such as firewood availability.

Research projects directed at smallholders should be designed on the basis of detailed knowledge of the farming system, including such aspects as labour inputs, time allocation preference, gender division of labour and income and perceived constraints to production, credit and marketing. Where such data are inadequate, resources should be made available to conduct surveys, at least at rapid appraisal level and preferably using participatory appraisal.

CQIP did not record and/or publish information relating to project costs and benefits. Such data should be helpful during implementation as well as for ex-post evaluation. For example, economic analysis requires foreign and local costs to be recorded by year and class in order to derive project cash flow and economic costs. If the data are not recorded and analysed under the project period, they are often difficult or impossible to locate after completion.

Project managing contractors should make an effort to record information on local costs, consultant inputs and project benefits. Such recording should be at a level which permits adequate assessment of constraints and efficiency, but does not demand excessive resources. Contracts written with managing agents should require such data to be recorded and analysed.

Project completion reports which lack sufficient data for ex-post evaluation should be returned to the managing agent for revision. Any revision of AusAID's operational guidelines should require recording of necessary information and its inclusion in PCRs.

Numerous training courses were conducted under CQIP. However, no course reports or evaluations could be located in CCRI. In addition to assisting in the evaluation of training components, such reports can form a valuable resource for others engaged in training in the country or sector.

Training course reports should be prepared on all or most training activities. These might include course content, attendance by gender and (at least) an end-of-course self-evaluation.

The trial solar driers in East New Britain are installed by CCRI staff at no cost to the smallholders. In a smallholder context, this confers a major potential benefit on individuals. Consideration should be given to requiring payment for the test driers. Costs could be discounted and/or deferred in return for collaboration in the testing program. This would provide information on financial performance and the demand for commercial units as well as on technical performance.

Maintenance is also provided free of charge. This represents a minor input but may contribute to the enthusiastic use of the driers and to a false expectation of the likely uptake of the technology. It also precludes assessment of the likely level of maintenance under commercial conditions.

Where new technology developed under a project is trialled under smallholder conditions, consideration should be given to requiring some level of payment for the asset's capital and operating costs, on a subsidised or deferred basis if necessary.

Coffee Research Institute Project

The Coffee Research Institute project (CRIP) ended in November 1992. The delay prior to ex-post evaluation means many of the project 'actors' have left and some of the records required to define effectiveness do not exist. No benefit monitoring and evaluation was undertaken under the project and, in the absence of a detailed field survey, it is difficult to assess impact, particularly since no higher order objectives were defined in the project documents.

The project was closely linked to the Coffee Development Agency (CDA) project and in practice they came under 'one roof' when the Coffee Industry Corporation (CIC) was established in 1991. Given the time lags in getting research results to coffee producers, some review is required of activities by CDA and Extension Services Division of CIC in relation to the research undertaken or commenced under the project.

At the time of project design, coffee was a substantial contributor to both GDP and export income, earning foreign exchange of around K100 million in the late 1980s or half of national agricultural exports. Despite the growth of mineral and timber exports since that time, coffee remains one of the leading export earners, with foreign exchange earnings averaging K200 million per year over the three-year period to 1996 (see Figure 2-1). About one million people, or a quarter of the national population, are estimated by CIC to depend on coffee for some part of their income. An average of 75 per cent of national production comes from Eastern and Western Highlands provinces (Figure 4-1). Smallholders produce about 70 per cent of PNG's coffee with the balance from plantations and blockholders (Figure 4-2).

Figure 4.1 Coffee production by province ('000 bags)

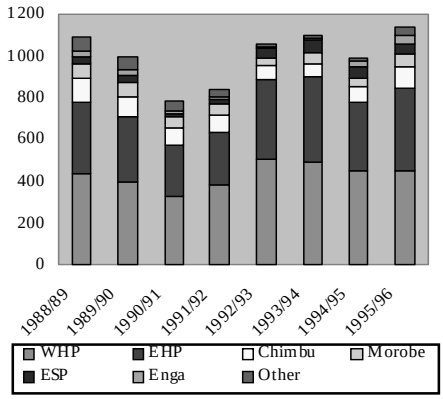
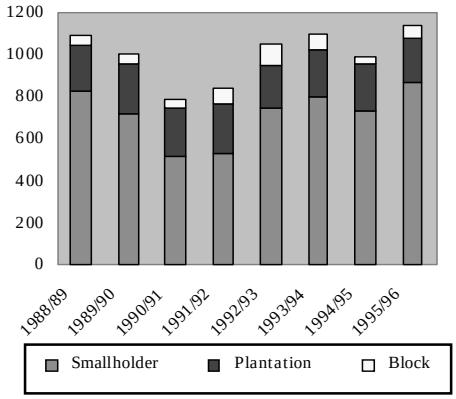


Figure 4.2 Production of coffee by year and class ('000 bags)



Source: CoffeeIndustry Corporation

Project Description

Rationale

Coffee rust was confirmed in the highlands of PNG in May 1986. Coffee rust is a fungal disease which spreads readily by wind or other media. Its effect on the coffee bush may be low in the first one or two years of infection, but over four or five years it can cause a severe yield reduction. For example, leaf rust was responsible for the disappearance of Sri Lanka's coffee industry in the 1870s. PNG had suffered three outbreaks prior to the 1986 epidemic, but these were confined to minor coffee production areas and the disease had been isolated and eradicated. The extent of the 1986 outbreak in the major highlands production areas meant that eradication was not possible. In the short to medium term, control of the disease was thought to require development of a systematic program using fungicides. In the longer term, disease resistant varieties were believed to offer potential.

The Coffee Research Institute is located at Aiyura near Kainantu. It was constituted in March 1986 to take over the research activities of the Coffee Industry Board. According to the project's appraisal report (p11):

"CRI is relatively new and while some research programs have commenced, including the introduction and propagation of reportedly rust resistant material which has been obtained from

overseas, delays have been encountered in relation to recruitment of staff and handover of facilities from DAL. Recent progress has been made in resolving these constraints and in the construction of new laboratory facilities. The proposed Australian technical assistance should provide a much needed impetus to the research program which has taken on an increased and critical importance since the confirmation of coffee rust in PNG.".....Without outside assistance "CRI would not have the technical capacity to speed up research activities and to meet immediate research demands in relation to spray technologies".

Formulation

In early January 1987, the PNG government officially requested Australian assistance with a planned coffee rehabilitation and rust control program. By the time the request was received, a decision had been taken to establish the Coffee Development Agency (CDA) as the extension service for coffee production.

An appraisal of the proposed project was undertaken by AusAID in March 1987. The appraisal report was finalised in September, recommending that the project should be divided into two 'sub-projects', one providing extension assistance to CDA and the other research assistance to CRI. This evaluation is primarily concerned with the second of these projects.

Objectives and Scope

The common goal of both the CDA and the CRI projects was identified in the appraisal as "assisting PNG agencies to arrest the decline in smallholder production in areas at risk from or affected by coffee rust." The project was intended to contribute to maintaining national production and yield at least at 1986 levels.

The objective of the CRI project was indicated as "to accelerate research into major aspects of coffee rust prevention and control". An increase of at least 50 per cent was anticipated in information regarding the nature of the disease in PNG and its control compared to existing information.

In practice, the higher order (purpose level) objective of the project could be considered to be 'provision to coffee growers of effective and tested recommendations relating to spraying programs and planting material to permit the control of coffee rust'. The assumptions

required for this objective to be realised would be that the research programs under the project generated extendable results and that the extension agency (CDA) was effective in transmitting this information to farmers.

The main outputs anticipated from the Coffee Research Institute Project were:

(i) recommendations on fungicides, equipment, application methods, spraying schedules and health and safety measures relating to coffee leaf rust control;

(ii) a micro-propagation technique for the rapid multiplication of rust-resistant varieties obtained from overseas; and

(iii) information about the epidemiology of coffee rust under various climatic conditions in PNG to assist in the development of control recommendations targeted for different areas in PNG.

A review of the project was undertaken (PRT 1991) within the context of providing assistance to the newly formed Coffee Industry Corporation (CIC). A revision of the project was recommended with three main components:

(i) **Coffee Rust Research** – develop safe, environmentally acceptable and cost-effective recommendations to control coffee rust;

(ii) **Training** – train PNG scientists in plant pathology, spray technology and integrated pest management; and

(iii) **Rust resistant varieties** – assist with the research, micro-propagation and demand analysis of Catimor as a rust resistant variety.

Project Cost

At design, project costs were budgeted at $1.4 million including Australian costs of $1.15 million and local contribution of $250,000 as shown in Table C-1 in Appendix C. The project extension was budgeted at $732,000 making a total planned input by AusAID of $2.13 million. An additional $1.7 million in costs was approved, of which $600,000 was for procurement of the micro-propagation laboratory and equipment in Australia. The total Australian

contribution is stated in the PCR as $3.7 million, but with no breakdown by component, category or year or comparison with budget.

Complete records of local costs are not available. Staff salaries and operating costs were paid from within the station's normal operating budget, and no estimate of total local project costs has been made. The CRI accountant prepared a summary of the local contribution to the project by cost category for the year ending 30 September 1990, which amounted to K73,000 (A$95,000). This is close to one third of the $250,000 estimated in the design document and confirms the opinion of CRI staff that local budget and staff inputs were sufficient for efficient implementation.

Implementation Performance

Identification, Design and Change

The project was designed in response to what was considered to be an emergency situation – the outbreak of coffee rust. In this context, Australia's response was rapid and appropriate. The appraisal mission was fielded within two months of the official request to AusAID, though a further 14 months passed before the project advisers commenced work in the field.

The initial project design included procurement of equipment "to validate and refine methods (acquired from overseas sources) for the tissue culture and rapid micro-propagation of coffee". Provision of laboratory and glasshouse facilities was to be considered by AusAID as soon as it became clear that the technology was relevant and appropriate for transfer to CRI. The construction of a tissue culture laboratory and associated infrastructure at Aiyura was approved at the October 1990 coffee research advisory committee meeting. The buildings were completed by the following June and operation commenced in September 1991.

The project implementation document (undated but based on a visit to PNG from 22 May to 2 June 1988) focused on the design of the proposed research program. It did not contain a logframe though an 'Implementation Report' (also undated) does contain a basic logframe. The 1991 review stated that: "the project logframe appears ill-defined in the Implementation Document and has been confused in subsequent reports. The managing agent has obvious difficulty in describing the project in a logical framework and it is advisable that

this is corrected. Similarly, the description of the project extension has been poorly described and the budgets seen by the review team are questionable in content and estimation." The review report revised the logframe in relation to its performance indicators and assumptions, but not its basic rationale.

Late in the project (in April 1992), the project coordinating group approved additions to the project for the development of strategies for control of coffee berry borer, coffee berry disease and cicada infestation.

Technology Transfer and Adoption

Technology transfer can be considered at two levels: the transfer of knowledge and skills from the Australian advisers to their counterparts; and transfer of research results to industry. Overall, the project made a significant contribution to capacity building and staff development in CRI. In addition to the formal training provided for three scientists, the approach to research and the working relationships of the advisers and the CRI scientists has had a positive and lasting impact on the operation of the Institute. This has made a contribution (for example) to the quality of the research proposals put up to the coffee research advisory committee and the calibre of publications. The latter continue at a high professional standard, five years after project completion.

The aim of applied research is to contribute to industry development and operation. To achieve this it needs mechanisms to link research findings to the coffee growers - normally through an extension agency. In the case of CRI, its extension agent during implementation was the Coffee Development Agency. Extension, particularly to plantations, was also achieved through CRI publications such as *PNG Coffee* and through the *CRI Newsletter* which is published between one and four times per year. The spray regime for coffee rust developed through project research has been widely adopted by plantations. The links between research and the grower are further discussed in Section 4.3.

Organisation and Management

A full-time Australian project leader was based in Aiyura for the duration of the project. Other staff, including the Australia-based project director visited Aiyura regularly and when specific needs arose. Most project scientific and technical staff were employees of

research institutes of the Victorian Department of Agriculture. Project administration was the responsibility of the Overseas Projects Corporation of Victoria.

From the PNG side, the researchers came from core staff of CRI. During the project, the Institute director made a significant contribution to the efficient operation of the project. He ensured, for example, that local funds and staffing inputs were adequate to support project activities and that land was provided for project facilities.

Project Completion

The project was originally planned to run for three years ending in June 1991. However, in May 1991, an 18 month extension was given, taking the completion date to November 1992. A review of the project and the (parallel) CDA project was undertaken in November 1991 and published as the *Review of Australian Assistance to the Coffee Industry Corporation* (PRT 1991). The review made recommendations for the remaining 12 months of Australian inputs to the CRIP.

A completion report was prepared at the end of the project and summarises activities and outputs. The PCR (in common with two of the other three PCRs in this cluster evaluation) contains no useable information on project costs and has little to say about sustainability, institutional factors or the mechanisms for ensuring that the project met its (implied) purposes.

Impact Assessment

Operational Performance

a. Coffee Rust Research

A major component of the project was to develop safe, environmentally acceptable and cost-effective recommendations to control coffee leaf rust. This required development of an understanding of the epidemiology of coffee leaf rust under PNG highland conditions; an understanding of the effect of rust on the growth and yield of coffee in this environment; evaluation of fungicides and their application; and development of recommendations for rust control. These tasks were accomplished under the project and the results were documented in a series of high

quality publications by project staff and CRI scientists. Some of the research was basic, in that it had to be completed before the more applied work could be attempted.

Some of the plant pathology research was not complete at the end of the project. It was continued and extended over the period 1993-96 after the project finished. As a result of this work, there is now a good understanding of the relationship between rust incidence and environmental conditions in the PNG highlands.

This component included the evaluation of spray technologies for chemical spraying of coffee plants affected by rust. The work produced significant results which have potential application in other sectors. It was continued after the project completion until the scientist trained under the project was retrenched by CRI in 1997. The results have been made available in four technical publications.

The key conclusions of the research were that:

(i) rust is not severe above 1600 metres in altitude;

(ii) good management may significantly reduce rust levels;

(iii) epidemic development is restricted to the period April-July;

(iv) three applications of protectant and systemic fungicides applied in January-March are effective in controlling severe rust outbreaks;

(v) rust has no significant effect on coffee yield unless it affects more than 20 per cent of leaves; and

(vi) that no residues of fungicides were detectable in green bean from coffee plots treated with the recommended spray program.

In the event, rust has not posed the major threat to the PNG coffee industry anticipated when the project was formulated. Thus the findings have had less impact on the industry than if rust was a more serious problem in the main highland valleys. Nevertheless, some of the findings of the research have been taken up by the industry.

The research confirmed the need for good management, that is, attention to drainage, weeding, shade levels, pruning and fencing to exclude pigs. These points are the core messages promoted by the Extension Services Division of CIC. The research indicated that less

frequent use of chemicals was needed for control than had been recommended when rust first was detected in PNG in 1986. This finding is mainly applicable to the plantation and blockholder sectors of the industry as smallholders seldom spray for rust control. The plantation sector adopted this recommendation as shown by the plantation cost-of-production survey between 1988 and 1995 (see Figure 4-4).

b. Coffee Rust Epidemiology by Zone

The project produced information about the epidemiology of coffee rust under various climatic conditions in PNG and recommendations were made for rust control for different altitude zones. This information was passed onto CDA staff and incorporated into their extension material. It was suggested at the coffee research advisory committee meeting in October 1987 that PNGRIS could be used to define areas with appropriate environmental conditions for coffee as defined in the 'Robinson/Hackett CSIRO publications on Arabica and Robusta coffee' (*CSIRO Technical Memorandum 86/5 and 86/6*). In the event, PNGRIS was not used and has yet to be installed at CRI. This would have represented an ideal use for PNGRIS and highlights the need for mechanisms to exchange data between sectors and projects.

Eight weather stations were purchased under the project and established on six smallholder blocks and two plantations. The data generated were used to determine the relationship between different weather variables and development of coffee leaf rust. It was found that temperature played a significant role and for practical purposes, coffee grown in areas where the minimum temperature rarely exceeds 15°C does not require any rust control measures or the planting of rust resistant varieties. The weather stations were removed from the blocks at the end of the project. Some were set up on other on-farm trial sites but were removed following theft of the solar panels.

c. Rust Resistant Varieties

An imported dwarf rust-resistant variety (dwarf Catimor) was selected by Agrophysiology Section at CRI during 1986. To provide CRI with the capability of rapid multiplication of rust resistant coffee lines, the project included a component on the development of micro-propagation technology. This included an evaluation and refinement of protocols for initiation, multiplication and root

initiation of coffee; assessment of the potential for the micro-propagation of coffee planting material; and development of protocols for PNG conditions. Protocols for rapid multiplication were tested successfully in Australia and at Aiyura.

Following this assessment, the project team recommended that a micro-propagation laboratory should be built at Aiyura. This was approved by the research committee in October 1990 and a laboratory capable of producing some one million coffee plants per year was completed by June 1991. An intensive training program was established for graduate and technical staff to run the micro-propagation laboratory. At the coffee research advisory committee meeting of October 1989, total cost was estimated at $445,000. Actual cost as at May 1991 is reported in the project files at about $580,000 including equipment costing $180,000.

This component has had little impact on the coffee industry due to the less than anticipated effect of rust. Hence, there has not been a great demand for coffee seedlings and the limited demand has been easily met from standard nursery seedling propagation. The low prices for coffee during the early to mid-1990s and limited new plantings by smallholders have also restricted demand. The dwarf cultivar selected for rust resistance has received only limited acceptance by smallholder growers. This is reportedly due to its low branching habit, dissatisfaction with an earlier dwarf variety and the fact that limited planting or replanting has been undertaken by smallholders.

CRI was contracted by the Fresh Produce Development Company to produce potato planting material. The laboratory was unable to produce the contracted 7200 plantlets per year and the contract has now been let to the Lowland Agricultural Experiment Station in East New Britain. Staff have also had problems in multiplying taro cultures. These problems suggest that the facility is not functioning properly and that further training of the present staff is needed for them to run it efficiently.

The micro-propagation facility at Aiyura is under-utilised and is being allowed to run down because of insufficient funding for maintenance and to purchase the necessary inputs, such as agar (Kukhang 1997). The standby generator has not worked since 1994, which results in

failure of the ultraviolet lighting system in the laminar flow cabinets and consequent loss of plant material during blackouts. Several of the air conditioner units also require service.

It is important that the facility remains operational and that staff are capable of using it effectively. Coffee berry disease is reported to be present in Irian Jaya. Should this disease reach PNG, it would probably have a devastating impact on smallholder coffee production in the highlands. In this event, it would be necessary to propagate large numbers of seedlings of coffee berry disease-resistant lines as rapidly as possible. The micro-propagation laboratory would be vital for this. Despite current problems, the laboratory is the best facility of this nature in PNG and should be regarded as a national asset to be used for all micro-propagation purposes.

d. Other Pest and Disease Problems

The mid-term review of the project (PRT 1991) recommended the inclusion of short-term consultancies to develop action plans for outbreaks of coffee berry borer and coffee berry disease; and to develop recommendations for research on control of cicadas in coffee plantations. The action plan for coffee berry disease contributed to raising awareness of the problems relating to PNG's plant quarantine procedures. Research on the control of cicadas in plantations was conducted. This resulted in a series of recommendations to manage the pest including integrated pest management.

Institutional Development

a. Training

Training programs in plant pathology, spray technology and entomology for three Unitech graduates were designed to provide CRI with staff who could continue the work initiated by the project. One graduate was trained successfully at La Trobe University and graduated with a MAgSc in 1992. He completed his research thesis on aspects of coffee rust epidemiology. Another completed a one-year post-graduate diploma in agriculture (spray technology) at University of Queensland. Both trainees attended conferences of the Australasian Plant Pathology Society. The trainees spent part of their time at CRI so that continuity was not lost. The plant pathologist remains at CRI five years after he completed his studies and comments favourably on the quality of his masters degree training. The researcher who was trained in spray technology was retrenched

from CRI in mid-1997 in response to the financial crisis affecting CIC. He is currently employed by the Oil Palm Research Association in West New Britain.

The mid-term review recommended that the project should provide training for an entomologist capable of providing the coffee industry with integrated pest management advice. This took place with the CRI entomologist spending a year at La Trobe University. He is currently conducting integrated pest management research at CRI and indicates that his training under the project contributed to his interest in integrated pest management.

Training of staff also occurred for the micro-propagation facility. A laboratory manager and two laboratory assistants were trained under the project, but all three have now left the Institute and have been replaced. The new staff were trained on-the-job by other CRI staff.

Overall, the project made a significant contribution to the institutional development and capacity of the Coffee Research Institute. The number of scientific staff at CRI has been maintained quite well since project completion, with 10 scientists in 1997 compared to 12 in 1992. This continuity is now threatened by the financial crisis facing CIC and possible further retrenchment of staff.

b. Training facility

A grant of $300,000 was provided by the Australian High Commission to construct a dormitory, kitchen and dining room as part of the training facility at Aiyura. The facility can accommodate 30 persons. This has been in steady use since the end of the project. It is used to accommodate people being trained by CIC, DAL and Fisheries Department, as well as other groups such as police and agricultural students. CRI records indicate that it has been used for some 7800 person-nights over the period October 1992 to April 1997, averaging 1750 person-nights per year (Appendix C Table C-3). The facility is being maintained by CRI and a charge of K10 per night is levied, although this money is not retained by CRI.

c. Coffee Industry Corporation - Extension Services Division

Excellent liaison is reported to have occurred during the project between the Australian advisers at CDA and CRI staff. Research staff also made useful contributions to the extension material developed by CDA. These links were institutionalised and CDA coffee division managers attended quarterly review meetings at Aiyura. Within two

years of project completion, the links were weakened due to staff changes and problems in CIC. Relationships between extension and research staff are now characterised by minimal contact, mutual distrust and even antagonism. Similar problems apply to relationships between staff of other CIC divisions.

Despite these problems, the project contributed to extension through the research results made available to CDA and later Extension Services Division of CIC. It has also contributed to the development of CIC's Technical Advisory Management Service. This small group provides advice to the plantation and blockholder sector. Some of the research results from CRI, in particular the recommended spraying schedule, have been incorporated into the coffee calendar and training courses which are conducted for blockholders about three times a year throughout the main coffee growing provinces.

Financial and Economic Impact

The project design documents and completion report contain little information on the potential for financial or economic impact.

a. Financial Impact

Information on actual and budgeted costs for CRI and other divisions of CIC was difficult to obtain. However, results were available for 1995 and 1996, indicating average annual costs for CRI of the order of K2.9 million (Appendix C Table C-2). This includes the operating costs of the Institute's plantation coffee areas and a coffee factory, which generate revenues of about K1 million annually.

The project had a significant direct financial impact on CRI. This was primarily through increasing the level of operation of the Institute with consequent recurrent cost implications. This particularly relates to the micro-propagation laboratory. The laboratory operating costs have not been recorded but would probably be of the order of $200,000 per year for a moderate level of operation. At the present low level of operation, additional costs are limited.

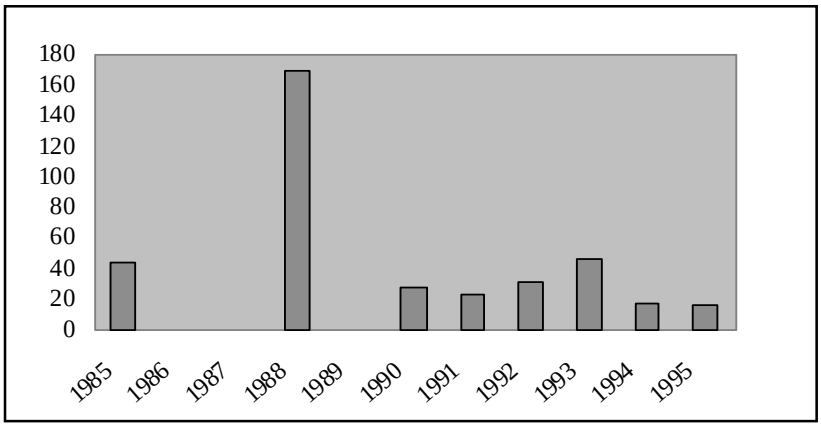
Economic impact is difficult to define. However, each of the main project components have some current or potential economic impact.

b. Spraying Systems and Technology

The Australian team and CRI scientists consider that the project was instrumental in reducing the spraying intensity for coffee rust on plantations and some blocks in lower altitude areas from about six

fungicide sprays to one systemic spray and two contact sprays annually. It is likely that the industry itself would have developed a lower intensity spraying program over time. However, the research program was at least able to accelerate the benefits of the program. In addition to less frequent spraying, the spray technology program recommended a different nozzle to that normally used in backpack sprayers. This reduced the volume of spray required per unit area of coffee by some 50 per cent. Information on rust control costs is available as time series data from the annual plantation cost of production survey carried out by CIC.

Figure 4.3 Annual expenditure on rust control by plantations



Source: CIC Plantation Surveys

Expenditure on rust control by the plantation sector peaked at around K160 per hectare in 1988 (Figure 4-3). Unfortunately, data are not readily available for 1987 and 1989. However, 1987 expenditure may have been of the same order as 1988, while 1989 can be interpolated at around K100 per hectare. The reason for the expenditure in 1985, before the epidemic was identified in PNG, is uncertain, and casts some doubt on the reliability of the data. The improved spray technology and regimes recommended by CRI are assumed to have moved the decline in rust control costs forward by three years. On this basis and assuming (conservatively) that no change in yield would have occurred with and without the project, costs 'saved' by

the plantation sector totalled around K2.1 million between 1988 and 1991. If it is assumed that the blocks generated savings at half the rate of the plantations (based on their lower chemical usage), blockholders would have saved about K540,000 over the same period, indicating total cost savings in relation to rust control of about K2.6 million. The cost of the rust control and spray program are not identified in the project documents. However, if the component cost totalled K1.3 million, the indicated benefit cost ratio would be of the order of 2:1.

Additional benefits were generated by the sprayer testing program. This provided useful recommendations, many of which were adopted by smallholders. The benefits of the recommendations mainly related to increased sprayer life and reduced costs related to breakdown. They are difficult to quantify in the absence of knowledge of adoption rates.

c. Micro-propagation

The development of micro-propagation capability was considered necessary under the project in order to generate rust resistant planting material more quickly than is possible with conventional multiplication from seed. Due to the low impact of the rust problem, the need for rapid propagation of coffee plants did not develop. While other species have been multiplied using the facilities, for example potatoes and orchids, the direct economic benefit of the micro-propagation facility to date has been limited. Capital and operating costs have been high, suggesting a net economic loss to the country. However, two factors suggest that the facility may yield long term benefits – the potential use of the facility in the event of a new 'emergency' such as a major outbreak of coffee berry disease; and possible commercial production of plant species other than coffee.

In the event of an outbreak of coffee berry disease, resistant varieties would need to be identified and replicated rapidly. Given that the disease may already have reached Irian Jaya (from its origin in Africa), this program should be initiated immediately, and may represent a substantial opportunity for economic gain from the micro-propagation laboratory and CRI as a whole. A major study would be required to identify the economic gains from such a program. However, CRI research and development could make a major contribution to the survival of the K200 million per year

industry, with posible direct gains of several tens of millions of kina. The micro-propagation laboratory is worth preserving for this reason alone.

Staff at Aiyura are keen for the laboratory to succeed, and have drawn up plans and options for commercialisation. This would comprise leasing the facility to forming a partnership with a private operator, and using the laboratory for the production of commercial species, such as orchids, taro, banana and other species which are best propagated vegetatively.

Environmental Impact

Analysis of residues was conducted on green beans from plants treated with three different spray schedules. This indicated that fungicide should not accumulate within beans when the recommended spray regime was followed. Hence the recommended spray regime for coffee rust should not have any negative impact on the acceptability of PNG coffee. Exporters have not reported problems with residues.

The project demonstrated that fewer sprayings are needed each year to control rust than recommended prior to the project. This has had an impact on the plantation sector where there was a substantial decline in spending on rust control between 1988 and 1990. The finding has had little impact on the smallholder sector as few smallholders spray for coffee rust.

The project's integrated pest management component had a significant and positive environmental impact. This was mainly through its finding that the destruction of ant populations (which was thought to assist in green scale control) was promoting the build up of cicada numbers. The recommendation from the project that plantations should minimise or eliminate insecticide sprays has been quite widely adopted and appears to have reduced the cicada problem – though the cyclical nature of the problem is recognised. The concept of integrated pest management should make a significant contribution to plantation management and may have aspects relevant to other tree crop sectors.

Social and Gender Impact

The project did not have any known positive or negative impact on women. The absence of female staff, other than in junior support roles such as secretaries, in all divisions of CIC is striking. Only one senior CRI staff member, the head of the Scientific Liaison Department, is female. Another female was offered the position as manager of the micro-propagation laboratory, but she declined after pressure from her family, who did not wish her to move to the highlands. This typifies a general constraint in recruiting females to the highlands, especially for people from coastal provinces.

The Extension Services Division of the CIC is also dominated by men. Whilst not assessed during this cluster evaluation, it is likely that few extension messages are transmitted to female members of coffee growing households, despite their contribution to the production and harvesting of coffee and their common role in the highlands as custodians of part of household cash income.

Occupational Health and Safety

During the project, some seminars were given to CIC and industry personal on safe handling, application and disposal of pesticides. These messages have been incorporated into the extension material produced by the Extension Services Division of CIC. Some sprayers were provided to smallholders through CDA. These have been used for weed control rather than for rust. Spraying with weedicide is becoming common, as least in some villages near Goroka, although it is uncommon in much of the rest of the coffee growing region. Limited field observation suggests that the training and publications on safety have had little impact. Lethal weedicides such as Gramoxone are stored in single room dwellings and villagers report that they do not use protective clothing when spraying weedicide.

Although smallholders and blockholders often acquire safety equipment, it is generally not replaced when it wears out or is lost. In practice, the extension recommendations for full protective gear may not be appropriate for PNG conditions - for example full overalls are hot and may even be dangerous as they would seldom be washed. Basic precautions such as the use of masks and gloves, particularly when handling concentrate may be more appropriate for most agricultural chemicals.

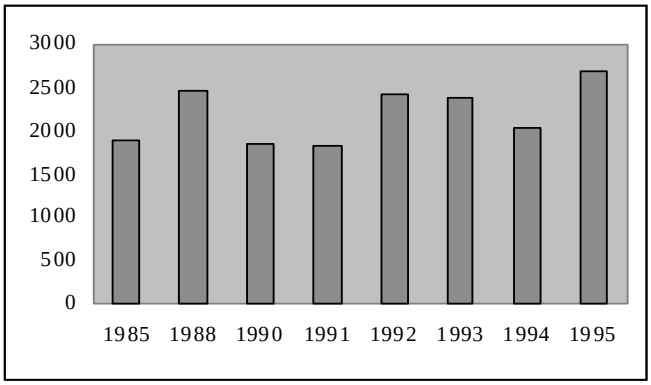
Sustainability

The project was completed almost five years ago. Several of the staff trained under the project remain at CRI. However, the financial crisis facing CIC has resulted in the retrenchment of the spray technologist, and is threatening further redundancies. It is too early to predict the extent of the cut back, but under the worst case scenario being considered, the research capacity of CRI would be greatly reduced. It is nonetheless considered that the research results from the project will have continuing relevance, and will contribute to the ability of the coffee industry to control future disease outbreaks.

Some of the problems experienced by CRI over recent years have resulted in part from weak management. This may have resulted from the policy of appointing researchers to senior management positions for which they lacked experience and capacity. Recent management changes in CRI and in other areas of CIC appear sound and should lead to improved prospects for sustainability in both institutions. However, long-term sustainability of CRI may require the organisation to be given a degree of financial autonomy from CIC. In particular, it may be necessary for CRI to generate its own research funds and accept assistance which is project based and controlled by Institute management.

The coffee industry itself faces threats to its sustainability. This is particularly important in the plantation and to a lesser degree in the block sectors. Production costs in the plantation sector in 1995 averaged almost K2,700 per tonne of green bean (Figure 4-4). The high prices realised in 1997 have provided some welcome relief to the plantations; but there is no reason to believe that downward pressure will not continue in the long term. In this situation, the contribution made by the project to containing rust control costs, and the future potential to provide high yielding rust resistant varieties will assist plantation and blockholder sustainability.

Figure 4.4 Coffee cost of production on plantations, 1985-95



Source: CIC plantation surveys 1992, 1994 and 1995

The sustainability of the small holder sector is less threatened, since it has few cash costs, estimated by Overfield (1994) at around K130 per tonne of green bean equivalent. While PNG smallholders are sensitive to coffee price, and for example will often not pick coffee unless they can earn about K5 per person-day, coffee is the major source of cash to the majority of villagers in the highland provinces. Production is likely to be sustainable at prices down to K2 per kg or less.

Most at risk in relation to sustainability is the micro-propagation laboratory. It is currently deteriorating. While it could be brought back to peak operating condition for little expense (perhaps of the order of $30,000 in repairs to equipment and structures), deterioration will accelerate if remedial action is not taken. Further review of management and operating options is required as a matter of urgency. Ideally the research advisory committee and the CIC board should make a decision on the future of the laboratory before the end of 1997.

Lessons Learned and Key Issues

Conclusion

Overall, the project is considered to have been partly successful. Useful research into coffee rust and spray technology was undertaken and the results were passed to coffee producers. The spraying regimes recommended from field research were largely adopted by the plantation sector, with consequent cost savings and environmental benefits. However, the micro-propagation laboratory

built under the project was found to be unnecessary in relation to coffee rust control and did not prove sustainable after the end of the project in November 1992. If an appropriate institutional arrangement can be developed and funding found to retain staff and operate the facility, it may have an economic future in producing planting material for the horticultural sector. This would be highly desirable, as it would provide a potentially valuable insurance against the day when coffee berry disease reaches PNG. This disease has the potential to pose a far more serious threat to the industry than leaf rust, which in the event has not been a significant problem under PNG conditions.

Overall, the project has made a useful contribution to the development of capacity and capability in CRI. Unfortunately, this is now threatened by management problems and the financial constraints facing CIC. The evaluation team considers that the long-term prosperity of the coffee industry in PNG is critically dependent on a sound and responsive research program. All necessary steps should therefore be taken to ensure the survival of CRI and to promote mechanisms for delivering its research findings to the coffee industry.

Key Issues and Lessons Learned

The Coffee Research Institute Project was designed at much the same time as the Cocoa Quality Improvement Project discussed in Chapter 3. Perhaps not surprisingly, it suffered from many of the same design and implementation issues. Key 'problems' include (i) a poorly developed set of objectives and logical framework; (ii) lack of a baseline survey or defined benefit monitoring and evaluation systems; (iii) non-recording of local inputs or costs; (iv) non-preparation of training course reports or evaluations; and (v) absence of detailed institutional analysis. All of these factors are evident, often to a greater degree than in CQIP and many of the conclusions and lessons that can be drawn are identical to those highlighted in the previous chapter. The following sections consequently concentrate on issues that are especially relevant to the CRI project.

a. Institutional

The project was designed as an 'emergency response' to a perceived threat to the coffee industry. As such it did not include institutional strengthening objectives, even though the project design identified

institutional weakness as an issue. As originally designed, the project budget was relatively small ($1.4 million). Over time, the project budget grew to almost $4.0 million and developed a major asset in the micro-propagation laboratory and associated buildings. Despite the need for sustainability, institutional support and recurrent cost financing, no attempt appears to have been made to institutionalise the new project component. The investments came late in the project period, contributing to the lack of institutionalisation.

*Projects should not be substantially expanded or modified in their basic objectives or structure during implementation without detailed analysis of the result*ting institutional and recurrent cost implications.

A wider issue is whether a relatively narrow research project should have been funded as a development assistance project at all. In practice, the coffee rust program would have been well-suited to ACIAR (Australian Centre for International Agricultural Research) funding for example. At the least, this would have reduced the likelihood of the project 'growing' and acquiring development assistance objectives which could not be supported.

b. Economic Assessment

As in the case of Cocoa Quality Improvement Project, no economic analysis was undertaken during project design and implementation. No attempt was made to measure project impact, although the capacity existed to do so within CDA, for example through the smallholder sample surveys and the plantation/blockholder surveys.

Research projects (in common with other economic sector projects) should be required to include estimates of economic impact and to collect data that allow impact to be assessed. This is becoming mandatory in many rural research and development corporations in Australia.

This evaluation has been undertaken almost five years after project completion. Earlier evaluation may have allowed some of the sustainability and extension message marketing problems now facing the Institute to be identified and perhaps corrected. It may also have been useful to include the CDA project within the cluster evaluation, since the two projects were linked so closely.

Ex-post evaluation of projects should ideally be conducted one to two years after completion when it retains some capacity to improve impact and sustainability.

c. Flexibility

Australia responded rapidly to what was perceived by Australian and international experts as being a potentially major threat to coffee – a key aspect of the social and economic fabric of the country. The response by AusAID is considered to have been appropriate. Once the initial research had been completed and the relatively limited economic impact of rust had been identified, the project broadened the research program to include a six-month study on control of cicadas in coffee plantations. As well, studies were conducted on the potential impact of coffee berry disease in the PNG highlands and on coffee borer.

Research projects should be designed with substantial flexibility, so that (i) early results can lead, if necessary, to a change in direction; and (ii) new ideas and knowledge can be followed through. In general, components with major institutional implications should not be added late in the life of a project.

d. Extension

Research results need to be extended effectively to the industry. For the Coffee Research Institute, this involved CDA and later the Extension Services Division of CIC. Although the CDA Project has not been evaluated in detail, some data have been collected on the extension program, which suggest that its philosophy may not have been fully appropriate for smallholder agriculture in PNG. A number of issues are listed tentatively below since they lead to useful lessons for project design and because they have implications for the adoption of research findings from CRI.

- PNG smallholders may demonstrate limited demand for technology, once initial changes to the farming system have become established (in this case, introduction of coffee into smallholdings);
- Project interventions need to take a broad view of farming systems and particularly to understand the value smallholders place on time, leisure and risk;
- The various levels of farming have different extension needs – in the case of coffee, varying between the plantation, block and smallholder systems. CDA had limited capacity to extend research results to commercial-scale growers;

- It may be difficult to establish a new system in a PNG institution. Under-estimation of the complexities of establishing training-and-visit extension under CDA led to the Australian advisers acting largely in 'doing' rather than 'advising' roles, reducing their capacity to assess policy and institutional requirements and ensure sustainability; and
- The problems associated with establishing a major bureaucracy (with a staff of over 500 in the case of CDA) to perform extension functions. The current financial crisis facing the CIC will inevitably lead to major cutbacks in the extension service and a change in delivery mode.

Projects should be preceded by (or in exceptional circumstances undertake) both detailed socio-cultural analysis of the intended beneficiaries and institutional analysis of organisations which are interposed between the project and the its beneficiaries.

Particularly in a country with as many socio-cultural complexities as PNG, baseline surveys of the sectors being assisted are highly desirable, both to contribute to project design, and to allow assessment to be made of project impact.

e. Ongoing Operation

The financial problems of CIC will also impact on CRI. There will inevitably be temptation for the budget of CRI to be cut radically in parallel with extension. While the extension service has a number of options for message delivery, for example radio, videos and field-days, which can be inexpensive, there are few alternatives to research.

Particularly for export crops, which have to compete on world markets with efficient and often low-cost producers, research is fundamental to long-term prosperity. It is consequently suggested that any cuts to the CRI budget are made with due caution and do not jeopardise the overall effectiveness of the institution to undertake research. At the same time CRI may be able to develop other funding modes through, for example, commercialising the micro-propagation laboratory and possibly undertaking contract research for plantations. If adequate funding cannot be provided under the CIC umbrella, the issue is thought to be sufficiently critical that consideration could be given by government to a specific research levy, which could be partially additional to the present K0.04/kg

export levy. This was discussed with a number of blockholders, and all supported in principle the concept of additional industry-funded and directed research.

Research is the foundation for long-term survival of export-oriented agricultural industries. Research often takes a number of years to complete and budgets need to be secure if research investment is not to be wasted.

Consideration could be given to expanding research programs in PNG's export industries through direct levies on the value of exports in the coffee industry and possibly other export-oriented sectors.

The Australian model of research funding and direction could have considerable merit in PNG and other developing countries. Most research is funded and directed by industry and coordinated by research and development corporations. This removes research and development from wider industry political and financial pressures and usually improves both research effectiveness and accountability.

f. Links Between Research Institutes

The project undertook useful work on sprayer testing and design. CCRI and perhaps other research institutions also have substantial interest in backpack sprayers. However, little if any transfer of information appears to occur between institutions.

Formal mechanisms should be developed for technology transfer between sectors. This may represent a useful function for the National Agricultural Research Institute.

Coffee and cocoa production follow similar processing paths, involving fermentation and drying. Coffee processing by smallholders is less sophisticated than for cocoa, with less need for precise fermentation temperatures. Smallholder and some plantation coffee beans are sun-dried, resulting in substantial work during wet periods to prevent rain damage. Consideration could be given to assessing and modifying as necessary the fermentation and solar drying technology developed under CQIP for application in smallholder coffee production. This could represent a useful research and development project for CRI.

PNG Resource Information System Project (Phases II & III)

Project Description

The original Papua New Guinea Resource Information System project (PNGRIS I) commenced in 1982. It ran for four years and was intended to integrate and standardise existing information on the natural resources, current land use and population distribution in PNG. It was designed as a resource assessment and management planning tool for the Department of Agriculture and Livestock (DAL). PNGRIS I was a personal computer-based system and was also published as a seven-volume report. It was one of the first national level resource information systems in the world.

AusAID funded a training course in the use of the system in 1987. Partly as a result of the course, PNGRIS became more widely known and adopted. This ultimately resulted in a request for assistance from Australia to develop the system and expand it to other agencies.

PNGRIS I brought together data collected under CSIRO and DAL programs over 40 years. The total cost of data collection PNGRIS (including forestry) to the start of Phase II has been estimated by the project director at $70 million in 1992 dollar terms (PNGRIS PID summary and p14). The cost of PNGRIS I itself was approximately $2 million, funded half by World Bank and half by CSIRO.

Rationale

The PNG government places high priority on village-based food and cash crop development. This has been seen as the most direct means of bringing economic development to the dispersed 85 per cent of the population who live in rural areas as well as contributing to export

income and urban food supply. At the time of project design, there was evidence from agricultural surveys that increasing cropping intensity was threatening long-term sustainability in some areas. At the same time, many areas of high potential productivity were unused or under-used.

PNG is a complex country in terms of topography and natural resources such as forest, water and agricultural land. By 1980, considerable information was available on these resources as a result of a number of programs and surveys, but the information was not integrated or easily accessible to potential users. Planners and policy makers in the Department of Primary Industry (now Department of Agriculture and Livestock) found that the lack of easy access to information was limiting their capacity to plan for rational development.

PNGRIS I made a useful contribution to establishing a natural resource information system. However, by 1987, substantial changes had occurred, more data had become available and computer systems had evolved. There was therefore a perceived need to update PNGRIS, develop computerised mapping and to make it more widely available to government and private organisations.

Formulation

A formal request for assistance in the maintenance and development of PNGRIS was made by DAL in 1987/88 and was confirmed in a request by the government to AusAID in 1988/89. A design document was prepared for the project by staff of CSIRO Division of Tropical Crops and Pastures and submitted to AusAID in March 1991.

There was substantial overlap between PNGRIS II/III and the Forestry Rapid Resource Appraisal Project (FRRAP) under the (then) Department of Forests. Their time frames and reporting requirements were identical. The main reasons for separating them was that they had different primary implementing agencies and it was considered desirable for a clear commitment to be made to implementation of the Tropical Forest Action Plan (TFAP). While the benefits of separating the projects were seen at the time as outweighing the costs, in practice a simpler and more easily managed project may have resulted from their combination under one 'umbrella' project. The requirement for both projects to contribute

to TFAP led to a need for rapid project preparation. The design consequently provided for a "substantial project inception stage to precede project implementation".

The inception stage (referred to as PNGRIS II) commenced in March 1992. Three workshops were held in Brisbane and Port Moresby during this phase in order to define the mapping and development strategy for PNGRIS and FRRAP. The workshops were attended by representatives of DAL, Department of Forests, Department of Environment and Conservation (DEC), National Mapping Bureau and other parties involved with natural resource planning and education. Workshop reports were not prepared, making it difficult to assess their contribution to the design process. They are likely to have promoted a sense of ownership of PNGRIS although many participants lacked sufficient familiarity with resource information systems to make a major contribution to the discussions.

The project implementation document was submitted in December 1992. Following review by AusAID and the PNG government, a revised PID was submitted in February 1993. PNGRIS III commenced in June 1993.

Objectives and Scope

As described in the PCR (page 9), the goals of the project were to "(i) upgrade Department of Agriculture and Livestock capacity in survey analysis and planning through further development and training in PNGRIS; and (ii) to assist in the development of inter-agency collaboration in integrated land use planning". However, since the project included system development and training, the first 'goal' in practice is effectively an output of the project while the second is an activity. Rephrased and extended these 'goals' can be considered as the purpose level objective of the project, which for this evaluation is taken to be:

Improved efficiency and effectiveness in PNG government agencies in the integrated planning and management of natural resource development.

The objectives of the project are only specified to the output level in project documents (although they are referred to in the project logframe as 'purposes'). The main components and component activities as specified in the project logframe are:

PNGRIS II

1. Inception – review PNGRIS status, install revised version of PNGRIS, add climate and farming systems data and prepare implementation document for PNGRIS III;

PNGRIS III

2. PNGRIS upgrade – upgrade and update the existing PNGRIS for application as a landuse planning tool in the Departments of Forests, Agriculture & Livestock and Environment & Conservation;

3. Catchment planning – develop resource survey methods appropriate to catchments and project level assessment and planning at scales of 1:50,000 and 1:100,000;

4. Land suitability assessment – develop an upgraded system to use PNGRIS for assessment of land suitability for food and cash crops and prepare an initial assessment of resource use sustainability;

5. Provincial planning – develop a comprehensive natural resource and landuse planning system at provincial level;

6. Training and publication – provide training in the field and at post-graduate level in the use of PNGRIS, computer systems and land evaluation and plan publication of major books on PNG resource use; and

7. Institutional collaboration – assist in the development of inter-agency cooperation in the use, maintenance and development of PNGRIS in landuse planning.

Project Cost

The budgeted cost based on the project implementation document was $3.9 million (Appendix D Table D-1). According to the PCR, actual project cost was $2.8 million or some $1.06 million under budget. No estimate was made in the PID or PCR of local or recurrent costs. An estimate of local costs was included in the project design document (totalling $307,000 for components 2, 3 and 4) though no detail is provided. Overall, the project is considered to have been cost-effective and efficient in its use of resources.

Completion

The project was completed on schedule in June 1995. A Project Completion Report (PCR) prepared by the managing contractor discussed the design, scope, implementation and operational aspects of the project and provides limited project information.

Implementation Performance

Identification and Design

Overall, the design of the project was sound. However, the design document lacks detail, for example summaries of staff inputs, which can only be derived by adding the component totals from the project input schedules (Appendix D, Table D-1). The project logframe is also poorly developed and of limited assistance in identifying project objectives, linkages, risks and performance indicators.

The design and technology adopted were well thought through and appropriate. Implementation proceeded essentially according to design, but retained adequate flexibility. The addition of Unitech in Lae as a major site late in the project life, and installation in several other government agencies is evidence of this, and will make a major contribution to the sustainability and development of PNGRIS as a planning tool.

System Development and Commissioning

The project met its targets and all components were completed in a timely manner. No substantial problems were experienced during installation of the updated PNGRIS in any of the three primary beneficiary organisations.

Organisation and Management

a. Installation Sites

In addition to DAL, the project implementing agency, PNGRIS was installed within DEC and the National Forest Service (NFS) of the PNG Forest Authority. It was also installed in the Melanesian Land Studies Centre in the Department of Surveying and Land Studies at the PNG University of Technology (Unitech) in Lae. The Centre was responsible for supporting the official PNGRIS sites under the

Australian Contribution to the Land Mobilisation Project (ACLMP). The structure of the four organisations as they relate to PNGRIS is in Appendix D, Table D-2.

b. Project Management

A full-time project coordinator was appointed under the project and remained with the project for the first 21 months. A new coordinator was appointed for the last five months to June 1995. The (expatriate) coordinators are considered to have made a substantial contribution to the success of the project. Total inputs by local staff were estimated at 107 person months in appendixes to the PID. No record exists of actual staff inputs. The coordinators were also responsible for FRRAP, though the majority of their time was spent on PNGRIS.

Of the total planned consulting inputs of 201 person months, 132 were to be provided in Australia (Appendix D Table D-3). Data on actual inputs are not available. The high proportion of time spent in the consultants' home offices was largely dictated by the need for repeated short-term inputs and interaction between many of the individuals involved. This would have been difficult to achieve had the services been provided in PNG. While the approach was both necessary and cost-effective, it did reduce the degree to which PNG staff felt involved with and understood the program and development process. The project coordinator advised the evaluation team that it was intended to award masters degree scholarships to two staff, who would work closely with the project team and undertake research in PNGRIS-related areas. However, this is not mentioned in the project documentation and in the event, neither candidate took up the scholarship.

Impact Assessment

Operational Performance

a. PNGRIS Upgrade

The first component was to upgrade the then 10-year-old PNGRIS to take advantage of increased computing power. A computer mapping system was developed using Mapinfo; further population data were added; the upgraded PNGRIS was installed in several institutions; and staff from DAL, NFS and DEC were trained in the use of the upgraded PNGRIS. These tasks were completed successfully. PNGRIS is now installed in 17 institutions, all in the public sector (Table 5-1). Most are in Port Moresby, but it is also installed in institutions in Goroka, Keravat, Lae and Madang.

Table 5.1 Institutions where PNGRIS is installed

Department/Section	Institution	Location
Bureau of Statistics	Department of Planning and Implementation	Port Moresby
Bureau of Water Resources	Department of Environment and Conservation	Port Moresby
Environment, Nature Conservation and Field Surveying Divisions	Department of Environment and Conservation	Port Moresby
Department of Surveying & Land Studies	University of Technology	Lae
Environment Science Program	UPNG	Port Moresby
Geography Department	UPNG	Port Moresby
Environmental Unit	Electricity Commission of PNG	Port Moresby
Planning Division	PNG Forest Authority	Port Moresby
Forest Research Institute	PNG Forest Authority	Lae
Geotechnical and Hydrological Survey	Department of Mineral Resources	Port Moresby
Land Utilisation Section	DAL	Port Moresby
Lowlands Agricultural Experiment Station	DAL	Keravat, ENB
National Mapping Bureau	Department of Lands	Port Moresby
National Research Institute		Port Moresby
Planning Division	Department of Madang Province	Madang
Policy and Planning Division	Department of Transport	Port Moresby
Technical Advisory Management Services	Coffee Industry Corporation	Goroka

It is estimated by the project director that about 150 people in PNG have received at least some training in the use of PNGRIS. Almost all trainees have been from government or semi-government institutions .Despite the extent of training, there are few regular and competent users, mainly in:

- Department of Surveying and Land Studies, University of Technology, Lae
- Land Utilisation Section, Department of Agriculture and Livestock, Port Moresby
- Planning Division, PNG Forest Authority, Port Moresby
- National Mapping Bureau, Port Moresby
- Department of Environment and Conservation, Port Moresby

All regular users are based in Port Moresby, except for those at Unitech. At the other institutions, usage ranges from occasional to nil. Not surprisingly, staff who have become regular and competent users are from the three institutions that have received the most training (DAL, NFS and DEC).

PNGRIS has been used for several purposes since the start of PNGRIS II. The most regular use is by staff of the Land Utilisation Section (LUS) of DAL who provide a service for staff in other departments, NGOs and, occasionally, private enterprise. Inquiries have included: general information on specific locations or projects, such as for a rural development project or area study; and summary information as statistics and maps on the distribution of resources, land use and population.

Department of Environment and Conservation staff have used PNGRIS to evaluate the environmental impact of proposed logging operations. They have developed maps of environmental constraints and have been mapping forest types vulnerable to depletion or elimination by resource development. At the National Forest Service, PNGRIS is used regularly in the Planning Division to extract information on climate and soil for forest planning and to help formulate the National Forestry Plan. Examples of use made of PNGRIS by the Department of Surveying and Land Studies at Unitech include: working out possible transmission routes for wildlife diseases into PNG from Irian Jaya; selection of mosquito collection sites for malaria research (in support of the Australian Army Malaria Unit project); and land use planning for the Department of Morobe. It is also used in a number of final year student projects.

Prior to the commencement of Phase II, PNGRIS was also used to set-up a sampling framework for the National Nutrition Survey and it was used to help plan the route of the Kutubu oil pipeline. Staff of the Coffee Industry Corporation used PNGRIS to map zones where army worm might threaten coffee plantings. At the National Research Institute, one staff member has been extracting information from PNGRIS for conservation and land use planning projects in Morobe Province.

PNGRIS is rarely used by the private sector and the database has not been officially installed in any company involved in resource extraction. This is unfortunate, since the system has considerable

potential for use by companies involved in activities such as road building, mining or constructing pipelines. It would also be helpful to people working with landowner communities to help them to increase the benefits resulting from resource development.

a. 1:250,000 Provincial Mapping Applications of PNGRIS

The second component was to investigate technical aspects of producing a 1:250,000-scale application of PNGRIS with a map system. This was undertaken in Madang province with the development of MADRIS (Madang Resource Information System) which combined information on natural resources, forest, land use and population. Another closely related component was to develop methods for resource-based land use planning at provincial level and test its application using MADRIS. The component included a workshop attended by some 30 staff.

The project team concluded that it is technically feasible to produce an expanded 1:250,000-scale application of PNGRIS, where data is recorded at a scale of 1:500,000. No increase in computer power is required to handle the increased volume and complexity of the expanded system. However, at the national level, upgraded hardware and software would be needed to handle data for all provinces (Keig 1995). It was concluded that the existing PNGRIS can meet most needs for overall provincial planning and that available funding would be of greater benefit if applied to develop project level applications at say, 1:50,000. However, the lack of topographic and resource data available may limit most provincial systems to 1:100,000 scale.

The evaluation team agrees with this conclusion. There is little to be gained from mapping the existing PNGRIS at double the scale. Even in Madang where the provincial mapping is at the larger scale, PNGRIS/MADRIS are not being used for planning by provincial staff. However, following devolution of planning responsibility to the provinces, the application of MADRIS type systems will become more common. The increasing interest of the Morobe provincial government in GIS for planning is indicative of this trend.

b. Catchment Planning

This component developed resource survey methods appropriate to catchment and project level assessment scales of 1:50,000 and 1:100,000. The Upper Ramu catchment was selected as the pilot

area, centring on the Yonki reservoir which holds water for the Ramu hydro-electric power station. The information system developed under this component was used to assess current and potential land use in the catchment. Substantial formal and on-the-job training was undertaken and six staff received formal training in New Zealand.

The component was conducted competently by the project team and high quality printed material was produced. It demonstrated that it is feasible conduct surveys at the catchment or project level using PNGRIS as the starting point, though such undertakings are costly. The Yonki catchment study was the most expensive project component, with a budgeted cost of $720,000. Actual cost is not known.

This component has given Land Use Section limited capability to conduct resource surveys at the catchment or project level. The conclusion in the PCR (p4) that further surveys at catchment or project level form one of the next logical developments for resource planning in PNG is endorsed. However, the project did not provide the capability to conduct such work satisfactorily in PNG.

c. Land Suitability Assessment

An application of PNGRIS was developed to assess the suitability of land for a range of crops using the FAO Automated Land Evaluation System (ALES). Crop requirements were taken from a CSIRO study titled PLANTGRO which was developed during the earlier version PNGRIS. This application was developed using Arabica coffee as the test crop.

One staff member of Land Use Section is using this software to assess the suitability of land for particular crops. Requests for this analysis have been made by at least seven provinces and four other institutions. Section staff provided information to the Commonwealth Development Corporation on sites for potential oil palm plantations. Section staff also use PNGRIS to extract preliminary information on a location, prior to more detailed field or desk studies. A recent example was the extraction of information on Madang province prior to more detailed soils mapping.

The capacity of the system is being extended by adding further crops in response to requests for information, particularly for introduced vegetables. The component is making a useful contribution to agricultural planning in PNG.

The second part of this component was the initial assessment of suitable natural resources use. During a workshop involving staff from DAL and DEC, each resource management unit in PNGRIS was anal ysed to indicate specific physical constraints to development. Some DEC staff have used this data to generate maps of environmental constraints. The data have been used as input to the Forest Inventory Mapping project to define areas unsuited to logging. Other implications for planning are not known.

d. PNGRIS Extension

At the conclusion of PNGRIS II/III in 1995, the PNGRIS Users Group identified the need among users for additional support to ensure sustainability. A 12 month extension was approved and this became a component of ACLMP. The extension covered: (i) on-call technical assistance for PNGRIS users; (ii) technical support/system maintenance; and (iii) training. The cost of the extension was $184,000, of which $115,000 related to personnel costs and $43,000 to training.

The support centre, established at Unitech, also brought together the PNGRIS technical working group which investigated ways of increasing exposure to PNGRIS and linkages to other systems including FIMS and ALES. The group formulated a set of recommendations for consideration by the PNGRIS policy user group, including a series of workshops, though a source of funding has not yet been identified.

This PNGRIS extension contributed to the continuing use of the database in PNG, particularly through the visits to installations of a technical adviser from Unitech. PNGRIS users made only limited use of the on-call technical assistance. This component of the ACLMP has now been completed.

Institutional Development

Prior to PNGRIS III, access to the PNGRIS database was restricted to Land Use Section of DAL. Following the project, many more people in PNG institutions now have access to PNGRIS, with some

becoming expert users. The project has contributed to a significant increase in resource planning capability within PNG. Substantial training has been conducted. The persistence of the project team in making PNGRIS more widely known and used was commendable.

The project has also made a useful contribution to inter-agency coordination and collaboration. Links between and often within PNG institutions are weak. The PNGRIS user's group has contributed to enhanced coordination, although the group has not functioned for some time. Training workshops attended by staff from different government institutions involved in resource assessment and use has also been instrumental in facilitating professional contact between staff, often for the first time.

Despite the training conducted under and prior to the project, incorporation of PNGRIS into planning and resource management in PNG remains fragile. Even in institutions where it is used regularly, continuity of use of PNGRIS is dependent on one or two expert staff.

The inclusion of PNGRIS in a number of university courses will extend the number of people with general familiarity with the program. Further courses are expected to include it in their curricula over the next one or two years. This should assist sustainability, through promoting demand for PNGRIS outputs. In terms of the long-run sustainability of the overall information system, a program for improving and developing PNGRIS is considered essential if it is remain relevant as a planning tool into the 21st century.

Financial and Economic Impact

The project design document provides little assistance in identifying the intended economic impacts of the project. It reports that benefits essentially relate to "improving land use planning for both agricultural development and conservation. The project aims to make the [$70 million] already invested in PNGRIS plus census and other relevant data available to government, planners and educators in an easily accessible form. This has been largely accomplished at the national level. The project aims to transfer the PNGRIS technology to provincial and catchment planning levels."

The accessibility of the data contained in PNGRIS should have two main benefits for planners: reducing the time needed to access a particular item of information; and increasing the likelihood that the

information will be found and used in planning. For either of these benefits to be achieved requires that persons able to benefit from access to the data are both aware that PNGRIS exists and are able to gain access to it efficiently. Further 'marketing' of PNGRIS would be helpful for this objective to be achieved.

In terms of long-term economic impact, PNGRIS has the potential to make a significant contribution. The PNG economy will remain largely dependent on the exploitation of the country's natural resources. Subsistence food, cash crop, timber, minerals and oil production will be major determinants of national wealth for much of the 21st century. The ability to plan the development of these resources and manage them effectively will be important in maximising the benefits to be derived, particularly from the renewable resources. PNGRIS provides planners with a unique tool and has the potential to generate high economic benefits. Achieving this goal will demand that PNGRIS is not considered as the end of the technology road, but as a stepping stone to a full GIS, which will integrate many of the parameters required by planners at national, provincial and local levels.

Environmental Impact

PNGRIS is now a valuable tool that has potential to be used to contribute to reducing the environmental impact of resource extraction, for conservation assessment and planning. The database contains much information on PNG's natural resources and on the populations using them. It also contains information on forest types and disturbance levels, the presence of nature conservation areas, areas affected by volcanic activity and soil related data relevant to resource use sustainability.

PNGRIS has been used to some degree for applications that have the potential to reduce environmental degradation. These uses include the formulation of the PNG conservation needs assessment and identification of areas vulnerable to environmental degradation. Provided that provincial planners make use of the available information, the net benefits of the project from an environmental perspective should be highly positive.

Social and Gender Impact

PNGRIS II/III did not have a positive or negative gender impact. A number of the most competent users are females, although only 2 of the 35 persons trained under PNGRIS II/III were women. Field-work in parts of PNG involves a degree of security risk. The risk is greatest for women and an office-based tool such as PNGRIS lends itself to use by professional female staff.

All students in the Department of Surveying and Land Studies undertake at least an introductory course in PNGRIS. Some 30 per cent of the students are female. Under ACLMP, four women were trained under the PNGRIS support component out of a total of 15 trainees.

Sustainability

The sustained use of PNGRIS remains dependent on a small number of skilled users. This is continually under threat because of staff transfers and promotions.

Teaching of geographic information systems in university courses offers the best hope for long-term use and development of PNGRIS. PNGRIS is taught in all three academic programs in the Department of Surveying and Land Studies at Unitech. Following revision of the Forestry program, (under the AusAID Forestry Human Resource Development project) GIS will be taught to Forestry students next year and more fully in 1999. PNGRIS and FIM will be the principal tools used. The curriculum in Agriculture has not been formally amended to include GIS, but PNGRIS is currently introduced to soils students in final year and to three or four post-graduate students each year. Some final year and post-graduate students use PNGRIS data for their projects with assistance from staff from the Department of Surveying and Land Studies. The courses developed for Forestry are likely to be suitable for inclusion in the Agriculture course when the syllabus is next revised, probably making use of the GIS laboratory of the Department of Surveying and Land Studies.

Ultimately PNGRIS's sustainability will depend on the demand for its outputs. Although PNGRIS has been used quite widely, in the long term it will need to develop further if interest in the system is to be sustained. In particular, it will need to be given full GIS capability and to develop increased capacity to contribute to local area planning. This does not represent a criticism of PNGRIS, but rather serves to

highlight the requirement that highly technical systems of this nature need to evolve in parallel with their underlying technology. In addition, it is desirable that demand for the system's outputs is actively promoted.

Lessons Learned and Key Issues

Conclusion

The project succeeded in meeting most of its objectives. PNGRIS is now installed in 17 public sector organisations compared to one prior to the project. A large number of people have received at least some training in its use. Despite this, it is used regularly by only a limited number of people in three institutions in Port Moresby and one in Lae and its sustainability is not guaranteed within government departments or semi-government organisations. It has been used for a wide range of applications, well beyond those for which it was originally conceived, but still only a fraction of its potential.

It has taken more than 10 years for PNGRIS to achieve the degree of use within PNG that it now has. The inclusion of PNGRIS and GIS in undergraduate courses at Unitech and UPNG offers the best chance for the system to be fully used for planning, research, conservation and resource exploitation.

Key Issues and Lessons Learned

a. Ownership

A high proportion of project activities took place in Australia. While the actual allocation of adviser inputs was not recorded, two thirds of budgeted person-month inputs were in Australia. This approach was cost-effective and necessary due to the nature of the project, but it resulted to some degree in a lack of local ownership of the project and also in a lack of familiarity with PNGRIS's structure and systems. This has resulted in limited capacity to maintain, update and modify PNGRIS in-country. Project management selected two masters degree candidates to study in Brisbane in a relevant discipline and undertake research using or developing PNGRIS with the project team. This did not eventuate because of the non-availability of the two selected candidates.

Even for highly technical projects, mechanisms to promote local involvement and ownership should be assessed.

b. Design and AusAID Systems

An issue relating to AusAID's overall project management system is the poor specification of objectives in project documents. While the project designers presumably had a clear idea of why the project was to be undertaken, this was not documented. Consequently no time bound and specific objectives were defined, making evaluation against original objectives impossible.

Current country program operation guidelines (CPOG) for PCRs are inadequate and are resulting in documents which are of limited use for post-evaluation. In particular, their level of analysis is limited, as typified by the discussion of efficiency in the PNGRIS PCR (p19). Since a major aim of the PCR is to assess efficiency, further information is desirable. Improved data and higher order analysis in PCRs should be useful for AusAID, implementing agencies, managing contractors and evaluators.

Managing agents should record and report project (and local) costs in a form suitable for assessment of efficiency and cost-effectiveness. At the least, costs should be summarised in the PCR by year, component and class.

PNGRIS documentation does not include any attempt at economic analysis of the project. No reports were prepared on project workshops or training courses, making evaluation difficult and limiting the information available to subsequent course designers.

c. Impact Maximisation

A major benefit of PNGRIS has been the identification of information on natural resources, its classification and greater accessibility. In the absence of all phases of the project, much data would either have been lost or would now be inaccessible.

Since PNGRIS built on an immense body of prior work, its cost-effectiveness compared to developing a GIS from scratch is likely to have been high. Comparison may be made with a recent attempt to develop a GIS for Sumatra under a multilateral agency funded project. Despite the expenditure of some $40 million, the resulting GIS is reported to be virtually unusable.

Projects in information systems which build on prior knowledge and systems often have greater prospects for successful development than those which involve primary data collection as well as graphical presentation.

GIS technology is changing rapidly. The three stages of PNGRIS have followed the evolution of data processing technology along a reasonable development path. However, the development of computer hardware and software systems, as well as computing skills in PNG during the 1990s, suggest that further development of PNGRIS, perhaps into a fully fledged GIS, is now feasible. Such a development may in fact be necessary if the potential benefits of PNGRIS as a planning tool are to be maximised. The long-term framework for PNGRIS development is not clear, or at least has not been documented. This leads directly to a number of general lessons:

Project designs for projects involving information technology and systems should include a long-term plan for system development. Project activities would contribute to the early phases of the plan.

Long-term plans for information systems development need to be dynamic. They require periodic updating as new technology emerges or becomes affordable, competing systems are developed or the market for the system's output changes.

Numerous natural resource information systems have been established in PNG over recent years. Taking a broad definition of GIS, to include data presentation systems such as PNGRIS and FIM, these also include Land Evaluation Systems (PNGLES – DAL), Land Geographic Information System (LAGIS or PNGLIS – Department of Lands); and Mapping Agricultural Systems Project (MASP – DAL), West New Britain GIS (prepared under the AusAID-funded Kandrian Gloucester integrated rural development project) and BIORAP (Centre for Resource and Environmental Science at ANU).

It is suggested that a review of GISs at present operating or being developed in PNG should be undertaken as a matter of urgency. Such a review would focus particularly on ways in which data can be shared between the different systems, and possibly on recommendations for setting a standard base for all PNG GISs – for example the projection used for the 1:100,000 map series. The review could include a long-term plan for PNGRIS/FIM development.

d. PNGRIS Management

PNGRIS is now a complex system. It is located in about 20 sites with further sites planned or anticipated. As different users develop PNGRIS applications, some mechanism is required: (i) to ensure

adequate quality control; (ii) to advise other users of the availability of, for example, an additional overlay or an improved data set; and (iii) to coordinate management and development. Examples of overlays which would be of use to a wide range of users are the digitised catchment boundary data developed by DEC and the physical infrastructure data being developed by National Mapping Bureau.

The Melanesian Land Studies Centre in the Department of Surveying and Land Studies at Unitech in Lae probably has the greatest capacity in relation to system maintenance. This Centre, in association with the Department of Maths and Computing, also has substantial capability in system development. In the near future, Unitech, or possibly National Mapping Bureau or Department of National Planning, may need to be designated as the 'development and maintenance' centre of PNGRIS. This would require the agreement of the PNGRIS policy users' group.

Development of PNGRIS to date has been largely under Australian and World Bank projects. Local agencies are currently using and maintaining PNGRIS mainly under local budget. However, major future development would not be feasible under current management systems without external assistance. Ways thus need to be found to make PNGRIS self-sustaining. In part, this may be achieved through establishing a scale of fees for interpretation of data and production of output. It is important that fees are used for management and development and do not disappear into general revenue. The setting of fees may limit the use and application of the data and care needs to be taken that fees are not set at a level which unduly constrains usage.

A record of databases (a metadatabase) in PNG needs to be maintained by one organisation, with the most likely location being the Department of National Planning and Implementation as this Department has been given a coordinating role for the planning and implementation of government programs.

Information systems projects need to focus on their market and market development. Ways for the system to be managed, maintained and developed after the end of the project intervention need to be built-in to project design.

In 1996, a paper was presented at Unitech explaining the need for a national steering committee on geographic data. The rationale expressed applies directly to PNGRIS especially with respect to the need for metadatabases and a strategic plan for distribution, pricing and custodianship of the geographic data (including resource information). The GIS user group has looked at development of metadatabases, but the group has no official sanction or policy role.

e. Data Sharing

In PNG as in most countries, knowledge is power. There is thus a feeling among some PNGRIS users that the expansion of PNGRIS to new users should be carefully controlled. For example, the PNGRIS user group has recommended against PNGRIS being provided to consultants on the reported grounds that "consultants will sell the data back to the government or to other clients", though quite why this is seen as undesirable is not reported. The appraisal of the implementation document noted that "the greatest failing of the previous PNGRIS was its restriction to Land Use Section of DAL on the spurious grounds that it would be misused or used to commercial advantage" (ACPAC 1993).

PNGRIS data has been collected over many years, funded almost entirely by the PNG and Australian governments. The data should therefore be considered essentially as a public good and its distribution to those in a position to use it effectively should not (in the opinion of the evaluation team) be limited. If individuals or organisations can 'add value' to the basic PNGRIS system, for example through the skill of their operators or their access to data over which they have some degree of control, there should be no objection to their selling it. It is consequently suggested that the PNGRIS user group gives consideration to removing its 'ban' on consultant access to PNGRIS on the grounds that it is unnecessarily restricting the use and development of the program.

A decade after it was made available within PNG, no agricultural research institution within PNG is an 'official' PNGRIS site and it has been installed at only one location (Lowland Agriculture Experiment Station at Keravat) as part of a related project. Effort should be made (possibly under ACLMP) to ensure that all agricultural research institutions have access to and a degree of support for PNGRIS, as the system is a valuable planning and research tool for agricultural researchers.

Little use is made of PNGRIS by companies involved in infrastructure development and resource extraction. Several companies contacted by the evaluation team expressed an interest in using PNGRIS, for example to plan road routes or identify locations with high land intensity within their project areas. Chevron Oil has applied for membership of the PNGRIS user group and has sent one staff member on a familiarisation study in DAL. All mechanisms should be explored to maximise the distribution and use of PNGRIS by all sectors in PNG, including agricultural research institutions and the private sector.

Information systems projects in the public sector need to incorporate ways in which private sector organisations can gain access to the data.

If institutions or individuals are able to add value to a publicly-funded information system or database, they should be encouraged to charge for their services or the data provided and to use part of the revenue for system development or the collection of improved data.

PNGRIS has the potential to assist provincial governments in their planning. Consideration could be given to distributing PNGRIS to all or selected provincial planning divisions. The Department of Planning and Investment would be the logical coordinating unit for such a development. It would need to be supported by training courses and workshops.

f. Training in PNGRIS

Training in the use of PNGRIS has taken place over 10 years, with funding from a number of sources. This level of input has been necessary to make the system reasonably secure from an institutional perspective. The best chance for long-term sustainability and development is for PNGRIS to be covered in undergraduate courses at Unitech and UPNG. It is suggested that Unitech and UPNG should develop courses to increase the extent of undergraduate teaching on PNGRIS and other geographical information systems, particularly in the Departments of Agriculture and Forestry at Unitech and Geography and Environmental Science at UPNG.

The success of the introduction of GIS systems in resource disciplines is highly dependent on the establishment of a group of expert users, fully competent in spatial analysis and mapping. The Department of Surveying and Land Studies has started to develop

such capacity but needs additional support to raise the level of expertise and infrastructure to fully support GIS developments in PNG.

Geographic information systems represent a powerful teaching tool to promote understanding and analysis of resource management. Natural resource information systems should be included in undergraduate teaching for students in natural sciences and planning courses.

g. PNGRIS Development

As improved data are acquired, PNGRIS's potential accuracy could increase. An example is the Year 2000 PNG census under which the coordinates attached to each census point will be measured, However, under the present system, with all data related to static polygons, the addition of data of improved accuracy is difficult.

Consideration could therefore be given to converting PNGRIS to a full GIS. This should allow reproduction of the data at any scale, though with suitable provisos on the accuracy of some parts of the database. As part of the development, conversion of the data to a projection agreed by major users could be considered. The addition of a physical infrastructure overlay, including roads, urban areas and rivers, would greatly increase the utility of PNGRIS.

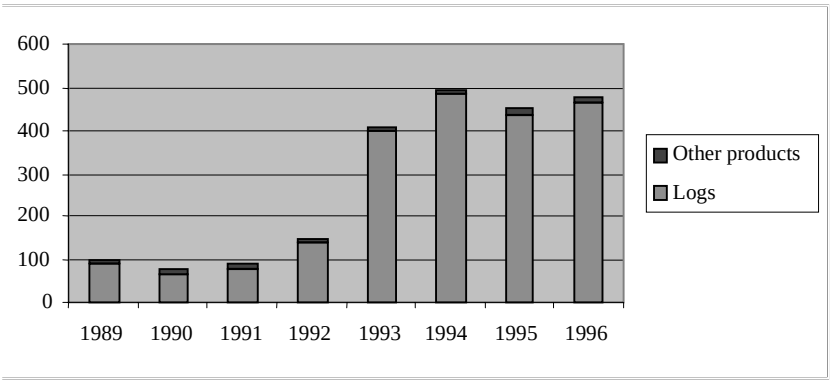
The PNGRIS system currently uses Foxpro for data storage and Mapinfo for mapping. Any review would need to assess the optimal combination of programs for data storage, analysis and mapping, taking account of the systems used by other GISs in PNG and the region. Training would be required in the new systems (eg, in the use of Arcinfo) and should be established early in any upgrading program.

Forestry Rapid Resource Appraisal Project

Project Description

Forests are one of PNG's most valuable natural resources and cover some 80 per cent of the country's land area. The logging industry expanded rapidly in the early to mid-1990s, as indicated in the increase in export values in Figure 6-1. Round logs comprise well over 90 per cent of export value with the balance including woodchips and sawn timber.

Figure 6.1 Log and other timber product exports 1989-96



Source Bank of PNG 1997

Rationale

At the time of formulation (in 1991), considerable controversy surrounded the sector, with numerous reports of corruption, illegal logging and over-exploitation of timber resources. In particular, the Barnett Inquiry into the industry, the World Bank-financed Tropical Forestry Action Plan of 1990 and the subsequent National Forestry and Conservation Action Plan had raised major issues relating to the

management of the country's forest resources. Both plans indicated the need for comprehensive information on the extent and type of the forest resource for forest management planning and assessment of sustainable yield.

Substantial data on PNG's forestry resources were available from prior surveys. The Forestry Rapid Resource Appraisal Project (FRRAP), was intended to analyse and integrate these data into a form which would support the TFAP and form an initial step in the development of a forest resources GIS. The World Bank forestry sector loan to PNG required production of a national forest plan as a prerequisite for loan approval, providing the justification for the project.

Formulation

The concept for the project was developed during the training course held after the end of PNGRIS I in 1987. Following completion of the TFAP, discussions were held between AusAID and CSIRO in relation to the possibility of extending PNGRIS and the associated map data to meet a number of TFAP project proposals. The design document notes that "the project proposal was prepared internally by CSIRO following discussions with AusAID officers. Although only limited contact has been made with Department of Forests officers during formulation, most of the activities have been examined with them on previous occasions." The overall design process followed the same path as PNGRIS discussed in the previous chapter.

Objectives and Scope

As in the case of PNGRIS II/III, there is no clear specification of higher order objectives for FRRAP. However, the implicit objective of the project can be considered to be: "improved forestry resource planning, management and use at national and provincial levels".

Project objectives are specified as activities in the implementation document. However, the main required outputs can be inferred to be:

- maps of the main forest types at national and provincial scale, the degree to which they had been disturbed, estimates of timber volume and species lists at 1:500,000 and 1:100,000 scale;

- an integrated resource information system relating forest data to topography, soil and climate, land and forest use and population distribution to assist in planning forest development and conservation strategies;
- methods to update forest resource information over time; and
- trained staff with capability in the use of the information systems for planning and forest resource assessment.

Components and component activities were as follows:

Inception Phase

1. **Interim resource assessment** – prepare an estimate of the national forest resource to provide interim working material for Department of Forests and TFAP planning. In addition to 1:1,000,000 forest resource mapping, the component was to include an initial study of DEC biodiversity database requirements. Preparation of project implementation document;

Implementation Phase

2. **Rapid resource appraisal** – link forest resource information to PNGRIS, and produce 1:500,000 scale forestry resource maps. Conduct a survey to determine forest regeneration rates (funded separately by World Bank);

PNGRIS upgrade and forestry extension – transfer the information into PNGRIS including software modification. Develop an evaluation procedure to identify the potential of specified areas for reforestation.

3. **Forest mapping at 1:100,000** – mapping of all forests and other vegetation types at 1:100,000 and recompilation of this material at 1:250,000. Mapping was to be suitable for a forest/ vegetation/land use layer in a subsequent GIS.

4. **Updating resource appraisal** – implement procedures to update the rapid resource appraisal information from existing (early 1970s) data. This would involve satellite imagery. The efficiency of light aircraft small format photography for information updating was to be investigated.

5. **Environment and conservation information** – addition to PNGRIS of information relating to conservation needs assessment. Preparation of initial catchment mapping at 1:1 million.

6. **Training, system installation and publication** – conduct training courses in Department of Forests, DEC and DAL in forest resource mapping. Publication of component outputs.

7. **Forest resource assessment design** – carry out a study of forest and natural resource data and assist in design of a sampling strategy [to improve data quality].

A subsequent component under ACLMP involved development of a Forest Inventory Mapping database (FIM). This extension was reviewed but was not evaluated in detail. Draft completion reports for both FIM and the PNGRIS extension under ACLMP were provided to the evaluation team.

Project Cost

Project costs were budgeted at $1.7 million in foreign costs and $187,000 in local costs. The PCR indicates actual project expenditure of $1.2 million but provides no further information. Budgeted costs by component are summarised in Appendix E. The Forest Inventory Mapping component of ACLMP was completed in June 1997 at a cost of $825,000.

Implementation Performance

Identification and Design

Project design was undertaken largely as a desk study but was to include discussion with PNG government agencies. It was to be completed in 15 days including visits to PNG and to Canberra. While the project was closely integrated with PNGRIS, the approach to design is not considered adequate, and this translated into two problems for the project – lack of clear specification of objectives and lack of institutional analysis, both of which tended to limit project effectiveness.

Organisation and Management

The project was implemented initially by the Department of Forests and subsequently by the National Forest Service of the PNG Forest Authority which superseded it. The Authority was formed in 1994 to take over the responsibilities of the Department of Forests. The PCR (p17) indicates that:

"Weaknesses in the project related to the operational environment in which the project was conducted. [In the early project period] the NFS was being restructured and there was no direct point of contact as the NFS planning division was embryonic and staff appointments were being finalised. It is clear that a longer period of exposure to RRA outputs by NFS staff, which would have occurred had planning staff been in place earlier in the project, would have significantly increased technical appreciation of the nature and use of RRA outputs. In the event, the uptake of these outputs in the last six months of the project was in any case quite rapid."

The management arrangements were similar for FRRAP as for PNGRIS. The project managing contractor was the CSIRO Division of Wildlife and Ecology, based in Canberra. Over the life of the project, two locally engaged project coordinators were based in Port Moresby and shared with PNGRIS.

The project was largely implemented as planned. However, component 7, Forest Resource Assessment Design, was cancelled early in the project at the request of NFS. This was intended to provide assistance in conducting a national forest inventory project and to form the basis of a detailed forest resource inventory and assessment. According to the PCR (p6), this was in part due to component 3 leading to a 'de facto' national forest resource inventory, making component 7 unnecessary.

A major fire destroyed the NFS mapping and records Section during the project. While it was possible to replace project maps and other outputs rapidly (with the agreement and assistance of AusAID), Mapping Section did not recommence full operation for an extended period.

Project Completion

The project was completed on schedule in June 1995. As in the case of PNGRIS, the PCR provides some useful information but is of limited use for assessing efficiency or for ex-post evaluation.

Impact Assessment

Operational Performance

a. Rapid resource appraisal

Available forest resource information was converted into a PNGRIS overlay by assigning forest types or a mix of types to the existing PNGRIS resource mapping units. This added a useful dimension to PNGRIS although, as in the case of other PNGRIS overlays, the spatial resolution of the data is limited. A 1:500,000 scale set of forestry resource maps was produced. These subsequently were used as the basis for the National Forest Plan of PNG prepared by the Forest Authority in May 1996. This included provincial plans with major forest types, forest production area boundaries and major potential forestry areas. A 1:1 million scale map of vegetation types was also produced in four sheets.

b. Forest mapping at 1:100,000

This was the key component of FRRAP, involving the definition of forest type and other landuse boundaries on the base of the national 1:100,000 topographic maps and the 1975 aerial photography on which the topographic maps were based. The 280 maps (essentially comprising tracings on clear film) were combined into 70 maps at 1:250,000 scale. The substantial volume of forestry resource information was prepared as hard copy and the maps were coded with the 200 forest classes identified. This component formed the foundation (as intended) for the subsequent Forest Inventory Mapping project undertaken under ACLMP. FIM is making a major contribution to forest planning in PNG as discussed below.

c. Updating resource appraisal

This component reviewed the options to provide updated GIS information in the subsequent ACLMP FIM project. This ultimately was to involve a combination of satellite image analysis and ground-truthing which was undertaken effectively under ACLMP/FIM.

Forest Inventory Mapping

The 1:500,000 scale mapping was produced as digital data for integration into PNGRIS and the 1: 100,000 mapping as hard copy stable film overlays. The number and size of the 1:100,000 maps made them cumbersome to access. In order to make the resource information data more accessible and useable, a decision was taken to digitise the 1:100,000 data under a component of the ACLMP. This produced a database and Mapinfo based mapping system known as Forest Inventory Mapping (FIM).

FIM was undertaken to provide an easily accessed forest inventory database with up-to-date information on area, forest areas and types, species distribution and, through a link to PNGRIS, on related natural resources and population data. The project was also to provide information and mapping on existing concession areas and the extent of current logging. Land use was updated to 1996 using satellite image interpretation.

Overall, the development of FIM represents the main impact of FRRAP. It is being used to update the provincial management plans initially based on FRRAP. Eight plans have been completed and NFS anticipate that the remainder will be completed when adequate provincial data become available. The plans provide a useful basis for forest management in the provinces. However, for the plans to translate into tangible benefits on the ground, they require the support and active involvement of NFS field staff. The Service is currently under strength in most areas, and it will be difficult for field officers to monitor and control logging operations in line with the plans unless further resources are allocated.

FIM is currently installed on two computers in NFS Mapping Branch and has also been installed in DEC and in Unitech, without the timber volume data. Full use of the system will require it to be networked to other terminals in NFS and made more widely available to other potential users. NFS is currently seeking support to expand the system. This may involve networking FIM to the NFS resource assessment and planning groups and to senior officers dealing with resource owners and the logging companies. NFS also considers that integration of large-scale project mapping (at 1:25,000) into the system would be desirable to assist in monitoring logging codes of practice. Conversion of FIM to a full GIS on (say) Arcinfo software is also considered desirable together with necessary training.

Institutional Development

PNGRIS was installed on three computers at the National Forest Service offices in Port Moresby. Although it has been superseded by FIM for forestry resource analysis and planning, PNGRIS continues to be used to provide information on non-forest resources. Institutional aspects relating to PNGRIS are discussed under PNG Resource Information System Project (Phase II and III).

Two NFS staff are reasonably familiar with PNGRIS/FIM and three others have some general knowledge. However, according to the FIM completion report (p5) "NFS staff do not possess the computing skills to update the system and therefore cannot add new concession areas and areas which have been logged over". This problem and the limited number of sites may be addressed in the FIM expansion project which has been submitted to AusAID for possible funding.

FRRAP itself had little direct impact on the Forest Service. Most development was undertaken in Australia and there is some disappointment in NFS that local staff were not more closely involved, for example, in the air photo interpretation aspects of the 1:100,000 mapping program. In part this was caused by the restructuring of the Department of Forests, with numerous transfers, resignations and sackings, resulting in there being few staff available to train.

Financial and Economic Impact

As essentially a turnkey project, the FRRAP had little direct financial impact on the National Forest Service. No specific budget is identified for maintenance of the system, though development and use of the FIM represents a significant proportion of the activities of mapping branch with an annual operating cost budget of K150,000 plus salaries for the 11 staff.

Forest resources constitute one of the country's major assets. As indicated in Figures 2-1 and 6-1 (pages 11 and 53), forestry is a significant export earner, currently lying third behind crude oil and gold, and generating close to K500 million annually in export revenues. Unfortunately, the level of management of the national forest resource has been poor over the last 10 years, as indicated by the Barnett Inquiry and the national forestry action plans of the early 1990s. The FRRAP resource inventory and FIM are assisting in the strategic planning and management of the country's timber

resources through for example the analysis and assessment of forest concession applications in terms of resources type, volume, sustainable cut and environmental impact. Prior to the project NFS had little information on which to base its recommendations.

At the field level, the projects will not of themselves affect the standard of resource management. However, if the improved strategic planning permitted by the projects is accompanied by: (i) a more serious effort to control logging; (ii) improved management of the forest resource in forest management areas; and (iii) promotion of sustainable development of the infrastructure associated with logging activities, the long term gains to the country will be immense.

Environmental Impact

The long-term impact of FRRAP and the successor FIM on the PNG environment are not clear. To some degree, the improved accessibility of the inventory data may speed up the logging of PNG's forests. However, the development of provincial management plans, baseline mapping and the definition of areas at environmental risk (and thus to be excluded from forest management agreements with logging companies) are all indicators of a potential net environmental gain from the project.

Other Impacts

The project has not resulted in any identifiable social and gender or occupational health and safety impacts. Few women are employed in professional positions in the NFS and none of the staff trained under the project was female. Any benefits to women from improved forest planning and management will be long-term and indirect. The main benefits in rural areas would result from the potential contribution of FRRAP/FIM to increased and sustained landowner benefits from improved forest management agreements with logging companies. Sustainable management of the national forest resource is a key plank of government policy, and has the potential to contribute greatly to national prosperity – with a resulting impact on all population groups.

Sustainability

The integration of FRRAP outputs into the forest inventory mapping program and uptake of the information into the provincial forest management plans should ensure that the project outcomes are

sustained for the foreseeable future. Staff of the Planning and Mapping branches of National Forest Service's Planning Division are making substantial use of the forest inventory maps produced under ACLMP.

Lessons Learned and Key Issues

Conclusion

The Forestry Rapid Resource Appraisal Project achieved virtually all of its output objectives and is classed as successful. Its outputs have been taken up in the main mapping tool used by the National Forest Service. New provincial forest management plans have been completed for eight provinces. NFS staff intend to complete the remaining provincial plans as soon as possible. The new plans will include improved assessment of risk categories and areas to be left unlogged. Delays in the completion of the program largely relate to a lack of willingness or capacity in some of the remaining provinces to supply the required material to the national forest service.

Whether the improved planning results in any change on the ground will depend on strengthening management and inspection at the provincial and project level. However, the project has at least provided the means to monitor production and to develop more sustainable logging practices.

Key Issues and Lessons Learned

FRRAP was designed and implemented in parallel to PNGRIS II/III. Consequently many of the issues and lessons are similar. Only those particularly or specifically applying to FRRAP are discussed in the following sections.

a. Access to Data

The RRA data are available in hard copy form. However, they are difficult to access, as are the hard copy data underlying PNGRIS. Through FIM, the data are now readily available and can be used for a number of purposes. FIM is currently available in NFS, DEC, DAL, Unitech and the Forest Research Institute in Lae, though the last of these is not using it. The evaluation team considers that wider access to the data is desirable, for example by landowners, logging companies, universities, consultants and NGOs. If this is to be achieved, mechanisms will need to be identified to promote this

access. It is recognised that a number institutions in PNG do not share this view, and would prefer the data to be closely held by NFS and a small number of other government agencies.

At present, the gross and merchantable log volume data are officially excluded from all versions of FIM outside the NFS. However, in practice some institutions do have the volume data, which have in any event been published in hard copy form. Improved resource knowledge by actors on both the extraction and conservation sides of the timber industry should allow more informed debate on conservation issues, logging areas and the protocols to be drawn up under new forest management agreements. It is suggested that NFS reviews and revises its policy on access to the log volume data. Given the nature of the data, it may be open to misinterpretation, and a suitable disclaimer would need to be developed to remove any potential liability in the event that reported volumes are incorrect.

Information systems projects need to assess the systems for and constraints to marketing and/or distributing their data. For GIS projects, consideration may be given to establishing a national steering committee on data collection and management and GIS development.

b. Data Accuracy

FIM contains information that logging companies (for example) may come to rely on. If closer investigation indicate that the data are inaccurate, financial loss may be experienced by users, potentially resulting in legal proceedings. This also applies to PNGRIS and other resource information systems in PNG but is particularly relevant to FIM. No problems have been reported in this regard for either PNGRIS or FRRAP/FIM. However, on the grounds that prevention is preferable to cure, some consideration of the issue is merited.

Where individuals and organisations may rely on data provided from an information systems project, assessment is required of data accuracy, which should be provided to all users. A suitable disclaimer could be developed and integrated into the systems.

c. Institutional Factors

According to the PCR – "the restructuring of Department of Forests into the NFS resulted in poor linkage between the project and local agencies. The key local computing expert did not commence training until half way through the project. As a consequence there were

repeated misunderstandings, and although these were resolved, they delayed the production of provincial forest plans, which only commenced towards the end of the project period." Other key staff, including the original project coordinator resigned or were transferred during the restructuring, and it was fortunate for the project that the trainees recruited late in the project were of high calibre and are likely to remain with NFS.

The institutional capacity to use FIM (and PNGRIS) in the National Forest Service and other organisations remains weak. Further training in the use of the system is required. Ways in which the system can be updated and developed in PNG should be assessed, ideally using local resources such as the revenues accruing from timber royalties.

High technology projects should attempt to establish a sustainable institutional base. In sectors such as forestry with high income-earning potential, agreement could be sought from the national government on ongoing provision of budget for system maintenance and development.

The planned incorporation of PNGRIS/FIM into the second year forestry course at Unitech in Lae is seen as a positive development.

d. Ownership and Knowledge

Partly because of the institutional factors mentioned above, the level of in-country knowledge of the systems required for FRRAP/FIM development is more limited than for PNGRIS. In particular this relates to air photo and satellite image interpretation.

Projects which require complex technical tasks to be undertaken offshore should assess the potential to include mechanisms for involving local staff in key project activities. This should ensure that understanding of the systems by local staff is maximised and, in the long term, the ability to update and develop the systems is enhanced.

References

Project Reports

	Design Document	Appraisal	Implementation Document	Mid-term review	Project completion report
1. Cocoa Quality Improvement	✓	✓	✓ 2 volumes	Extension proposal ✓	✓
2. Coffee Research Institute		✓	✓	✓Vol 2 (Vol 1 = CDA)	✓
3. PNGRIS	Draft ✓	✓ note	✓	TAG review ✓	✓
4. Forestry RRA	Draft ✓	✓ note	✓		✓

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LUS 1994 LUS program and activities for 1994, Agricultural Research Division Team Leaders' Research Review Meeting June 94, Land Use Section of DAL

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PRT 1991 *Review of Australian assistance to the Coffee Industry Corporation*: Volume 2, *Coffee Rehabilitation and Rust Control* Project: Assistance to the CRI and proposals for further assistance to the coffee industry. Final Draft November 1991, Pacific Regional Team

PRT 1994 Appraisal of the extension to the Cocoa Quality Improvement Project, Pacific Regional Team, Mosman

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Appendix A

Cocoa Quality Improvement Project Data

Table A-1 CQIP Budgeted project costs (A$'000)

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Australian inputs						
Research	355.6	109.4	148.9			613.9
Extension, Information & Training	481.3	491.2	341.9	273.5	130.2	1718.1
Management	54.5	102.1	77.2	76.6	38.5	348.9
Total Australia	891.4	702.7	568	350.1	168.7	2680.9
PNG Inputs						
Research	48.0	114.3	101.8	0.0		264.1
Extension, Information & Training	76.0	42.4	50.0	57.3	28.7	254.4
Total PNG	124.0	156.7	151.8	57.3	28.7	518.5
Total	1015.4	859.4	719.8	407.4	197.4	3199.4

Source: PID page 4-13

Table A-2 Cocoa production in PNG 1988/89 to 1994/95

(tonnes/production year Oct-Sept)

Cocoa Year	Plantations	Small-holders	Total	Per cent smallholder
1988/89	18,350	29,481	47,831	62%
1989/90	13,871	24,580	38,451	64%
1990/91	13,331	18,633	31,964	58%
1991/92	14,407	22,888	37,295	61%
1992/93	13,105	22,628	35,733	63%
1993/94	11,390	19,885	31,275	64%
1994/95	8,302	18,169	26,471	69%
1994/95	8,302	18,169	26,471	69%

Source: Omuru 1997

Table A-3 Volume and value of cocoa exports, PNG 1989 to 1996

	Exports	Price	Export value	Estimated smallholder exports	Estimated plantation exports
	tonnes	K/t	K mil	K mil	K mil
1989	46600	970	45.2	27.9	17.3
1990	33900	882	29.9	19.1	10.8
1991	35800	950	34.0	19.8	14.2
1992	38600	882	34.0	20.9	13.2
1993	37800	859	32.5	20.6	11.9
1994	26000	1115	29.0	18.4	10.6
1995	30600	1559	47.7	32.7	15.0
1996	41000	1603	65.7	45.3	20.4

Source: Bank of PNG 1997

Appendix B

Cocoa Quality Improvement Project Economic Analysis

Labour inputs are a key determinant of technology adoption by smallholders in PNG. The effect of on-farm fermenting and drying on labour demand is uncertain. Clearly additional labour is required to turn both the fermenting and the drying beans on a daily basis. However, around half of all smallholders in East New Britain and Oro provinces own or have a share in a traditional fermentary (Yarbro & Noble 1989 p42) and the time requirements for processing would probably be higher than for on-farm processing due to the need to collect and transport firewood.

Firewood requirements have been estimated at 0.75 tonnes per tonne of wet beans (PCR p16). Firewood is becoming increasingly scarce in many areas, notably in much of the Gazelle peninsula in East New Britain. In these areas, many fermentary operators have to collect and cart their firewood from a substantial distance with time and transport costs estimated at K30 per tonne of dry cocoa. Yarbro & Noble (1989) estimated cash costs for firewood collection by four dealer-operated fermentaries at K21 per tonne of dry bean.

Table B-1 Minibox fermenter and solar drier – budgeted cash flow per smallholder

Year		1	2	3	4	5	6	7	8	9	10	11	12
Wet bean production	kg	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160	2160
Wet bean price	K/kg	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Wet/dry conversion ratio	37.5%												
Dry bean production	kg	810	810	810	810	810	810	810	810	810	810	810	810
Dry bean price													
World Bank price projections (index)		140.4	141.1	141.9	142.7	143.1	143.5	143.8	144.2	144.6	144.7	144.8	144.9
World Bank price projections (real terms)	K/kg	1.441	1.448	1.456	1.465	1.469	1.472	1.476	1.481	1.484	1.485	1.486	1.487
Revenue - sale of dry beans	K	1167	1173	1180	1186	1189	1193	1196	1199	1202	1203	1204	1205
Residual value	K												357
Capital, equipment & construction cost													
Mini-box fermenter	K	253											
Solar dryer		1533											
Cost of wet beans (opportunity cost inflated by WB projections)	K	821	825	830	834	837	839	841	843	846	846	847	847
Operating costs	K	134	134	134	134	134	134	134	134	134	134	134	134
Reduction in timber cost (K30/t dry bean)	K	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24	-24
Maintenance	K					110					260		
Total	K	2717	931	931	931	1041	931	931	931	931	1191	931	931
Incremental benefit	K	-1550	236	236	236	126	236	236	236	236	-24	236	594
Internal rate of return		9%											
Add K80/tonne quality benefit	K	-1485	301	301	301	191	301	301	301	301	41	301	658
Internal rate of return		15%											

Source: Adapted from Omuru 1997. Price forecasts – World Bank Commodity price forecasts 22 April 1997

Appendix C

Coffee Research Institute Project Data

Table C-1 Summary of Coffee Research Institute Project costs (A$'000)

Component	Budget			Actual		
	AusAID	Local costs	Total costs	AusAID	Local costs [a/]	Total costs
Project design						
1. Personnel (spray technologist)	600	130	730	na	224.1	na
2. Supplies services and equipment	330	45	375	na	43.4	na
3. Travel	95	75	170	na	61.4	na
4. Post-grad training in Australia	122		122	na		na
	1147	250	1397	na	329.0	na
Including project extension (from PCR)						
Professional fees	1730.2					
Individual allowances	363.2					
Procurement Australia	1072.9					
Procurement PNG	75.8					
'Other related costs'	320.9					
Other project-related overseas costs	323.5					
Total [b/]	3886.5	375	4261.5	3691.4	329.0	4020.4

a/ Based on 4.5 times 1989/90 cost (as provided by CRI).
b/ No information is available on the basis for the budget.
Source: Project design and implementation documents and PCR

Table C-2 CRI and Extension Services Division budget and actual expenditure (K'000)

	1995	1996	Average
ESD budget	6414	3723	5069
actual	5204	4960	5082
Actual/Budget %	81.1%	133.2%	100.3%
CRI budget	3788	2456	3122
actual	3103	2666	2885
Actual/Budget %	81.9%	108.6%	92.4%

Source: Coffee Industry Corporation.

Table C-3 Usage of the Training Support Centre

Dates	Purpose of Usage	Group Identification	Comment
Oct 92 - Sept 93	Management Skills Training	Extension Services Division	The first full year's use of the Centre has seen a high level of occupancy mainly by Extension Services Division (ESD) of CIC. The dormitory was occupied for over 2500 bed nights
	Harvesting and Processing		
	Factory Liaison		
	New Extension Officers' Orientation and Training		
	Train the Trainers		
	Soils and Crops Field Trip	Unitech Student	
Oct 93 - Sept 94	Harvesting and Processing	Extension Services Division	A total of 328 occupants have spent 2245 bed nights at the Training Support Centre
	Management by Objective		
	Harvesting and Processing		
	In-Service Training		
	New Extension Officers Orientation and Training		
		Indonesian Farmer Groups	
		DAL	
		Fresh Produce Development Corporation	
Oct 94 Sept 95	Sweet Potato Processing Workshop	Provincial DPI	12 staff spending 3 nights
	Special Police Task Force	Acting Governor General Escorts	18 police spending 2 nights
	Individual Researchers	ANU	Collecting research data
Oct 95 Sept 96	Individual Researcher	Hawkesbury	Collecting research data
	New Extension Officers Orientation and Training	ESD	30 for 13 nights
Sept 96 - April 97	Fisheries Farmers Carp Farming Workshop	JICA Funded Project run by Fisheries Dept	30 farmers - 10 nights
	Fisheries Extension Officers	JICA	23 Fisheries Extension Officers- 10 nights
	Village Police Constable Training	EHP Police Dept	23 new recruits + 2 trainers spending a total of 13 nights
	4th Year Agriculture Students field trip	UNITECH	18 students spending 2 nights
		Kainantu Admin Officers	6 officers - 5 nights
	Fisheries personnel from Nepal	Under JICA Project	1 JICA personnel - 20 nights

Source: CRI Scientific Liaison Department

Appendix D

PNGRIS Data

Table D-1 PNGRIS II & III Summary of project costs

	Budget			Actual		
	AusAID	Local costs	Total costs	AusAID	Local costs	Total costs
Component	A$'000	A$'000	A$'000	A$'000	A$'000	A$'000
Phase II Inception						
Phase III						
1. Upgrade PNGRIS map	568					
2. 1:250,000 provincial mapping	313					
3. Catchment planning	720					
4. Land suitability	211					
5. Provincial planning	404					
6. Training & publication	131					
7. Institutional collaboration	217					
8. Project management	1291					
Total	3855	na	na	2800	na	na

Table D-2 Primary PNGRIS Installation Sites

DAL	DAL is the agency responsible for policy development in the agricultural and livestock sectors in PNG. PNGRIS is installed within the Land Utilisation Section (LUS) of the Agricultural Research Division of DAL which provides expertise and technical support on land use matters, with the (long-term) objective of providing support to the provinces on the sustainable use of PNG's resources. While maintaining its traditional role in soil surveying, it has expanded its activities to include land evaluation, agricultural landuse planning, natural resource surveying and mapping, soil conservation research and extension, soil and water conservation projects, environmental impact assessment and conservation planning (Montague 1995 quoting LUS 1994).
DEC	Within DEC, PNGRIS is maintained by the Policy and Planning Unit of Policy Coordination Branch. The responsibilities of the Unit are to ensure that the planning and management functions of DEC's other units are effective. Projects under the unit's control (in 1995) included – improving landowner involvement in resource planning and management; the development of practical environmental standards for resource extraction and the development of resource inventories of resource stocks. The planning and management functions of this Unit are removed from the direct management of environmental resources. PNGRIS is therefore most commonly used as a reference tool.
PNG Forest Authority	The Authority comprises the National Forest Board and the National Forest Service (NFS). NFS undertakes extension, research, training and education, resources assessment, policy and planning advice, monitoring and enforcement. Under the forestry sector restructuring of the early 1990s, NFS absorbed all of the functions and responsibilities of the national Department of Forests and the provincial Forest Divisions Two sets of PNGRIS are maintained in NFS. Both are within the Planning Division - one in Mapping Branch and one in Inventory Branch. Both branches perform important functions in the resource planning process, providing essential data for planning and management decision-making. Inventory Branch is responsible for the resource assessment functions of the NFS, focusing on the preparation of an inventory of forest resources. PNGRIS is used as a reference source for the compilation of inventory reports. NFS officers use PNGRIS to conduct preliminary investigations into forestry and other resource data prior to field surveys or to add additional environmental information to survey reports. Mapping Branch is responsible for the compilation and presentation of forestry resource information. PNGRIS is used within the branch for verification of existing resource data and for providing additional baseline environmental information.

Table D-3 PNGRIS budgeted adviser and local staff inputs (person-months)

Advisers		Total Total	PNGRIS upgrade Comp 2	Madang 250,000 Comp 3	Catchmt planning Comp 4	Land suitability Comp 5	Province planning Comp 6	Training pubicatn Comp 7	Instit collaboration Comp 8	Manage-ment Comp 9
Team leader/LU Planner	Aust	2.0					2.0			
	PNG	1.0					1.0			
Programmer	Aust	12.0	6.5	5.5						
	PNG	3.0	2.5	0.5						
GIS Specialist	Aust	17.3	10.5	3.5	3.3					
	PNG	4.0	3.5	0.5						
Data entry/verifier	Aust	13.5	8.5	5.0						
	PNG	0.5	0.5							
Landuse planner	Aust	4.8		0.5	4.3					
	PNG	3.3		0.5	2.8					
Technical assistant	Aust	7.5	4.0	3.5						
Resource analyst	Aust	8.5		4.0		4.5				
	PNG	2.0		1.0			1.0			
Geomorphologist	Aust	1.5				1.5				
Draftsman	Aust	1.0		1.0						
Soils specialist	Aust	4.5			2.5		2.0			
	PNG	4.0			3.0		1.0			
Land resource mapping	Aust	6.5			4.5		2.0			
	PNG	4.0			3.0		1.0			
Watershed mgmt	Aust	1.0			1.0					
	PNG	1.3			1.3					
Agric systems	Aust	0.3			0.3					
	PNG	1.0			1.0					
Data processing	Aust	10.0			3.0	5.0	2.0			
	PNG	1.0					1.0			
Land evaluation spec	Aust	4.0				4.0				
Cartographer	Aust	3.0				1.0	2.0			
	PNG	1.0					1.0			
NZ Training supervisor	NZ	2.0						2.0		
Public admin	Aust	2.0							2.0	
	PNG	2.0							2.0	
Natural resource planner	PNG	1.5							1.5	
Project director	Aust	1.8								1.8
	PNG	0.3								0.3
Business manager	Aust	7.5								7.5
	PNG	0.5								0.5
Project manager	Aust	13.5								13.5
	PNG	2.5								2.5
Technical Report coordinator	Aust	8.0								8.0
In-country coordinator	PNG	24.0								24.0
Secretary	PNG	12.0								12.0
Total		200.8	36.0	25.5	29.8	16.0	16.0	2.0	5.5	70.0
Australia		132.0	29.5	23.0	18.8	16.0	10.0	2.0	2.0	30.8
PNG		68.8	6.5	2.5	11.0	0.0	6.0	0.0	3.5	39.3
PNG Inputs										
Cartographer	PNG	2.0	2.0							
Environment officer	PNG	2.0	2.0							
Forest officer	PNG	13.3	4.0	2.0	1.3		6.0			
Landuse officer	PNG	52.5	4.0	2.0	28.5	3.0	12.0	3.0		
Computer officer	PNG	9.0						9.0		
DEC Water resources officer	PNG	1.3			1.3					
ELCOM environmental officer	PNG	1.3			1.3					
Field assistants	PNG	14.0			8.0		6.0			
Technical officers	PNG	6.0					6.0			
Study tour	PNG	6.0							6.0	
Total PNG		107.3	12.0	4.0	40.3	3.0	30.0	12.0	6.0	0.0

Source: Project Implementation Document

Appendix E

Forestry Rapid Resource Appraisal Data

Table E-1 Forestry Rapid Resource Appraisal -summary of project costs

Component	Budget			Actual cost		
	AusAID	Local costs	Total costs	AusAI	Local costs	Total costs
	A$'000	A$'000	A$'00	A$'00	A$'000	A$'000
Phase 2 Inception	na	na	na			
Phase 3 Implementation						
2. Rapid resource appraisal	92.0		92.0			
3. 1:100,000 forest type mapping	802.2	107.2	909.4			
4. Updating resource appraisal	96.3	49.2	145.5			
5. Environment & conservation info	102.8	7.2	110.0			
6. Training & publication	242.6	23.4	266.0			
7. Forest resource assessment design	90.5		90.5			
8. Project management	313.4		313.4			
Total	1739.8	187.0	1926.	1200		na

Source: Project Implementation Document and PCR

Table E-2 FRRAP budgeted adviser inputs (person-months)

		Total	RRA Comp 2	1:100,000 mapping Comp 3	Updating RA Comp 4	Environ-ment Comp 5	Training Comp 6	FRA design Comp 7
Project manager	Aust	6.0						6.0
	PNG	2.0						2.0
Forester	Aust	18.5	0.5	18.0				
	PNG	1.5		1.5				
Programmer	Aust	8.5	3.0		2.0	2.5	1.0	
	PNG	0.5				0.5		
Data entry verifier	Aust	9.0	2.0	3.0		4.0		
Cartographer	Aust	23.0	0.5	20.5	1.0		1.0	
	PNG	1.0	0.5	0.5				
Cartographer (hydrology)	Aust	2.0				2.0		
Editor	Aust	6.5	0.5				6.0	
Forester (assessment)	Aust	1.5	1.0				0.5	
Forester (survey)	Aust	4.0		4.0				
	PNG	6.0		6.0				
GIS specialist	Aust	3.5		2.0		0.5	1.0	
	PNG	0.5				0.5		
Remote sensing consultant	Aust	0.5			0.5			
	PNG	1.5			1.5			
Forester (Air-photo interp)	Aust	0.5					0.5	
Resource analyst	Aust	0.5					0.5	
Forest inventory statistician	Aust	3.0					3.0	
Forest inventory specialist	Aust	1.5					1.5	
Project director	Aust	2.0						2.0
Business manager	Aust	4.0						4.0
Technical report coordinator	Aust	4.0						4.0
Total		111.5	8.0	55.5	5.0	10.0	15.0	18.0
Total Australia		98.5	7.5	47.5	3.5	9.0	15.0	16.0
Total PNG		13.0	0.5	8.0	1.5	1.0	0.0	2.0

Source: Project Implementation Document