Australian Government

Australian Centre for International Agricultural Research

Final report

project

Facilitating the availability and use of improved germplasm for forestry and agroforestry in Papua New Guinea

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1 Acknowledgments

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FPCD: Yati Bun, Bazakie Baput, Israel Bewang, Taksey Dobon, Linson Zamang, Fletcher Onise, Kafuri Yaro,

QDPI: Ken Robson.

VDT: Kentis Igai

OISCA: Gesley Torivan

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Abbreviations

ACIAR	Australian Centre for International Agricultural Research
CPL	Coconut Products Limited
CSIRO	Commonwealth Scientific and Industrial Organisation
CSO	Clonal Seed Orchard
ENB	East New Britain
FPCD	Foundation for People and Community Development
FRI	(PNG) Forest Research Institute
NGO	Non Government Organisation
NTSC	National Tree Seed Centre
OISCA	Organisation for Industrial, Spiritual and Cultural Advancement
PNG	Papua New Guinea
PNGFA	Papua New Guinea Forest Authority
PNGFRI	Papua New Guinea Forest Research Institute
PNGNFS	Papua New Guinea National Forest Service
QLD	Queensland
SDA	Seventh Day Adventist
SDP	Sustainable Development Project
SPA	Seed Production Area
SO	Seed Orchard
TNC	Trust Nature Conservancy
VDT	Village Development Trust
WA	Western Australia

2 Executive summary

Papua New Guinea has a total land area of over 46 million hectares of which 73% is covered by tropical rainforest, mangroves and dry deciduous forest. 97% of the land is owned under customary title with most rural people living on their own land. The tropical forest area is a major source of income to the country based on log export largely by foreign logging companies. This log export industry is under pressure due to a number of factors including reduced access to areas that can be harvested and international pressure to produce sustainably managed timber.

The inevitable decline of natural forest logging provides opportunity for development of planted forest estate as has occurred in many other countries. There is currently a small plantation resource and agroforestry systems focussing mainly on domestic needs and environmental protection.

Favourable conditions in PNG provide a clear opportunity for and expansion of planted forest areas in PNG to meet international markets. PNG's conventional plantation estate, involving species such as hoop and klinkii pines, balsa, kamerere and acacias, may not expand in a major way, as a result of land tenure issues. The opportunity exists to develop a rural landowner based plantation industry. However, there are a number of technical and policy issues which need to be addressed in order to support such an approach. ACIAR is developing a suit of projects to address these issues one of which is the development and supply of suitable germplasm in order to meet future tree planting programs.

The rationale for the project was to support community tree planting programs in PNG by making available improved germplasm for a range of high value timber species as well as some non-timber species, and by training rural communities in the propagation and deployment of this material. Additionally, new eucalypt hybrids with potential for plantation forestry in PNG and north Queensland also formed part of the strategy.

The three year project commenced in August 2005 involving Partner country institutions; Papua New Guinea Forest Research Institute, The Foundation for People and Community Development, Queensland Department of Primary Industry Agency for Food and Fibre Science and CSIRO. In addition to the key funded partners there were several other NGO partners and target rural communities.

The project demonstrated an effective model whereby Australian and PNG forest research and development institutions can collaborate and cooperate in the delivery of community development activities.

In PNG, the project developed improved knowledge and established germplasm sources for 11 target tree species; *Dracontomelon dao* (walnut), *Calophyllum euryphyllum* (kalophilum), *Endospermum medullosum* (basswood), *Tectona grandis* (teak), *Pometia pinnata* (taun), *Eaglewood (Gyrinops ledermanii)* (eaglewood), *Santalum macgregorii* (PG sandalwood), *Santalum album* (Indian sandalwood), *Acacia crassicarpa* (crassicarpa), *Eucalyptus pellita* (pellita) and *E. deglupta* (kamarere). An attempt was also made to develop a hybrid between *E. deglupta* and *E. pellita*. In Australia, a series of hybrid combinations were trialled in Queensland. No significant progress was made on advancement of germplasm supplies or the development of novel eucalypt hybrid combinations. However, it is hoped that over the next five years the established seed sources will start to provide seed for distribution to tree planting programs.

Development of tree planting skills through nursery training programs was successfully implemented in a number of rural communities in four regional hubs; Madang, Markham Valley (Morobe), Eastern Highlands and East New Britain. The training was delivered by NGOs linked to rural communities following initial training of the trainers. Whilst difficult to quantify, it is evident that the community forest nursery training and development program

has had positive community impacts, including economic and environmental benefits by 'next users' of the project outputs, and including a 'spill over' of benefits to other agricultural sectors, such as coffee production.

3 Background

Forestry is currently a very important component of the PNG economy based on round log exports from natural forest together with a small plantation resource and agroforestry systems focussing mainly on domestic needs and environmental protection. The environment for logging from the natural forest will over time become more questionable and less sustainable requiring development of alternative income sources.

An opportunity therefore exists to develop a new industry based on planted trees. A planted forest industry has many advantages, including (a) compatibility of production from planted trees with both customary land tenure and traditional agroforestry practices (implying potential for a substantial involvement in the developing industry of the socioeconomically vulnerable rural population); (b) planted resources can be located strategically, i.e. close to further processing facilities and ports; (c) access to international markets is facilitated through access to existing industry supply chains; (d) flexibility of location permits a wider geographic distribution of economic benefits of forest production; (e) unlike some other commodities, medium-term real prices for high-quality timber are expected to rise and (f) planted trees can have major positive environmental effects.

PNG's conventional plantation estate, involving species such as hoop and klinkii pines, balsa, kamarere and acacias, may not expand in a major way, as a result of land tenure issues. The opportunity addressed in this project relates to the development of a smallholder based plantation industry. A range of technical, social, logistical and economic challenges, too complex to be addressed in a single project, must be met for this to be achieved. ACIAR therefore is developing a closely integrated suite of projects that address these issues, and this project must be considered in that context.

The specific aim of this project is to support community tree planting programs in PNG by making improved germplasm available, for a range of high value timber species as well as some non-timber species, and by training rural communities in the propagation and deployment of this material. Additionally, new eucalypt hybrids with potential for plantation forestry in PNG and north Queensland will also form part of the strategy.

Forestry is currently a very important component of the PNG economy. Major elements of the sector are:

- A large log export industry, based on harvesting of natural primary forests largely by foreign logging companies. This is a major industry, which has been returning hundreds of millions of kina annually to the PNG government, to communities, and to landowners. The accessible primary forest resource is being rapidly depleted, and harvesting from natural forests will, within a few years, necessarily be based on an uncertain yield from logged-over secondary forests.
- A small traditional plantation sector, based in particular on balsa, acacias, Eucalyptus deglupta, and Araucaria. Land ownership issues may limit the extent to which this sector expands.
- Widespread agroforestry systems, involving casuarina, betel, pandanus and many other species. These systems are a major element of subsistence agriculture, and make a strong contribution to local economies. The agroforesters involved are very skilled in tree growing.

There is clearly an economic challenge looming for PNG as current revenues from log exports dwindle. The loss of this revenue will have substantial impacts on the government, communities and landowners. Nevertheless, PNG does have some natural advantages in relation to a successful forest industry:

- Extensive areas of accessible native forest that, properly managed, could provide an ongoing source of valuable timbers

- Climate and soils conducive to good tree growth
- A range of high value species that are known or likely to grow well
- Extensive areas of land that would be suitable for tree planting
- A population of skilled agriculturists and agroforesters

In the context of a rising global demand for high quality timber from sustainably managed forests, these assets confer significant advantages in terms of a future PNG forest industry.

A key part of ACIAR's vision for PNG forestry is the development of a forest plantation industry based on smallholders. Such an industry could comprise:

- Smallholders growing high value species such as teak, New Guinea walnut and Calophyllum in agroforestry systems. Multipurpose tree species, and non-tree crops, would provide cash income and subsistence production annually, and timber trees would provide a major cash return from say age 15 years
- Partial processing of timber locally, for example rough sawing and flitching using portable sawmills, and perhaps air-drying
- Further processing, e.g. re-sawing, kiln-drying, dressing, and production of sliced veneer, at larger centres
- International marketing from major centres

This vision would entail an industry of several hundred million kina annually. This would be a significantly larger contributor to the national economy than the current industry, in particular by virtue of the significant value-adding sector. All sectors of PNG society would benefit:

This project is specifically designed to facilitate the deployment and establishment, in agroforestry and community plantings, of improved germplasm of a range of high value timber species, to meet an anticipated demand for planting stock.

There is some cause for optimism that, properly promoted and facilitated, a smallholder-based plantation industry could be successful. The current international demand for eaglewood has led to widespread community interest in growing this species, and to a significant demand for planting stock. This demand is being met in a very disorganised and unsatisfactory manner, with seedlings (which often turn out not to be eaglewood) being dug up in native forests and sold in markets at 25 kina or more per plant in some cases, to individuals who have insufficient knowledge of where to plant the species or how to manage it silviculturally. There is an emerging interest in planting teak, for which there is also an international market.

The project is well aligned with priorities specified in ACIAR's Annual Operational Plan, reinforced at the 2004 consultation that identified 'Domestication and improvement of multiple-use, fast-growing indigenous tree species for smallholders and plantation development' as a major priority for ACIAR's forestry program in PNG. The development of novel eucalypt hybrids, included in the project, will have applications also for northern Australia. In particular, these hybrids could have a role in agroforestry and smallholder plantings along the coastal strip that is dominated by the sugar industry. Foresters and sugar growers have long had a common interest in planting these areas. There have been a number of trials of the integration of tree planting into North Queensland agriculture. However, the need for diversification prompted by the decline in the sugar industry in recent years has promoted much more serious interest in commercial timber plantations in the region. There is thus a common element of industry decline driving this project – of forestry in PNG, and of sugar in north Queensland.

4 Objectives

The project comprises three objectives, two related to the development of germplasm for target tree species and the third to train rural communities in raising plants.

Objective 1. Generation of 'best bet' propagation populations of ten species with known or potential application in commercial, reforestation, rehabilitation and community agroforestry systems in PNG.

Activities

- Identify appropriate sources of best available germplasm material for each of the target species.
- Establish appropriate propagation populations (clonal seed orchards, seedling seed orchards, cuttings orchards, seed production areas, or combinations of these) as appropriate to the species.
- Where appropriate, maintain existing trials under project FST/1998/115 for ultimate conversion to a seed stand or genetic resource.

It is accepted that the material produced during this time frame will display only modest genetic improvement. However its availability will meet, in an organised and responsible way, the escalating demand that will drive the development of better quality material of the most desirable species.

Objective 2. Design and implement an appropriate training program in seed collection, propagation and tree establishment aimed at target rural communities.

- Identify four geographic hubs
- Select partners to represent each of four geographical hubs
- Identify three communities per hub
- Plan and implement a nursery training course to train representatives from the partner organisations
- Trainers to develop training material and conduct training courses at own facilities and/ or by visiting target communities
- Repeat the training and have follow-up visits to provide extension and monitoring
- Conduct survey among key end-users on application of training

The proposed approach is to link the project with target communities through 'Project Partners' comprising NGOs, CBOs and government.

Objective 3.a. Improve genetic quality and availability of E. deglupta in PNG

- Determine best *E. deglupta* families from PNG (CSO) (and Solomon Islands) based on growth and wood quality;
- Establish a new *E. deglupta* CSO containing the selected elite families

The objective is to replace the existing CSO by broadening the genetic composition through including Solomon Island selections (Plus Tree selections) into a new CSO will ensure that seed made available for growing will be of a high quality and acceptable to a wider range of growers.

Clones selected for inclusion in a seed orchard will be screened for wood properties (density, peeling quality) suited to producing trees with desirable commercial wood properties.

Objective 3.b. Develop novel hybrids between E. deglupta and E. pellita

- As part of Obj. 3.a, raise E. deglupta grafts from approximately 15 clones for use in controlled pollination. Assumption that grafted clones will flower earlier than seedlings.
- Once flowering, undertake controlled pollination combinations between the two species for development of hybrid seed.

The mating design used will reflect the objective so as to produce hybrid seed for testing rather than to determine breeding values of the selected trees. Hence, the use of a pollen polymix to increase the potential number of crosses achieved in a limited time frame.

Objective 3.c. Develop novel hybrid combination between eucalypt species in Queensland

- Attempt hybrid combinations involving *E. pellita, E. urophylla, E. tereticornis, E. grandis and E. dunnii*

Some of the hybrid crosses identified for this component have shown commercial promise in other countries, although no testing has been undertaken in Queensland.

5 Methodology

Objective 1. Generation of 'best bet' propagation populations of a range of species with known or potential application in community agroforestry systems.

The work for Objective one was carried out through the PNG Forest Research Institute in Lae with inputs from the Australian collaborators Ken Robson and Brian Gunn. An array of technical tree breeding cum propagation options were used to develop 'best bet' propagation populations suitable for end users. The technique used depended on the species and material available. Ten priority species were identified during development of the project as listed below. The list was developed by FRI and taking into account the species priority assessments which were undertaken as part of the previous ACIAR Project FST2004/009. This list was reviewed at the inception meeting in case there were other species considered to be of greater priority.

The species included in the project listed below are ranked tentatively in descending order of priority.

Dracontomelon dao (walnut)

Calophyllum euryphyllum (kalophilum)

Endospermum medullosum (basswood)

Tectona grandis (teak)

Pometia pinnata (taun)

Eaglewood (Gyrinops ledermannii) (eaglewood)

Santalum macgregorii (PG sandalwood)

Santalum album (Indian sandalwood)

Eucalyptus pellita (pellita)

Acacia crassicarpa (crassicarpa)

At the commencement of the project a strategy for germplasm improvement of the 10 target species was developed for implementation as follows. The strategy took account of existing trials and hedge garden of the six species (*Dracontomelon dao, Calophyllum euryphyllum, Endospermum medullosum, Pometia pinnata, Santalum macgregorii, Gyrinops)* developed as part of the previous project FST1998/115. The strategy was developed more as a 'wish list' as resources had not been reviewed against the activities.

Dracontomelon dao

A provenance trial had been established at Bumsi under the previous project. A 93% strike rate from cuttings had been achieved under the previous project but no grafting work had been undertaken.

1. Convert Bumsi trial into SPA by thinning to leave 50% of best formed trees.
2. Propagate cuttings from 30+ individual hedges at FRI
   - use existing material in FRI hedges to graft on to self and on to seedling rootstock to develop propagation techniques;
   - if procedure successful, graft select scion material from superior trees in Bumsi trial.
   - Raise seedling rootstocks for grafting work as required with seed collected from wild sources
   - Establish a new SO incorporating vegetatively propagated material.

Calophyllum euryphyllum

Two trials were established under the previous project (FST1998/115. A progeny trial (15 families from Rambuto Island) at Bumsi and a progeny trial cum provenance trial (5 provenances & 40 treatments) at Markham. The latter had been seriously damaged by a wild fire prior to the start of this project. *C. euryphyllum* is reputed on to re-shoot ready following felling thus making vegetative propagation more problematic. Preliminary work on this species under the previous project had resulted in a 15% strike rate for cuttings taken from hedge plants. No work had been undertaken on grafting. For this reason the following approach was taken.

1. Thin existing family trial at Bumsi (15 families from Manus established under FST1998/115) based on results of assessment analysis (ranking of families)and convert to SSO
2. Assess existing progeny/ provenance trial at Markham (established under FST1998/115) for survival following fire damage to determine future option s for trial.
3. Capture existing genetic material as part of developing a new seed orchard using the following approach:
   - trial coppicing ability of species by felling several trees at different heights above ground and observing response. If trees coppice, set cutting and grafts at FRI
   - use existing material in FRI hedges to graft on to self and on to seedling rootstock to develop propagation techniques;
   - if procedure successful, select superior trees (20-30) in the Markham Bridge and Bumsi trials and vegetatively propagate.
   - Raise seedling rootstocks for grafting work as required with seed collected from Bumsi trial
   - Establish a new SO incorporating vegetatively propagated material and seedlings from seed collected from superior trees in the trials and wild collections ex Manus. Final planting will depend on available plant material.
4. Undertake progeny seed collection from west coast Manus Is as part of a joint funded activity with kei beseu kampani (KPK logging contractors) and the provincial government. This to serve as a future seed source for the island.
   - Establish progeny trial on Manus to be maintained by provincial government forestry office.

Endospermum medullosum (Basswood)

Two provenance trials had been established, one at Wasap and the other at Rabaul as part of the previous project. Only three seed sources constituted the trial. The species propagates readily from cuttings.

1. AT Age 3 assess growth and thin to retain best 50% of trees for conversion to SPA.
2. Continue to try sourcing Vanuatu seed (2 seedlots)

New trial with Vanuatu material kept separate.

Tectona grandis

3. Contract Mr Neville Howcroft to review research work carried out on Teak in PNG and provide report containing recommendations on suitability of existing planted material for use in establishment of new seed orchards (pending EU funding)
4. Raise grafting stock from available seed
5. Collection of budding scion material from identified families based on information presented in Howcroft report.

6. Establishment of grafted CSO under FRI control to conserve germplasm and supply seed
7. Distribution of plants to selected village community growers through Partner NGOs for establishment of germplasm sources. (10 unrelated plants/ community grower)

Pometia pinnata (Taun)

A provenance trial had been established at Markham under the previous project which had been severely damaged by fire prior to the start of this project. The focus of selection here was on the development of improved fruiting varieties. Under the previous project, the strike rate for cuttings was as high as 100%. Taun is only eaten on the north islands (Manus, New Ireland, ENB) and north coast mainland. Methodology as follows:

8. Establish a grafted SO adopting the following approach:
    - use existing material in FRI hedges to graft on to self and on to seedling rootstock to develop propagation techniques;
    - if procedure successful, collect scion material from community identified good fruiting individual's. Material to come from 5 individuals x 5 sites (25 individuals)
    - Raise seedling rootstocks for grafting work as required with seed collected from wild sources
    - Michael Poesi to decide if SO sited at 5 communities and/ or also 1 bulk site (this site linked with NARI or DPI).
9. If grafting unsuccessful, then establish SO from seed collected from 5 individuals x 5 sites (25 individuals as per 1 above and establish following raising seedlings in the nursery.
10. Assessment trial at Markham for survival. If OK thin down for SSO (timber).

Eaglewood (Gyrinops ledermannii- northern species)

Under the previous project, 5 individual families (source plants) were in tubs at the FRI nursery for use in propagation studies.

11. Source an additional 30 unrelated source plants
    - Strike cuttings (10-20) per source plant at FRI nursery
    - Establish a SO at FRI comprising 3-6 reps of each source plant to serve as a conservation cum seed stand
    - Distribute 10-20 unrelated plants to community growers through the Partner NGOs to serve as a local seed stand

Santalum macgregorii

As part of the previous project, germplasm collections were made from wild populations. From these collections 21 individual families were represented in the FRI nursery. The species is of conservation concern having been depleted from most of its original natural distribution.

12. graft 10 ramets per family.
    - Raise rootstocks using either *S. macgregorii* or if unavailable use *S. album*.
13. Aim to have 30 to 50 families across the remaining natural distribution of the species which in turn will be propagated as discussed in 1 above. .
14. Establishment SO as single tree plots replicated 5 to 10 times at FRI.
15. Distribute 10-20 unrelated plants to community growers through the Partner NGOs to serve as a local seed stand

Santalum album

16. Purchase seed orchard seed from Australia for raising at FRI.
17. Establish 2 SPA containing approximately 200 sandalwood seedlings

Eucalyptus pellita

18. Purchase seed orchard seed from Australia for raising at FRI.
19. Establish 1 ha SPA

Acacia crassicarpa

20. Purchase seed orchard seed from Australia for raising at FRI.
21. Establish 1 ha SPA

Objective 2. Design and implement an appropriate training program in seed handling, propagation, tree planting and tree tending aimed at communities.

Rationale: Development of extension material and training of extension trainers to conduct training in key target locations in PNG involving researchers, government agencies, NGOs, tree growers, conservationists, land managers and other stake holders.

Four geographical hubs have been identified representing Morobe Province, Madang, Rabaul (representing the islands) and Goroka (representing the Eastern Highlands and highlands as a whole). In each of these hubs, 1-3 Partners per hub and three rural communities will be identified by the 'Project Partners' based on the existing sound relationships with communities and desire on the part of the community representative that they wish to establish trees on their land.

Methodology

- Hold workshop as part of the project inception meeting to discuss objectives and implementation of this work.
- Identify species to be the initial focus of the training program, targeting those for which there is already a demand
- Develop a training course to include production of posters to support training of field trainers;
- K. Robson to train approximately 12 extension trainers at FRI, Lae;
- Trainers to develop their training material and visit communities to start the training process and brief communities involved;

- Initial training course carried out by trainers under the supervision of K. Robson at one representative village. Depending on logistics, this would be carried out at each geographical hub in order to take account of local conditions.
- Conduct baseline survey amongst key end-users on application of training
- Seek support from PNGFA, NARI, other government agencies, donor projects (EU), Pvt companies and NGO groups willing to support training extension beyond the capacity of the projects resources.
- Conduct follow-up training reinforcement linked to review and revised processes which ensure effective implementation and impacts of the project objective.

Apart from training by Mr Ken Robson who has provided similar training under the SPRIG project, training material will also be provided to include posters in local language. Regular six monthly workshops will be held to brief Partners on project development and review progress at the village level. This will essentially be done by a representative from FPCD with guidance from Dr Hartmut Holzknecht (ANU) in terms of developing indicators through the related Project FST/2004/050.

Objective 3. Development of improved eucalypt germplasm within species and through novel eucalypt hybrids.

3.a Improve genetic quality and availability of E. deglupta in PNG

22. Determine best (50 elite) E. deglupta families from CSO, SSO and Philippines progeny trial together with grafting material from selections in Solomon Islands.

23. Graft scion material from selections and establish a new *E. deglupta* SO containing the selected elite families as a source for future improved seed of the species more aligned to industry requirements;

24. Risks under Objective 3a are mainly associated with the exchange of germplasm between PNG and Solomon Islands. This will be managed through government-to-government agreements which have been put in place. Other risks are common to any field plantings in PNG.

3.b. Develop novel hybrids between E. deglupta and E. pellita

25. Establish ramets (3) x 10-15 clones from the above grafts for establishment in a clone bank in order to produce flowering at an early age including the use of promontory techniques to induce early and prolific flowering;

26. Once flowering, undertake controlled pollination combinations between the two species for development of hybrid seed;

27. Collect and store seed, and document availability of progenies for trial establishment by the partners jointly, or by other parties as agreed.

3.c. Develop novel hybrid combination between eucalypt species in Queensland.

28. Attempt hybrid combinations involving *E. pellita, E. urophylla, E. tereticornis, E. grandis and E. dunnii* in Queensland.

Collect seed in anticipation of establishing progeny trials

6 Achievements against activities and outputs/milestones

Objective 1: To establish improved germplasm sources

no.	activity	outputs/ milestones	completion date	comments
1.1	Amass best available germplasm for the 10 selected tree species (PC and A)	Most germplasm was amassed during the life of the project	On-going	
1.2	Develop nursery facilities and skills to meet project needs (PC and A)	Improvements made to FRI nursery facilities including upgrading of mist house, purchase of consumables including rigid pot systems and construction of a shade house. Formal and hand on training provided to all project staff	On-going	High turn over of project nursery staff hampered skill development and continuity of work
1.3	Raise rootstocks of target species sufficient to produce desired number of plants for germplasm production(200 plants / spp. Represented by a minimum of 10 families)	Raising of rootstocks undertaken for teak, and calophyllum, sandalwood but not for walnut and pometia	April 07	Seed could not be obtained for walnut and plans for grafting pometia abandoned following departure of Anton Lata in February 2006.
1.4	Raise seedlings of species for establishing seed stands	Seedlings raised for S. album, A. crassicarpa, E. pellita, teak ex Thailand	March 2007	Two attempts were made to successfully raise seedlings of S. album and teak.
1.5	Strike cuttings from selected vegetative material	Cuttings struck for eaglewood were only partially successful leading to insufficient plants for establishment of seed stand and distribution of seedlings to community tree growers	June 2008	Lack of vigour in the hedge plants and poor strike rate led to lower than expected results. It is suggested that the low strike rate may have been caused by the age and height of the hedge plants

1.6	Graft scions on to rootstocks	Two attempts to graft the 29 clones from the Mount Lawes SO. The initial attempt in December 2006 had partial success with 19 clones producing one or more ramets. A 2nd attempt was made in June 2008 following interventions to stimulate new shoot growth.	June 2008	Bud material was accessed from the teak SO at Mount Lawes. The trees were over 40 years old and lacked vigorous new shoot growth essential for production of healthy active buds. As a consequence the majority of grafts failed to take as the buds were either dead or dormant.
1.7	Establish seed or clonal germplasm sources based on 100 plants / orchard x 2 locations	This milestone has only been partially met. Teak-2 SPA est. using Thai seed sources. No grafted SOs est. C. euryphyllum - 1 progeny trial est but no grafted SO Walnut - no trial established Taun - one seedling seed stand est. but no grafted seed source Basswood - no trial est. Eaglewood - one seed stand est at FRI but no surplus plants for distribution S. album - 2 SPAs established E. pellita - 2 SPAs established A. crassicarpa - 2 SPAs established.	Aug06 - Jun08	Teak- SOs not established because of poor grafting results. C. euryphyllum - SOs not est. because of lack of staff resources to develop grafting protocol Walnut -Taun - as for kalophilum Basswood - unable to obtain seed from Vanuatu. S. macgregorii - spp. work abandoned because of lack of success in grafting and poor survival of source plants which were reduced to 6.
1.8	Maintain germ-plasm sources and manage for optimum germ-plasm	Trials only partially maintained	On-going	Trials of E. deglupta, A. crassicarpa and E. pellita at Bulolo allowed to be overgrown by woody weeds reducing the growth and potential seed yield.

1.9	Maintain and measure trials established under the previous project as per schedule	Calophyllum and walnut trials at Bumsi maintained and assessed for growth and survival in August 2006 Calophyllum and taun trials at Markham damaged by fire during the previous project have subsequently been written off. Basswood trial at Wasap also written off due to neglect. A. mangium SPA at Wasap is now at an age to produce seed but has not done so to date. One possible explanation is the rain has adversely affected successful pollination.	On-going.	basswood at Wasap abandoned because of lack of maintenance
1.10	Make available germ-plasm to nurseries associated with Objective 2 below and other planting programs	No seed available for distribution	n/a	No seed was produced from the seed stands developed thus it was not possible to distribute seed.
1.11	4 project affiliates to visit NQLD with K. Robson to inspect associated activities including nursery, field trials, agroforestry systems	3 project affiliated personnel visited Qld under the guidance of Ken.	March 2006	
1.12	1.12 Promote benefits of using improved germplasm	During the training courses and subsequent partner meetings, the importance of using improved germplasm was demonstrated and stressed.	On-going	The benefits of using improved germplasm were not included in posters distributed to growers. This will need to be rectified in future training material
1.13	Upgrade seed database software and hardware at NTSC	This activity was shelved with funds used to purchase additional teak and sandalwood seed for establishing SPAs.	n/a	

PC = partner country, A = Australia

Objective 2: To train rural communities in raising plants

no.	activity	outputs/ milestones	completion date	comments
2.1	Develop training syllabus for trainers targeted at rural communities	Training syllabus developed and distributed for comment before final version completed	Sept 05	
2.2	Prepare user brochures, posters to assist in sending out key messages associated with training	5 posters prepared together with simple set of instructions.	Feb 06	
2.3	Plan and implement workshop for training trainers to include participant list at FRI	14 participants from across the 4 hubs and rep all partners attended workshop at FRI	Sept 05	
2.4	Develop strategy for delivering training to target users	Strategy developed as part of workshop to assist trainers to prepare and deliver training to communities under their jurisdiction. This included a schedule of activities, timing and reporting.	Sept 05	
2.5	Develop list of equipment and supply same to target users	Equipment list prepared and submitted to FPCD for action against project budget.	Oct 05	
2.6	Trainers to conduct training workshops at 12 rural communities with K. Robson support	Trainers conducted training to over 12 communities.	On-going	Village communities in turn trained other communities as reported by FPCD
2.7	Conduct baseline study on desirability of tree species by different target users. (Coincide with 2.6).	Survey of priority species conducted as part of the workshop and further spp lists developed as part of trainers training w'shops with communities.	Sept 05	

2.8	Make 6 monthly follow-up visits to target users as part of on-going training and evaluation	6 monthly follow-up visits made to communities by trainers together with periodic visits by Australian personnel	On-going	

Objective 3: To develop Eucalyptus deglupta germplasm

no.	activity	outputs/ milestones	completion date	comments
3a	**Establish new E. deglupta SO**			
3a.1	Take core wood samples from ~200 selected E. deglupta trees in PNG and Solomon Islands and assess for wood quality	Some cores were taken from the trees in the Bulolo CSO but not from any other source		In SI authorities were reluctant to allow coring of their select trees while in PNG, the trees in the CSO had heart rot making successful coring impossible.
3a.2	Test peeling ability of logs from E. deglupta CSO at Bulolo by PNG Forest Products to assess clonal variation against results from wood cores	Following discussions with the NTSC staff it was agreed that it was better not to fell the trees in case the new CSO was not successful.	n/a	This proved to be a wise choice as severe plant losses were experienced I the newly established SO
3a.3	Select (60) best E. deglupta families	30 families selected from Bulolo ex CSO SSO and Philippines progeny trial	Nov 05	Scion material from SI was confiscated by PNG quarantine while seed from the same trees did not germinate
3a.4	Establish a new E. deglupta CSO	A new CSO was established at Bulolo comprising 30 clones @ 4 ramets/ clone	May 06	This trial has been subsequently written off due to 27% survival at end of project caused by heavy weed competition and deliberate cutting of trees.
3b	**Produce hybrid between E. deglupta and E. pellita in PNG**			
3b.1	Raise E. deglupta seedlings for rootstocks	completed	Dec 05	
3b.2	Collect vegetative material form 50 selected E. deglupta families and raise cuttings/ grafts	Scion material obtained from 30 trees and grafted on to rootstocks at FRI	Dec 05 – March 06	
3b.3	Bring selected E. pellita pollen from Australia to coincide with flowering of E. deglupta cuttings/ clones	E. pellita and E. camaldulensis brought by P. Warburton to coincide with E. deglupta flowering in 9 clones	April 08	

3b.4	Seed produced from controlled crosses	No seed produced	July 08	
3c	**Develop hybrid combinations between select eucalypts in Qld**			
3c.1	Select best families from E. grandis, E. urophylla, E. tereticornis.	E. grandis and E. urophylla candidate trees selected for controlled pollination	Jan 06	
3c.2	Travel to trial sites with E. pellita and E. dunnii pollen, to coincide with flowering of mother trees	Controlled crosses undertaken on 19 E. urophylla candidate trees at 2 sites	March 06	No flowers available for pollinations on E. grandis trees. All crosses done on E. urophylla destroyed in March 2006 by tropical cyclone Larry
3c.3	Travel to trial sites with E. pellita and E. dunnii pollen, to coincide with flowering of mother trees	39 crosses completed on selected E. camaldulensis	June 06	Catastrophic damage to candidate trees led to alternative site. Significant drought stress impacts on capsule retention and seed yield.
3c.4	Seed produced from controlled crosses	Seed collected from a limited number of successful pollinations from 3c.3	Dec 06	
3c.5	Travel to trial sites if required to carry out addition pollinations	Controlled crosses undertaken at CSIRO clonebank	May 08	Failure of flower induction on E. camaldulensis clones. Seed collected from crosses done on E. pellita clones. 12 Cml x dunnii clones developed and planted in trial 2008.

7 Key results and discussion

7.1 Objective 1. Generation and supply of germplasm of "best bet" propagation populations

The output of this objective was to be, depending upon species, seedling seed orchards, grafted seed orchards, cuttings orchards, seed production areas or a combination of these, for 10 target species. A germplasm improvement strategy covering the 10 species was developed for implementation at the commencement of the project as detailed in Section 5 of this report.

The most successful approach to propagation of germplasm for establishment of seed stands was to access improved seed and raise seedlings as was the case for *S. album, A. crassicarpa, T. grandis and E. pellita*. Vegetative propagation techniques proved unsuccessful either because of skills shortages or lack of suitable vegetative material (T. grandis). Lack of sufficient plants meant that in several instances the required number of seed sources were not established and plants could not be distributed to growers as was originally planned.

Access to suitable planting sites with long term secure tenure caused significant constraints and delays in trials being planted. Option to plant on communal land and use of PNGFA land at Bulolo had their drawbacks which added to their risk. For FRI trials, lack of maintenance was an ongoing issue. This is partly brought about by the need to have the trials some distance from FRI creating transport problems and because FRI does not have a 'field team' who can go out and assess and maintain trials. Casual staff had to be engaged by the project in order to complete nursery work and any trial maintenance. Such activities are therefore often not attended to. Third parties have been found to be reluctant to assist with trial maintenance such as at Bulolo. The best outcome has been engaging Ramu Sugar to establish trials on their own land as is the case for E. pellita, A. crassicarpa, teak and S. album. Site preparation and trial maintenance have been most effective resulting in rapid growth and high survival. Seed from the E. pellita started to produce in the third year post planting. Results and discussions for each of the 10 species follows.

7.1.1 *Dracontomelon dao* (walnut)

29. The walnut provenance trial established at Bumsi (Lae) on community land was converted to a SPA in 2006 by removal of inferior trees to leave 67 stems (50% of original stocking). A number of trees had died partly due to poor maintenance resulting from weed competition and as a result of insect damage. An assessment was carried out on the trees at the time of thinning at age 5.5 years in which average and highest plot mean in parenthesis was 16.0 (20.3) cm dbh and 13.67 (15.95) m in height. The trees produced large coarse branching oval shaped crowns which manifested itself in the average merchantable stem height being 6.0 m. Once these crowns were formed, further height growth was reduced. The tree boles became increasingly attacked by a borer which was found to be boring under the bark resulting in the weakening of the tree and ultimate death of many of the trees post thinning. Borer infestation was noticed prior to thinning in both the trees at the trial site and those in the species trial at the Lae Botanical Gardens. These assessments on walnut would indicate that the species is unsuitable for monocultural block plantings.

30. It was proposed to use grafting and or cutting techniques to propagate 'best best' individuals for the production of a new seed orchard. However, this did not materialise. Some vegetative propagation experimentation work was carried out. Under the previous project, cuttings produced a 93% strike rate (Gunn *et al*. 2004). Attempts to

self graft four nursery hedge garden plants resulted in a 75% strike rate assessed as shoot development following grafting. It can be concluded from these preliminary results that both grafting and cutting propagation of walnut is possible.

7.1.2 *Calophyllum euryphyllum* (kalophilum)

31. The Bumsi trial comprising 15 families established in 2001 under the previous project has started to fruit from age four but insufficient quantities for distribution to growers. In December 2006, a mature seed crop was noted on over 50% of trees. The seeds subsequently shed resulting in seedling regeneration from which approximately 500 seedlings were harvested for use as root stocks. Growth of the trees was initially slow and may in part be the result of oversized seedlings (>1 m tall) being planted and weed competition. However, after about age five, height growth in particular picked up while still maintaining a narrow apical crown well suited to agroforestry applications and for growing in monocultures. Growth performance at age five had tree heights between 12-17 m and dbh 9-13 cm. At age 7, outstanding trees had dbh of 16-19 cm. Caterpillars eating the leaves of trees was a common site especially those trees suppressed by other trees. Because of the narrow architecture of the crowns and relatively wide spacing (3*4 m) the crowns had not closed so thinning of the trial for conversion to a seed orchard was not undertaken.

    This trial has provided encouraging results for the potential use of kalophilum as a planted tree species in both block planting, in agroforestry systems and as individual trees. Where planted in block planting it is suggested that a closer spacing be used (1600-2500) and as a line planting as close as 2 m. Given the very large fruit (unit for planting) and short storage life of the seed, there is potential for this species to be sown directly into the planting site thus saving on nursery activities.

32. A second progeny cum provenance trial was established under the previous project near Markham bridge on communal land in May 2002 based on 40 treatments including 33 individuals (Poesi *et al* 2005). Unfortunately fire destroyed most of the trial and was deemed written off following assessment at the commencement of this project. This highlights the problem of establishing field plantings in PNG as they are prone to fire and land disputes. Unfortunately FRI has very limited access to land except in Bulolo. They therefore have to rely on collaborating with resource owners and other government agencies.

33. The third intended result for kalophilum was to vegetatively propagate 'best bet' material from available sources and establish a new seed orchard. This did not eventuate mainly because of propagation failures and resources. Initial attempts to graft kalophilum failed and were not repeated. Under the previous project, experiments on cutting kalophilum resulted in a 15% strike rate (Gunn *et a*l 2004). A coppicing trial was conducted at FRI where trees were either felled at differing heights above ground (10-50cm) and girdled. Stumps produced some initial growth then died while girdling gave better success with majority of trees producing shoots.

34. A progeny trial was established at Lorengau, Manus Island based on seed collected locally from 20 trees. The trial was established as a RCB design with 6 replicates and trees spaced 3*2 m. Seeds were sown direct into the field with 7% losses recorded after six months. The trial, established in collaboration with the provincial government will be converted to a seed orchard and source of seed for planned reforestation of kalophilum on the island.

7.1.3 *Endospermum medullosum* (basswood)

35. Two provenance trials were established under the previous project. One at Wasap, Madang and a second at Kokopo, ENB on Cocoanut Products Limited (CPL) land. The trial at Wasap was abandoned because of lack of maintenance. A thinning has been undertaken in the Kokopo trial for conversion to a seed stand.

Attempts to acquire additional seedlots from Vanuatu did not materialise. As a result no new trial was established.

7.1.4 *Tectona grandis* (teak)

A significant amount of work has been undertaken in PNG on teak going back to the 1960s. A number of seed introductions and various trials were established ostensibly in ENB and Brown River. The plantation area of teak is approximately 1 500 ha mainly under PNG NFS management in Brown River and ENB. The focus under this project was to capture and duplicate the best available germplasm available in PNG and seed introductions.

36. Neville Howcroft, a former employee of FRI with a corporate knowledge of research teak planting in PNG was contracted to prepare a report on the status of germplasm in the country (Howcroft 2005). Based on the report findings, the focus was placed on capturing the clones contained in the Mount Lawes CSO.

37. Two attempts were made to capture all 29 clones in the Mount Lawes SO. This was carried out by bud grafting clonal material on to rootstocks. The trees in the SO were 40 years old and had lost vigour. As a result they were producing minimum growth and therefore poor bud development. Initial attempts therefore to harvest good buds were frustrated resulting in poor grafting results. The effect of lopping lower branches from selected ramets in the orchard resulted in stimulating vigorous shoot growth from the severed branches. This enabled more desirable buds to be harvested. However, because of the early failures and lack of clonal ramet representation, there were insufficient grafts to establish a new seed orchard as planned. As a consequence up to six ramets/ clone were established in a clone bank at FRI. This approach will both help to conserve the genetic based which is under threat and provide bud material for mass propagation at FRI as required if managed appropriately.

38. Two SO consignments from Thailand were imported with resulting seedlings used to establish two SPAs. One SPA comprising 1450 seedlings was established at Vunapalading in ENB in June 2008 with the second SPA comprising 675 seedlings established by Ramu Sugar. This amount to 2125 plants from 17kg of seed.

7.1.5 *Pometia pinnata* (Taun)

As with walnut, a taun trial was established at Markham Bridge under the previous project and was subsequently destroyed by fire.

39. The plan was to establish a seed orchard based on 'bet bet' material but this did not eventuate. Under the previous project cutting techniques were able to achieve 100% strike rate. Preliminary studies on tip cleft grafting of taun in the hedge garden resulted in 4 out of 12 grafts striking. Seed harvested from Madang and Manus were raised for the purpose of rootstocks. However, no mass grafting was undertaken so the remaining seedlings (200 ex Madang and 90 ex Manus) were established as a seed stand in the Lae Botanical Gardens.

7.1.6 *Gyrinops ledermannii* (eaglewood)

40. Thirty three unrelated source plants were acquired from sources mainly in the Sepik region of the country. Project staff at FRI worked on bulking up the number of plants from each source plant using cutting techniques with the plan to produce between 10-20 plants/ source plant. While early results were successful, as time went by so the strike rate drastically reduced. A shade house was constructed to securely house the potted source plants rather than having them stored in the mist house which was not conducive to growth. Source plants were also pruned back but the strike rate was still not acceptable. At the time of the review it was suggested that the source plants may have become too old (3-5 yrs) and should be replaced with new material.

While single representatives of each source plant were kept in the shade house, the remaining plants were planted out at FRI.

7.1.7 *Santalum macgregorii* (PNG sandalwood)

At the commencement of the project, 21 source plants were represented in the nursery. Attempts to graft from these plants failed and over time the source plants were reduced to only 5. Attempts to access additional seed were unsuccessful because of lack of seed availability and restricted access to the natural populations between Central and Gulf Provinces. Work on the species was therefore abandoned.

7.1.8 *Santalum album* (sandalwood)

Seed orchard seed (2 kg) was acquired from Kununurra seed orchards and sown at both FRI and Ramu Sugar nurseries. Approximately 300 seedlings were raised at each location and planted out as seed resource stands interplanted with *Gliricidia sepium* as host plant in 2007/8.

7.1.9 *Eucalyptus pellita* (pellita)

Seed orchard seed was acquired from Australia and seedlings raised. 250 plants were established as a SPA by Ramu Sugar and 470 plants established at Bulolo. The planting at Bulolo has been poorly maintained with weed growth outgrowing the trees resulting in loss of plants and poor crown development. The Ramu Sugar planting had been well maintained trees were starting to produce by the end of the third year.

7.1.10 *Acacia crassicarpa* (Acacia)

Seed orchard seed was acquired from Australia and seedlings raised. 150 plants were established as a SPA by Ramu Sugar and 450 plants established at Bulolo. The planting at Bulolo has been poorly maintained with weed growth outgrowing the trees resulting in loss of plants and poor crown development. The Ramu Sugar planting had been well maintained.

Table 1. Summary of germplasm facilities produced during the project

• *Species*	• Germplasm sources established	• Area	• Comment
• *Dracontomelon dao*	• 7 year old provenance trial cum SPA at Bumsi (established under previous project) thinned in 2006	• ~ < 0.5ha	• Major Fatalities / stem damage due to caterpillar/borer
• *Calophyllum euryphyllum* •	• Progeny trial cum SPA established on Manus Is in October 2007	• 0.36h a	• Contains 30 trees of each seedlot. Initial survival encouraging
	• 7 year old progeny trial cum SPA at Bumsi (established under previous project) maintained/measured.	• ~ < 1.0 ha •	• 2 of the 4 reps able to be thinned during 2008
• *Endospermum medullosum*	• 3 year old progeny trial cum SPA at Rabaul, ENB on CPL land (established under previous project) maintained/measured.	• ~ < 0.5 ha	• To be thinned to form SPA in 2008
• *Tectona grandis*	• Up to 29 clones Ex. Mt Lawes orchard established as Clone Bank at PNGFRI from 2006 to 2008.	• ~ < 0.2ha	• 18 clones established in clone bank. 11 grafted in June 08.
	• Imported Thai orchard seed established as SPA at Kerevat in May 08	• 3.5 ha	•

	• Thai seed orchard seed established as SPA at Ramu Sugar in Feb 08	• ~ < 2.0 ha	•
• *Pometia pinnata*	• 290 individuals (200 Ex. Madang and 90 Ex Manus) established in seed stand at Lae Botanic Gardens in mid 2007.	• 0.54 ha	• Individuals selected at markets on basis of fruit quality
• *Gyrinops ledermannii*	• Plans for CSO of all available plants of the 33 clones to be established at PNGFRI in 2008	• ~ < 0.1 ha	• Material ranges from 5 year old hedge plants in pots to recently set/struck cuttings
• *Santalum macgregorii*	• No sources established	• -	•
• *Santalum album*	• 360 seedlings Ex. WA Seed Orchard material established in SPA at Ramu Sugar (with host plants) in Feb 2008	• ~ < 0.6 ha	•
•	• 80 seedlings Ex. WA Seed Orchard material established in SPA at PNGFRI (with host plants) in April 2008	• 0.14 ha	• Further 36 plants to be established
• *Eucalyptus pellita*	• 450 seedlings Ex. QLD Seed Orchard material established at Bulolo as an SPA in Dec 06	• 0.54 ha	• Of marginal use as trial or SPA due to poor/variable growth and poor survival
•	• 150 seedlings Ex. Qld Seed Orchard material established at Ramu Sugar as an SPA in Dec 06	• ~ < 0.2 ha	• Good growth/survival reported
• *Acacia crassicarpa*	• 250 plants Ex. QLD Seed Orchard planted at Ramu Sugar as an SPA in Aug 06	• ~ < 0.5 ha	• Good growth/survival reported
•	• 470 plants Ex. QLD Seed Orchard planted at Bulolo as an SPA in Dec 06	• 0.54 ha	• Of marginal use as trial or SPA due to poor/variable growth and poor survival

Recommendation 1.1.6: That trials established under any future project be structured

7.2 Objective 2: Training rural communities in raising plants

In line with the project proposal, four geographical hubs were established; Lae/Morobe, Madang/Madang Province, Goroka/E. Highlands, Rabaul/East New Britain) supported by selected NGO Partners (FPCD, OISCA, VDT, SDA, TNC). Hub Partners were to identify 3 communities per hub thus totalling 12 in all. To all intensive purposes training was provided to at least 12 communities. As summarised in table 2, with over 100 nurseries established either as individual family or communal operations and over 130 000 seedlings raised. Nursery capacity ranged from 100 to 15 000 seedlings. The majority of plants raised have been casuarina and coffee in the highlands and a much wider range of species in other hubs. The nursery skills gained have also been used to produce vegetables and other non timber trees. It is encouraging that skills are being applied to other seedling production. Further encouragement has been the report that skills transfer is occurring between villagers which demonstrates an increasing interest in raising plants at the village level thus more likely to become self sustaining.

An initial 'train the trainers' workshop attended by 14 participants from the various Partners; FRI (2), FPCD (5), VDT (2), OISCA (2), TNC (1), SDA (1) and CPL (1) was conducted at the commencement of the project. Following the training, the trainers then selected communities interested in raising seedlings and provided training. In the case of community nurseries under FPCD and VDT, the trainers provided a number of follow-up training workshops at which both previously trained personnel attended and new participants attended. In the case of OISCA which has a central training facility outside

Kokopo, a large number of participants attended nursery training courses as part of broader based training. However, follow-up training was not standard procedure making it impossible to accurately assess uptake of training.

A Nursery Manual for community nurseries was produced in English and Pidgin, linked to the production of five nursery posters that were distributed to trainers and nurseries.

Limited equipment was provided to community nurseries by FPCD. However, feedback indicated a shortage of seed of required species and a need for additional equipment with a lack of poly bags in particular being of greatest concern. However, this shortage of supplies, in the face of greater than expected demand, seems to have promoted adaptation by communities, with examples of “shade” being constructed out of palm leaves instead of shade cloth, and old rice bags, drink cans, banana stems etc being used in place of poly bags.

Whilst there appears to be a need for a greater supply of poly bags and seed of high-value species, and in some situations for other materials such as seed, watering cans, wheel barrows, spades etc, in the long-run it could be argued that these costs will need to be absorbed by communities, and either funded from the sale of timber (where re-planting is part of commitment made for reafforestation after native forest logging) or from revenues obtained from the sale of plants (where nurseries are run as commercial enterprises).

However, whilst the funding of experienced trainers/mentors is clearly the most important requirement for success, in the formative stages of a program such as this it could also be argued that additional funds need to be allocated to provide equipment and consumables required to support the successful start-up of nurseries.

FPCD was the coordinating Partner for this objective and were therefore funded in order to carry out the activities under their responsibility. As an NGO organisation with a strong focus on forest development and conservation, they were ideally suited to coordinate training rural communities in raising plants. However, as FPCD found, it was a significant challenge to identify other NGOs who were actively involved with rural tree planting programs. The other NGOs were only funded to attend the training workshops and project meetings but not to meet their own training expenses. Limited funds were also provided for equipment as indicated above. It is suggested therefore, that delivery of outcomes would have been more effective if NGO partners could have been provided with funds to enable them to carry out the training activities more effectively and a stronger commitment to the project.

FRI staffers Agnes Sumareke and Maman Tavune who received nursery training under the project are now key personnel in the nursery activities under the fuelwood project FST2006/088. They have provided excellent support in assisting with the establishment of nurseries at Mount Hagen and Port Moresby and training the community staff. These nurseries both have a capacity in excess of 10 000 seedlings made up of over 5 species.

Table 2. Key outputs from community nursery establishment and training program.

<table>
<tr><th>• Organisation</th><th>• Outputs</th></tr>
<tr><td>• FPCD</td><td>
• Undertook 9 training workshops in 3 out of the 4 “hub areas”, being Eastern Highlands (Henganofi, Kainantu), Madang, and Morobe. The outcomes of the training are summarised below.
<table>
<tr><th>Location</th><th># Trainings</th><th># Trained</th><th>Nurseries</th><th>Total Seedlings</th></tr>
<tr><td>Henganofi</td><td>1</td><td>13</td><td>9</td><td>65,327</td></tr>
<tr><td>Kainantu</td><td>3</td><td>19</td><td>7</td><td>26,922</td></tr>
<tr><td>Madang</td><td>3</td><td>60</td><td>30</td><td>9,000</td></tr>
<tr><td>Morobe</td><td>2</td><td>24</td><td>10</td><td>10,473</td></tr>
<tr><td>TOTAL</td><td>9</td><td>116</td><td>56</td><td>111,722</td></tr>
</table>
• Purpose for selecting, raising and planting were for timber, environment amelioration, fuel wood, cash income, food (fruits, nuts etc) and indoor or outdoor ornamental plants. Nurseries range in size from 1,000 to 15,000 seedling capacity.
• Linzong Zaman is the FPCD trainer for Morobe, being responsible for Wantoat, Leron and Boana. Main species raised in Morobe were Araucaria, Elaeocarpus, Casuarina, Coffee. Examples of trained communities that are still active are Leron-Wantoat & Erap-Waing. SDA and VDT were also responsible for training in this province.
• Kafuri Yaro is the trainer for Kainanut. Main species raised in Kainantu were Casuarina, Eucalyptus, Pinus, Araucaria, Citrus, Cypress and vegetables. Examples of trained communities that are still active are Abinakenu, Keketupa, Kanimpa, Mapara, Duampa and Barric Gold.
• Fletcher Onise is the trainer for Henganofi. Main species raised in Henganofi were Casuarina and coffee. Fomu village is the active community in which nurseries have been established.
• Taksey Dobon is the FPCD trainer for Madang. Main species raised in Madang were Rosewood, Balsa, Podocarpus, Taun, Kwila and Acacia. Examples of communities still active are Uya, Berin and Jopoto. Training done in collaboration with Medang Forest Resource Owners Association (MFROA) who are part of FPCD’s Ecoforestry Program.
</td></tr>
<tr><td>• VDT</td><td>• Undertook 2 training workshops (with assistance from FPCD), facilitated the establishment of nurseries at 4 project sites in the Lae/Morobe “hub” area at Garam, Gabsongkeg, Yalu and KGWan, and produced around 5,000 seedlings of forest tree and other species, including some supplementation from VDT nursery sources. Main species produced include Kamarare, Kwila, Taun, Cocoa, Noni, Casuarina, Hoop, Klinki. George Rifi from VDT demonstrated the newly constructed nursery at Garam during the Project Review visit.</td></tr>
<tr><td>• OISCA</td><td>• Trained 240 trainees from East New Britain and from other provinces since 2005. Trainees have established basic nurseries in their communities with promotion of nurseries tied to promotion of their Rice Training Programme and to the supply of seedlings for the Soil Erosion project being implemented by the East New Britain Provincial Government. The OISCA training school has also included this training under their ‘Forestry and Wildlife Management’ subject. Total of 27 nurseries established in the Kokopo District and 25 established in the Gazelle District since 2005. A total of 3,648 ‘hardwood’ plants raised in 2006-07 and 2,612 raised in 2008. Species raised include Kamarare, Kwila, Acacia, Taun, Teak, Terminalia, Palm Tree, Gmelina, Sandlewood.</td></tr>
</table>

7.3 Objective 3: Development of eucalypt hybrids

Objective 3 has three elements:

3a Improve genetic quality and availability of *E. deglupta* in PNG

3b Develop novel hybrids between *E. deglupta* and *E. pellita*

3c Develop novel hybrid combination between eucalypt species in Queensland

The output of this objective was to develop germplasm sources of Eucalyptus deglupta and a range of hybrid eucalypts of potential relevance to PNG and northern Australia.

7.3.1 1.3a Improve genetic quality and availability of *E. deglupta* in PNG

Good progress was made on acquiring genetic material for establishment of a new Clonal Seed Orchard, even if it only ended up comprising of 30 clones instead of the 60 families (clones) originally envisaged. Clones were sourced from the current CSO in Bulolo (19 clones), 5 selections from the Bulolo seedling seed orchard and 6 selections from the Philippines progeny trial established at Bulolo. Quarantine procedure issues and seed storage/handling thwarted attempts to successfully import/raise vegetative and seed material from 11 Solomon Is clones. Training was provided to FRI staff in tip cleft grafting of E. deglupta which then enabled the trained staff to continue the work as required. Over four plants / selection were grafted and established at Bulolo early on in the project in December 2006. An assessment in early June 2008, undertaken by PNGFRI identified only 27% survival of trees in this trial at age 2.5 years. Vandalism and poor maintenance, resulting in significant weed competition, have been put forward as reasons for this poor survival. An inspection of this planting during the Project Review visit in June 2008, approximately three weeks after the trial was last maintained, confirmed this to be the case. Given the poor survival and clonal representation it has been decided to write off the seed orchard.

This leaves the current SO comprising 19 clones planted in February 1975 as the only seed orchard in the country. Unfortunately seed yields in recent years has been greatly reduced from this source thus requiring collections to be made from either the Philippines trial or mounting collection expeditions to wild populations. Even attempts by FRI in 2006/7 to acquire seed from the different clones for a progeny trial failed because of lack of seed.

Other planned work on the wood coring of trees in the original Clonal Seed Orchard at Bulolo (to assist with the selection of clones) was not fully completed due to most of the trees in the Bulolo seed orchard that were cored being found to have significant heart rot, possibly the result of the trees being topped at around 15 years of age.

The proposed harvesting of trees in the existing Clonal Seed Orchard at Bulolo by PNG Forest Products, to test peeling ability of clones, did not proceed as NTSC did not want the orchard trees felled in case the new seed orchard was not successful.

7.3.2 1.3b Develop novel hybrids between E. deglupta and E. pellita

A total of 64 ramets (comprising 25 clones from the 29 used in the CSO) were established as a Clone Bank at PNGFRI in February 07, with this material being used for undertaking pollination crosses.

Both *E. pellita* and *E. camaldulensis* poly-mixes were brought over by Paul Warburton of CSIRO in April 2008, to coincide with flowering of *E. deglupta* which was being monitored by PNGFRI staff.

Nine E. deglupta clones were pollinated from 15th – 23rd April by PNGFRI participants under the tuition of Paul Warburton. Three different pollination techniques were used, with all nine clones crossed with E. pellita and six of the nine clones crossed with *E. camaldulensis*.

Pollen testing protocols developed and implemented at PNGFRI during Paul Warburton's visit were not successful. It is thought that the testing protocol used, not the pollen, is likely to be the cause of this result. No seed eventuated from these controlled crosses.

7.3.3 1.3c Develop novel hybrid combinations between eucalypt species in Queensland

This component involved the selection of families and the making of a number of novel hybrid combinations at a number of locations in Queensland over a two year period extending from February 2006 to May 2008. Key activities undertaken were:

- E. pellita pollen (polymix) applied to E. urophylla and E. grandis trees at Kuranda and East Palmerston, North Queensland, in Feb/March 06.
- E. pellita and E. dunnii pollen (polymixes) applied to E. camaldulensis trees at Calliope, Central Queensland, in July/August 2006.
- E. pellita, E. camaldulensis and E. urophylla/tereticornis pollens (polymixes) applied to E. camaldulensis and E. grandis trees at Nambour, South East Qld, between January 2006 and May 2008.

Seed produced from these pollination activities is summarised as follows:

- No seed collected from the North Queensland pollinations made in Feb/March 2006 due to damage to trees and impeded access to sites resulting from Cyclone Larry.
- A small amount of seed capsules was collected from 8 of the 39 crosses undertaken at Calliope in Central Queensland. Approximately 12 clones from five E. camaldulensis x E. dunnii families have been raised, and are to be planted in a trial in 2008.
- Small amount of seed capsules have been collected from crosses completed at Nambour in South East Queensland, with further collections to be made in August 2008 and early 2009. Plans are in place for any remaining seed to be collected and planted out in a hybrid progeny trial in 2009.

8 Impacts

8.1 Scientific impacts – now and in 5 years

As identified in the Project Document (pages 18 and 19), although the production of new hybrids was thought likely to generate some novel scientific information, in all other respects the project was primarily considered to be a development and extension project.

The plan had been for at least one scientific publication to report on the hybrid work, particularly on the level of success in developing hybrids between specific eucalypt species. Whilst this has not occurred to date, and the success of some of the hybrid crosses is still unknown, there may still be some prospect of CSIRO and PNGFRI including information on the success or otherwise of this hybridisation work in a scientific publication or conference paper.

PNGFRI have the skills to undertake another round of CP and report on the relevant success of the 3 different techniques for producing *E. deglupta x pellita* hybrids (success rates vs productivity).

There is the potential for scientific impact through the assessment of the various trials established as part of this and the previous project and publishing the results. Of particular interest is the species trial established at PNGFRI in the botanic gardens in 2001/02 that has up to three replicates of block plantings for a number of species, including species included in Objective 1 of this ACIAR project, such as *D. dao, P. pinnata, C. euryphyllum* and *E. medullosum*, and other species such as *Elmerrillia papuana* (Wau Beach) and *Terminalia complanata* (Talis), both of which have performed well.

In addition to providing an opportunity for scientific or technical write up and publication of the data, the analysis of the species trial, including tree form and growth rates and survivals over time, would add value to the already significant demonstration potential provided by this trial e.g. the fact that only 3 of the 25 *Intsia bijuga* (Kwila) trees planted in this trial survived is quite significant, with this likely to have been a result of it being planted in the open without a “nurse crop”.

8.2 Capacity impacts – now and in 5 years

Staff at PNGFRI, FPCD, OISCA and VDT have been provided with opportunities to increase knowledge and skills through:

Participation as scientists on the project

- Bruno Kuroh (2005-08), Agnes Sumareke (2007-08), Gedisa Jeffrey (2005-08), Michael Poesi (2005-07) and Anton Lata (2005-07) all participated as scientists on the project.

Participation as project managers/coordinators on the project

- Nalish Sam (2005-06), Michael Poesi (2006-07) and Bruno Kuroh (2007-08) all acted in the capacity of Project Director/Coordinator during the project.
- Nalish Sam, Michael Poesi, Don Bakat (PNGFA), Brown Kiki (PNGNFS GM), Brian Gunn visited key forestry industries (JANT, Open Bay, Stettin Bay and CPL) to promote the services of FRI and explore collaborate opportunities with these companies.
- JANT signed a financial contract with FRI to provide research services associated with establishment of provenance/ species trials on their land to assess alternative germplasm options. Michael Poesi was project leader for implementation.

- In 2007, Michael Poesi took up the position running the forestry section of the PNG Sustainable Development Program from Kanawi Pouru is MD of the PNGFA. This position was hotly contested with many older and more experienced people applying. Michael paid tribute to his appointment on the excellent training and experience which he received as part of managing the ACIAR projects and receiving international training. I came with new ideas and a fresh approach to the position and a proven track record of delivering outcomes on time in accordance with project requirement.

Interaction with Australian project personnel during project visits

- Brian Gunn (9 visits), Ken Robson (5 visits), David Spencer (2 visits) and Paul Warburton (1 visit) provided individual and group training during the project.

Attendance at training courses

- Anton Lata and Gedisa Jeffrey participated in the two week Nursery Managers Workshop held at FRI, Lae, in September 2006
- Gedisa Jeffery, Agnes Sumareke, Alex Agiwa, Bruno Kuroh, Derek Bosimbi attended a 10 day controlled pollination training course in April 2008.
- Anton Lata, Gedisa Jeffery, Michael Poesi were provided with hands on training in E. deglupta grafting, care of plants and documentation over a two week period in December 2005. This included the supply of essential equipment for carrying out the work. Post training, the two staff members continued the clonal grafting.
- Anton Lata, Gedisa Jeffery, Michael Poesi and Bruno Kuroh were provided with hands on training in teak grafting on several occasions (4 weeks) over the course of the project.

Participation in study tours to Australia

- Anton Lata (PNGFRI) , Kafuri Yaro (FPCD), Gorethy Dipsen (Ramu Sugar) were participants on the study tour of forestry activities in North Queensland, completed in March 2006.

Making project presentations

- staff from FRI, FPCD, OISCA, VDT and SDA made presentations at the Project Inception, Coordinating Committee (PCC) and Project Review meetings. The quality of Power Point presentations had markedly improved between the Inception meeting and Review workshop.

Providing opportunities, directly or indirectly, for researchers to undertake management training and post-graduate studies in Australia

- In 2006 Michael Poesi undertook a visit to Australia under an ACIAR John Dillon Memorial Fellowship.
- In 2007 Anton Lata commenced a Masters program at JCU under an ACIAR John Allwright Fellowship.
- In 2007 Nalish Sam commenced a PhD program at ANU under an ACIAR John Allwright Scholarship.
- In 2006, Israel Bewang (FPCD project co-ordinator) commenced a Masters program at ANU under an AusAID scholarship.

From a technical perspective, PNGFRI research staff members associated with the project appear to have increased knowledge and skills in areas such as:

nursery skills including, soil media, watering, sowing techniques, pricking out, seed testing, striking cutting;

vegetative propagation by grafting (two methods);

vegetative propagation by cuttings and marcotting;

trial design and establishment (including use of trial design software packages);

establishment of seed orchards and seed production areas;

management of clone banks and nursery hedge plants to promote vegetative material for propagation;

control pollinations of Eucalyptus spp (three methods);

wood coring; and

development of germplasm development strategies.

My review of various trip reports also shows that Brian Gunn, Ken Robson, Paul Warburton and David Spencer put a concerted effort into instilling in the PNGFRI research staff the need to develop and apply knowledge and skills learned in "research management" activities, such as:

establishing and maintaining accurate information in the PNGFRI trial register database;

establishing experiment files, and the importance of recording information on electronic and hard copy files;

scheduling of activities and activity planning (including use of Gantt charts);

preparation of working plans and establishment reports (e.g. potting media trial);

project management (holding team meetings and taking/distribution of minutes);

strategic planning (e.g. for hybrid development and evaluation);

establishing base-line information on topics, and evaluating training outcomes;

risk management (e.g. putting trials at multiple locations and splitting seed between nurseries); and

communication, liaison, and collaboration with a wide range of stakeholders (e.g. Ramu Sugar, JANT, NGOs, PNGFA, etc).

During the course of the project there was a high turnover of FRI staff and insufficient PNGFRI human resources made available at times during the project (three scientific/project staff considered insufficient to deliver all required outputs). The leadership of the project changed over the life of the project and the key vegetative propagation person Anton Lata commenced his Masters program early in 2007 which greatly reduced the projects capacity to continue vegetative propagation work on the target species.

8.3 Community impacts – now and in 5 years

From an improved germplasm perspective, a group exercise completed at the Project Review Workshop held at FRI, Lae, identified potential for the:

C. euryphyllum progeny trial cum SPA established at Bumsi, to produce improved germplasm within 1 year.

E. pellita SPAs established at Bulolo and Ramu Sugar, derived from Queensland seed orchard material, to produce improved germplasm within 1 year.

A. crassicarpa SPAs established at Bulolo and Ramu Sugar, derived from Queensland seed orchard material, to produce improved germplasm within 3 years.

E. medullosum progeny trial cum SPA established at East New Britain, to produce improved germplasm in about 3 to 5 years.

S. album SPAs established at PNGFRI and Ramu Sugar, which are derived from W.A. seed orchard material, to produce improved germplasm in about 5 years.

T. grandis SPAs established at Kerevat and Ramu Sugar, which are derived from Thai seed orchard material, to produce improvement germplasm in about 5 years.

P. pinnata seed stand established at Lae Botanic gardens, which is derived from fruit selected from markets, to produce improved germplasm in about 5 years. AND

G. ledermannii seed stand established at FRI, to produce seed in about 5 years.

Given the relatively small areas involved in each of these plantings (See Table 1), and in

For the eucalypt hybrid seed, it is premature to speculate on the potential benefits of this program, for Australia or PNG. However, given the need for extensive testing of any new hybrids developed, it is unlikely that any significant benefits will be realised in the next five years. There are plans to produce hybrid clones of the Australian material within the coming year for evaluation by commercial growers but potential commercial deployment would take more than five years to be realised.

The successful training to-date of rural communities in the propagation and deployment of material, and the establishment of a training/support network, will continue to have impacts in the five year period after the project has been completed, subject to the "momentum" developed during this project being maintained.

While there is no evidence of clear economic impacts through greater monetary wellbeing or higher disposable income there are clear examples particularly associated with nursery training in rural communities that have improved the availability of planting stock and more efficient use of resources through improved planting stock and planting techniques.

From the nursery training reports, it is clear that the adoption of practices taught by the Trainers, and the creation of significant numbers of community nurseries, is significantly increasing the number of plants being produced. It is also evident that, in many situations, this has translated into more trees being planted by farmers or land owners.

In his Annual Project Report to 31 March 2008, Yati Bun of FPCD stated that

Over the last 6 months a total of 87 102 seedlings have been raised from seeds (17 513), wildings (9 413), and cuttings (88). Where as 13 489 seedlings have been planted within 70 ha estimated area, and 3 681 have been sold and 8 814 seedlings remain in stock.

From Table 2 it can be seen that most seedlings produced from FPCD trained community nurseries were in the Hanganofi District, with only nine nurseries producing in excess of 65, 327 seedlings, as a result of only 1 training session?

8.3.1 Economic impacts

There are no examples of improved monitory wellbeing or higher disposable income to families during the life of the project nor is it anticipated that there will be notable impacts over the next five years. However, forestry is a long term activity where the economic benefit of raising trees is many years and for high value tree species which was the focus of this project, the economic returns is likely to be in excess of 20 years. The establishment of improved seed stands will make available improved germplasm to growers over the next five years. This will have the impact of both making available seed of potentially commercial species with superior genetic quality resulting in faster growth and better product yield compared with any seed that is available. In many instances there are reports of growers not being able to access seed of choice.

Economic impact from nursery training is also not evident but has the potential to provide impacts within the next five years. To better understand what is happening here, it is useful to provide a direct quote from an FPCD Activity Report prepared by Fletcher Onise in March 2008, for his Target Community of Fomu Village, Henganofi, Eastern Highlands Province.

> *The community after 15 years of intensive tribal war with neighbouring villages have now settled. Equipped with the nursery techniques and skills it was observed that they are very aggressive in establishing agricultural cash crops plots, especially coffee, basically for income generation.*
>
> *The thirteen (13) trained participants who attend the agro forestry nursery techniques course have shared their skills learnt to 36 other people in the community who have established their own nurseries and are establishing coffee plots with nitrogen fixing plant species.*
>
> *More than fifty (50) participants are now engaged in applying the knowledge and skill demonstrated during the agro forestry training. An estimated area of more than 46ha has been established from seedlings produced from nurseries applying techniques learnt. An increase in the establishment area basically signifies that certainly seedling production has increased. Seedlings, especially coffee and Casuarina spp or other nitrogen fixing spp, produced is estimated to be over 60,000.*
>
> *The community on the overall greatly applauds the agro forestry training received for it has greatly enhanced their skills and enabled them to produce healthier and better seedlings, hopeful that it will increase yield which may on the other hand increase economic returns.*

Whilst it is appreciated that in this situation the establishment of coffee plantations could no doubt have occurred anyway using traditional methods, it appears as though the provision of community nursery training under this ACIAR project may, in this instance, have been “at the right time and right place” to act as a catalyst for a rapid expansion of coffee establishment by land owners or “next users” from this village.

Improved quality and growth of plants produced by community nurseries, resulting from the adoption of improved practices as use of high shade, racking of plants to improve drainage, and improved potting media, will also translate to significant benefits for land owners or forest managers, as the “next users” of this project outcome.

In Fletcher Onise’s report (see quote above), he identifies that for the production of coffee and associated nitrogen fixing species such as Casuarina spp., the production of “healthier and better seedlings” will hopefully “increase yield which may on the other hand increase economic returns”.

A quote from an FPCD Training Report compiled by Kafuri Yaro also highlights that communities in the Kainantu District of the Eastern Highlands Province saw significant productivity/economic benefits in the nursery training that had been provided:-

> *Nursery training was vital. It helped much of the owners in terms of availability of planting material. The planting material was always available and (they) never went searching for wildings etc... The skills learnt and applied worked and had a positive result. They were convinced and wanted to continue.*

One enterprising person from Kainantu, Sali Tony, established a commercial nursery operation following the nursery training. He sells his seedlings in the local market and has orders from local agencies (PNG Power, Works Dept., DAL, NARI) for the supply of seedlings.

8.3.2 Social impacts

The innovative approach to training target communities in nursery techniques and tree planting ensured that there were close links between the project partners and their communities. Village communities were selected on the basis of their close links with the partners and their commitment to tree planting. Yati Bun was particularly conscious of selecting Partners (NGOs) who had a proven track record of working with rural communities in tree planting and environmental activities. It was for this reason that the project was not able to reach its target number of Partners. However, those Partners that

were active, FPCD in Madang, Morobe and Eastern Highlands, VDT in Morobe and OISCA in East New Britain had close links with communities through their trainers. Following initial training, trainers were encouraged by communities to return on several occasions to provide back up training which often involved additional people. The number of community nurseries ended up being about 46 which is a significant increase from the project target of 12. In the last year of the project, there was strong interest in establishing nurseries as the idea caught on. As indicated under Economic Impacts, communities who had been training and established nurseries in the Eastern Highlands were providing training to other communities members. A clear indication of positive social impact. There is ample evidence that village communities in PNG are interested and familiar with the need for trees in their environment such as the use of *Casuarina oligodon* for agroforestry systems in the highlands. Trainers were

8.3.3 Environmental impacts

It is- clear that the enhanced production capacity and improved plant quality resulting from community nurseries is meeting a demand for more forest trees to be produced/planted for environmental purposes and/or acting as a focal point for environmental awareness programs. In particular this is being reflected in programs such as FPCD's Eco-Forestry Program, where target communities are required to replant harvested sites with high value species.

As identified in FPCD's 2006 Annual Report, the aim of FPCD's Eco-Forestry Program is "to train and build capacity of the landowners to manage their own forest resources and obtain direct benefits while preserving the forest for future generations". A key component of this program is the forest nursery trainings which are "conducted for landowners to utilise the skills to establish nurseries to grow and plant trees".

A quote from an FPCD Training Report, compiled by Taksey Dobson, shows how the ACIAR nursery training is being translated into environmental benefits in the Madang Province, one of the primary focus areas for FPCD's Eco-Forestry Program:-

> *Madang's Forest has been heavily affected through large scale clear felling operation and other uncontrolled human activities like shifting cultivation and fire. The biggest experience is in the Gogol Valley of the Madang Province, Papua New Guinea. We have at our best to carryout awareness of the issue to save the remaining forested land and even grow back forest on areas that have been deforested. The inception of the ACIAR Project has boosted our efforts technically in the establishment of nurseries and the continued planting of trees on the degraded areas, and further train the land owners to establish village nurseries and continue planting trees on their land.*

A quote from a further FPCD Training Report compiled by Taksey Dobson, following training conducted in the Bogia District, Madang for members of the Madang Forest Resource Owners Association (MFROA), also highlighted the environmental benefits of this component of the ACIAR project:-

> *The final training evaluation report received from the participants indicates that they really appreciated the training and it was one of the first of its kind in the Ramu area. It was considered as a major shake up for communities from forest destruction through gardening, and flood erosion. They said in order to combat this problem were through forest nursery set up and reforestation. The theme of the training was OPERATION PLANIM BEK DIWAI BILONG TUMBUN which means 'Operation replant native tree'.*

The following quote from another FPCD Training Report, compiled by Linzon Zamang, a trainer in the Leron/Wantoat and Erap/Waing LLGs of the Morobe Province, also identified the broader environmental awareness benefits aroused by the training:-

The interests roused from this nursery trainings with in each community have been increased as the nursery owners began producing more healthy plants stock from their nurseries. After the trainings conducted and the tree planting awareness carried out, the communities involved are now more environmentally concise and are more precautious when cutting down forest for shifting cultivation or other activities.

8.4 Communication and dissemination activities

Formal communications with ACIAR

- 3 Annual Reports
- Trip reports by Australian personnel visiting PNG

In country project communication

- Inception meeting at commencement of project involving PNGFRI, FPCD, OISCA,VDT, SDA, reps from Australian agencies.
- Six monthly PCC meetings with minutes distributed to project collaborators
- Periodic seminars by project staff held at FRI to include field site visits
- Regular email and phone exchanges between PNG and Australian personnel
- Partner coordination trainers disseminated information as part of training workshops held during the life of the project.

Publications

- Gunn, B. New ACIAR Project – FST/2004/009 in PNG. PI&FT Newsletter, No 3/05
- Gunn, B. Conservation of *Santalum macgregorii*. PIF&T Newsletter, No. 4/05
- Gunn, B. 2007. Facilitating the availability and use of improved germplasm for forestry and agroforestry in PNG. ACIAR Papua new Guinea and Solomon Island Nuis Vol.2 Issue 2.

A series of five ACIAR Nursery Training Posters (550mm x 400mm), published in Pidgin on water resistant paper, were developed in collaboration with FPCD and distributed by Trainers to community nurseries during the 2nd year of the project: The titles of the posters are:

Methods of raising seedlings and rooted cuttings

(Wei bilong kamapim pikinini diwai land sid na long han diwai)

Nursery Hygiene

(Gutpela Neseri Lukaut)

Seed germination

(Rot wei ilong grouim sid)

Seedling care

(Rot wei bilong lutaumin pikinini diwai)

What are rooted cuttings?

(Wonem samting en rut katings?)

9 Conclusions and recommendations

9.1 Conclusions

The project demonstrated a good working relationship whereby Australian and PNG forest research together with development institutions can collaborate and cooperate in the delivery of community forestry development activities.

It will be important that the seed stands established under the project be maintained and managed in a way to produce a balance between genetic improvement and seed yield. The current areas of seed stands especially of teak and rainforest species is likely to be insufficient to meet seed demand thus requiring additional seed stands to meet anticipated seed requirements.

A number of field trials have the potential to provide valuable scientific information on species performance. A culture of supporting staff to maintain meticulous records, assess trails, analyse results and write up their work is an important step towards achieving this important goal. Incentives need to be in place which encourages this commitment rather than the tendency to move on to the next 'exciting' activity rather than the hard task of information dissemination. The support of a mentoring system to encourage this work is recommended.

The development of NGO and CBO networks with rural communities to develop tree planting programs has been encouraging and needs to be fostered. Long term extension support of tree farmers will be essential if the idea of a rural landowner based plantation industry is to become a sustainable reality.

9.2 Recommendations

The majority of recommendations presented in the draft Review Report on the project (Stephen Walker 2008) are supported and incorporated in to the report. Given that a new project is being proposed (FST2007/078) which draws on the work carried out on this and the previous related project FST1998/115, it is important that relevant project activities be maintained with respect to the three Objectives.

Objective 1. Germplasm Germplasm development for target species

- FRI must maintain the various trials and seed sources in order to obtain maximum benefit in terms of information and seed production. A balance of funds are still in the FRI project account which if used effectively could meet the majority of the cost of maintaining and assessing the trials.
- PNGFRI project staff assess the various trials (species, walnut, kalophilum trials) and publish (at scientific or report level) the results of these trials. This requires PNGFRI management to support staff in this activity to ensure it is completed.
- For teak which will be the focal species for the proposed project, there are several activities which are important to continue working on for both the new proposal but more importantly for the forestry industry in PNG.
  - That all possible resources be applied to ensure the successful “take” of recent grafts undertaken in the *T. grandis* Clone Bank established at Lae, and to ensure that this facility is managed to ensure the identity of the clones and to maximise the production of healthy shoot/bud material.
  - Further attempts should be made to acquire any clones from Mount Lawes CSO that did not successfully strike and therefore not represented in the Clone Bank.

- Additional clonal material be sourced including ENB, Brown River and the Mare trials.
- That a high priority is placed on establishing and maintaining suitable rootstocks for the grafting on of bud material from the T. grandis Clone Bank, with the objective of producing sufficient grafted material for the establishment of one or more Clonal Seed Orchards in 2009.
- That a high priority be placed on collecting seed by individual clones from the Mt Lawes T. grandis Clonal Seed Orchard at the next available opportunity, with particular priority placed on collecting seed from any clones that may be known to have performed well in previously established progeny trials, or as controls in provenance trials.

Objective 2. Community nursery development

- FPCD should be encouraged to continue maintaining contact with the various communities with whom they developed nursery capability. Those communities particularly in the Madang and Markham Valley area may well become potential collaborators under the new proposed project.
- That CSIRO, with input as required from Ken Robson (Ex. DPI&F), finalise the Nursery Manual and provide to FPCD for conversion to Pidgin prior to dissemination by Trainers to community nurseries. The nursery should include information on the benefits of using genetically improved seed.
- Based on the experiences to date, review the equipment and consumables that need to be provided to community nurseries at start-up, and determine criteria to assist in determining the level and duration of follow-up support required for any ongoing provision of consumables.

Objective 3 Eucalypt breeding work

- Review the clonal composition and growth for the remaining trees in the newly established *E. deglupta* Clonal Seed Orchard established at Bulolo, to determine if the trial should be retained or written off.
- If a reasonable quantity of E. deglupta hybrid seed is produced at PNGFRI as a result of the controlled crossing program undertaken in April 2008, any progeny should be tested on multiple sites to evaluate the ability of hybrids to broadly adapt to a range of sites whilst providing adequate timber quality and volume. It is also important that any field plantings be established in an appropriate experimental design which also includes, where possible, seedlings controls of *E. deglupta* and *E. pellita*.
- The skills and resources are available for PNGFRI to continue attempts to produce hybrid seed of *E. deglupta* and *E. pellita* for experimental purposes

Project staff development

That the Director PNGFRI, with input from other project staff, develop a strategy to identify how the increased research capacity developed during this and other project, in particular the enhanced skills and knowledge of project personnel, can be used to strengthen the capacity of the Planted Forest Program and other FRI programs to deliver on its stated Goals and Objectives. This to include motivational factors that can be put in place to encourage officers to focus on providing quality reporting of information on trials, accurate and timely assessments which are analysed and published for public application.

Future opportunities

Strong support is given to the development of a new 5-year ACIAR project focussed on the rapid research and innovative development of applied propagation strategies, demonstration plantings and support networks that facilitate the rapid uptake of improved *T. grandis* germplasm by community and other forestry programs in PNG.

That scarce resources be directed in the future at the development of germplasm sources for a small number of high value species, instead of the 10 species targeted in this project, with a greater emphasis also placed on the creation of large-scale genetic facilities capable of producing significant quantities of seed for use in plantings in PNG. These genetic facilities require to be strategically located near planting operations to facilitate the deployment of germplasm to growers and nurseries.

Support given to the idea of including a study tour by key project staff who would benefit and implement the lessons learnt from visiting teak nurseries and planting activities overseas such as Solomon Islands.

That under any future project of this nature, project visits by key personnel from Australia be conducted every three months, with Project Coordinating Committee (PCC) meetings also to be held quarterly to tie in with these visits, and at least every 2nd PCC meeting i.e. one meeting every six months, being held in conjunction with visits to relevant field activities.

That under any future ACIAR project of this nature, the Project Leader maintains a running summary of achievements against each of the scheduled activities, in a similar format to that outlined in Appendices 4 and 5 of this report.

That under any future ACIAR project of this nature, a greater level of responsibility is placed on the relevant PNGFRI ACIAR Project Coordinator to compile Activity Report/s for attachment to the Annual Reports.

That under any future ACIAR project of this nature, the Managing Director, PNGFA ensure that, at project inception, and on an annual basis, the respective roles and responsibilities of various agencies within the PNGFA involved in the project are agreed and clearly understood, and that, where appropriate, formal Service Level Agreements (SLAs) are put in place to communicate these understandings between the various parties.

to assist PNGFRI to develop a management plan for the germplasm facilities established for the key species worked on over the last three years under FST2004/009, and under the previous project FST/1998/115.

to assist FPCD with the production of single-page “Species Notes”, to be published in PNG Pidgin and English (double sided) for around 10 key species, based primarily on the key information already contained in the publication titled “Seed Handling and Propagation of Papua New Guinea’s Tree Species” that was published under the previous project FST/1998/115.

The absence of project staff to undertake further studies associated with ACIAR John Allwright Fellowship had an adverse effect on the project outcomes for both this project and the previous one. In the case at PNGFRI where there are limited suitably trained staff to work on a project, one or two individuals become critical to the outcome of the project. The removal of a critical person during the course of the project leaves a serious gap in the capacity of the remaining project staff to deliver. One staff members are nominated to apply for a JAF, a significant amount of their efforts goes into the preparation to undertake the fellowship. Whilst the JAF scholarships are a very import part of personal development and long term benefits, more thought needs to go in to the timing of when staff undertake their studies so as to minimise disruption to the project. The potential of closer synergies between the students activities on the project and their studies should be explored more closely through greater dialog between the nominee, Project Leader, ACIAR, university and nominees institution.

10 References

10.1 References cited in report

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Howcroft, NHS. 2005. A review of available germplasm of Teak in Papua New Guinea. Internal Project Report, PNGFRI.

Walker, S. 2008. Review report ACIAR/PNG Project:FST2004/009. Facilitating the availability and use of improved germplasm for forestry and agroforestry in Papua New Guinea. ACIAR.

10.2 List of publications produced by project

Gunn, B. New ACIAR Project – FST/2004/009 in PNG. PI&FT Newsletter, No 3/05

Gunn, B. Conservation of Santalum macgregorii. PIF&T Newsletter, No. 4/05

Gunn, B. 2007. Facilitating the availability and use of improved germplasm for forestry and agroforestry in PNG. ACIAR Papua new Guinea and Solomon Island Nuis Vol.2 Issue 2.