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Final report

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Contents

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This report is dedicated to Yati Bunn (FPCD) and Samuel Famiok (OTDF) both of which were valuable contributors to the project, but sadly passed away during the course of the project.

2 Executive summary

This primary aim of this project was to advance the development of the Papua New Guinea (PNG) planted timber industry by establishing good quality germplasm supply and delivery mechanisms. This project sought to address the shortage of adequate supplies of tree germplasm (seeds or planting stock) for selected high value tree species in PNG. The reason for the shortage of germplasm material was due to a lack of quality sources and an absence of delivery mechanisms to smallholders. The project encompassed a range of activities to improve germplasm supply, including; (1) establishing "core" germplasm production units with project partners (OISCA, OTDF, PNGFRI) in three hubs; (2) securing existing genetic resources; and (3) enabling local germplasm production and delivery though "satellite" seed sources.

An important output of this project was the establishment "core" teak plantings in ENB. The work was undertaken with the assistance of Organisation for Industrial, Spiritual and Cultural Advancement (OISCA) - for the provenance trial, and the University of Vudal (UNRE) – for the clonal provenance trial. Approximately 3.36 hectares of block plantings involving 19 provenances from 10 countries (PNG, Laos, Thailand, Burma, Costa Rica, India, Ivory Coast, Tanzania, Malaysia, Solomon Is) was established. Teak seed from Costa Rica was introduced in the core Seed Production Area (SPA) at OISCA in East New Britain and at the four satellite communities in 2013. The solid maintenance and good ongoing survival of the satellite nurseries - with some exceptions - demonstrates a significant achievement for this project and success in the model we developed.

A clonal teak trial representing 576 individuals was established at UNRE Vudal Campus in January 2013. The trial represented 159 clones from 10 Seed Sources (China, India, Thailand, Honduras, Laos, Costa Rica (Jicaro, Nambi, Santa Alicia) and PNG (Vunapalading and Brown River)). Productivity in this trial has been very high and now offers the scope for early selection of consistently performing clones. The establishment of reliable protocols for propagating mature teak clones and the establishment of the teak clonal archive the PNG Forest Research Institute (FRI) are important outputs of this project.

Utilising satellite nurseries in each of the three Provincial hubs, just over 11,000 teak trees were planted by 128 smallholder farmers. In the East New Britain hub almost 12 hectares of satellite plantings have been established across 101 growers, each planting an average of 74 teak trees. The delivery of Local Priority Species (LPS) workshops in Madang and ENB were important in gaining an understanding of the desired species among smallholder farmers in lowland PNG. The priority species in Madang include Taun, Talis and Galip and ENB include Kumarere, Teak and Galip. In Western Province the clear intentions of communities to plant agarwood was recorded. In ENB a total of 18,000 LPS seedlings have been distributed across the four satellite communities (4,000 Kumerere, 4000 Galip, 10,000 Kwila).

The preparation of the multi-media toolkit has been an important advancement in broadening the capacity of our work beyond the lifespan of the current project. The toolkit increases the reach of the content developed from this project by allowing communities to access technical information on tree growing via more than 30 short educational videos. The multi-media toolkit is complimented by the 'Tree Growers Tool-Kit' hosted by Pacific Island Projects, which provides a one-stop source of information for tree-growers and their extension partners and improves overall awareness of the project. It also links-up with similar research and development initiatives at local, national and international levels.

A project variation to include the development of sandalwood in PNG was conducted during the final 12 months of the project. The variation commenced initial activities to determine the feasibility of sandalwood production in three target communities (Girabu, Kairuku & Iokea). The project engaged with and established agreements with these communities for further research and development. The project conducted initial surveys

of wild resources and determined the need and strategy for sourcing germplasm from a wide range of sources. An important achievement was the establishment of many smallholder nurseries in Iokea and subsequent planting of sandalwood woodlot to meet community objectives and expectations.

3 Background

The project was justified by its long-term potential impact for the planted forest industry and the rural PNG economy. Access to improved genetic material provides the necessary foundation to any forest plantation program and formed the basis of the research and development priorities for this project. There is a clear current international trend towards sourcing of forest products from sustainably managed stands, driven both by international processes and consumer preference. PNG is committed to sustainable management of its natural forests (PNG Forest Authority, 2007). However, annual timber harvesting is likely to be lower under sustainable management than in historical logging, while many accessible forests are now commercially exhausted. For these reasons, it is unlikely that the major current contribution of the forest industry to the national economy can be sustained without expansion of planted forests. Furthermore, plantation production is an attractive development opportunity in its own right. Industries based on export of domestically processed products sourced from planted trees can make significantly greater contributions to national economies than industries based on natural forests, even with a much smaller planted forest estate.

The production of high quality timber and other products from planted trees represents an important development opportunity for Papua New Guinea (PNG). An industry based on planted forests has the potential to generate significantly greater local and national-level economic benefits than the current natural forest based industry. This project addressed an important constraint to the development of a planted forest industry; the shortage of adequate supplies of timber tree germplasm (seeds or planting stock). The germplasm shortage results from both a lack of accessible, good quality sources and from an absence of mechanisms for delivery from source to end-user.

This project was conducted in three project hubs of PNG (East New Britain, Madang/Morobe and Western Province). The rationale adopting three hubs, was to firstly develop a model approach to germplasm production and delivery that is suitable for post-project scaling-up (within-hub) and scaling-out (to new hubs). Teak was chosen as a focal species, due principally to its established high commercial value and demand, growing local interest in its cultivation, and its proven suitability to lowland PNG conditions. Other Local Priority Species (LPS) were also identified for further development.

The strategy to address the shortage of tree germplasm involved the establishment of accessible seed sources, coupled with mechanisms for its delivery to end-users in three project “hubs”, with activities conducted in collaboration with end-users. This approach reflects probable future patterns of customary landowner involvement in an emerging planted forest industry. The two scenarios for smallholder participation include (i) participation outgrower schemes and other joint ventures with industry, typically taking the form of conventional forestry plantations and (ii) independent landowner integration of trees at relatively low density in traditional agroforestry systems.

These two scenarios require different approaches to development of sustainable germplasm supply and delivery systems. In each hub, the project sought to develop a “core and satellite” configuration of seed sources. The larger and more secure “core” sources were designed to meet the more centralized, concentrated germplasm needs of outgrower and similar schemes, while the “satellites” serviced more dispersed germplasm needs, as well as playing a key demonstrative role in capacity-building and dissemination. Germplasm for future “satellite” sources within each hub are sourced from the local “core” population. From a development point of view, the benefits of enterprises evolving from short-term community or institutional “project” nurseries include generating a profit while supplying local germplasm needs and providing basic silvicultural advice as “part of the service”.

The project strategy was to generate working models of decentralized germplasm production, focusing on a well-known species (teak) of established commercial value, and

developed in close collaboration and/or consultation with local stakeholders. These project hubs were located in three areas with ready access to port facilities and/or regional centres: the Fly River corridor (Western province); the Kokopo / Rabaul area of East New Britain, and the Markham/Ramu valleys (Madang/Morobe).

Four key characteristics of our approach were; (1) decentralized germplasm production; (2) location of germplasm sources and delivery mechanisms; (3) focus on teak; and (4) dual seedling / clonal approach.

Five specific research areas were addressed in development of the germplasm production and delivery pilot programmes:

1. Identification of suitable interim seed sources.
2. Adaptation of vegetative propagation techniques.
3. Demonstration plantations of vegetatively propagated material designed as clonal tests, both in order to eliminate undesirable material and to illustrate the importance of adequate use of genetic variation.
4. The feasibility of commercial nursery microenterprises as sustainable germplasm supply mechanisms examined through market and socio-economic research and consideration of suitable organizational models.
5. Identification of environmental and socioeconomic factors determining performance of the community-located teak plantations established by project collaborators.

Wider application of the approach was facilitated by the preparation of a “flexi-media” toolkit. As well as documenting the approach, the tool-kit, in digital form, includes training and extension material designed for different target groups (school teachers, smallholders, vocational training). The project included training in use of the toolkit with forestry and other rural development professionals and wider access via the Pacific Island Projects website. It also sought to further facilitate adoption by awareness raising among the rural population at large and among policy and decision-makers.

The project was closely aligned with the PNG government’s priorities for the forestry sector. The PNG Forest Authority Corporate Plan 2007-2012 reflected current policy directions and identified plantation development as an important priority (PNG Forest Authority, 2008). The PNG Forest Authority recognized the importance of community-based forestry through the creation of an Eco-forestry Branch and the preparation of an Eco-Forestry Policy. The latter has been approved by the National Forest Board, while a Reforestation Policy (PNG Forest Authority, 2008), recognises the importance of a planted forest estate in meeting both domestic and export demands.

4 Objectives

The aim of the project was to promote the development of the PNG plantation-based timber industry by developing approaches to establishment of germplasm supply and delivery mechanisms and by facilitating their adoption. This was achieved through the fulfilment of activities associated with five objectives (Figure 1).

1. Install “core” germplasm production units in each of three regional hubs. The “core” sources fulfilled four functions: (1) meet the more centralized, concentrated germplasm needs of initial stages of outgrower and similar schemes; (2) through their dual function as genetic tests, identify germplasm of adequate quality; (3) serve as founder populations for each hub — specifically, as seed sources for establishment of future additional “satellite” sources (see below); (4) serve as demonstration plantations. Objective 1 was facilitated by sourcing teak germplasm from domestic PNG and international sources
2. Secure existing teak genetic resources. Teak has been grown as an exotic timber species since the early 20th century and a genetic improvement programme commenced during the 1960s. This programme comprised a range of traditional improvement approaches and was centred around Kerevat (ENB) and Mt Lawes (Central Province) (Cameron 1966). The project aimed at securing and propagating some of the clones and identified plus trees from remaining resources from this period.
3. Enable and exemplify local germplasm production and/or delivery though establishment of working pilot projects. Project partners (FPCD, OISCA, OTDF) worked with local communities in the establishment of “satellite” seed sources. The “satellite” sources had two principal functions: (1) to meet local community germplasm needs and (2) capacity-building in, and dissemination of teak silviculture. Together, the “core and satellites” in each hub illustrate how, in a given area, a central founder population can be used to spawn, in different localities within the area, local seed sources of adequate genetic diversity and quality.
4. Determine the feasibility of nursery microenterprises as a mechanism for delivering germplasm from source (seed-tree) to end-users.
5. Facilitate scaling-out (to new regions) and scaling-up (within existing hubs) of the approaches developed and tested in the three hubs.

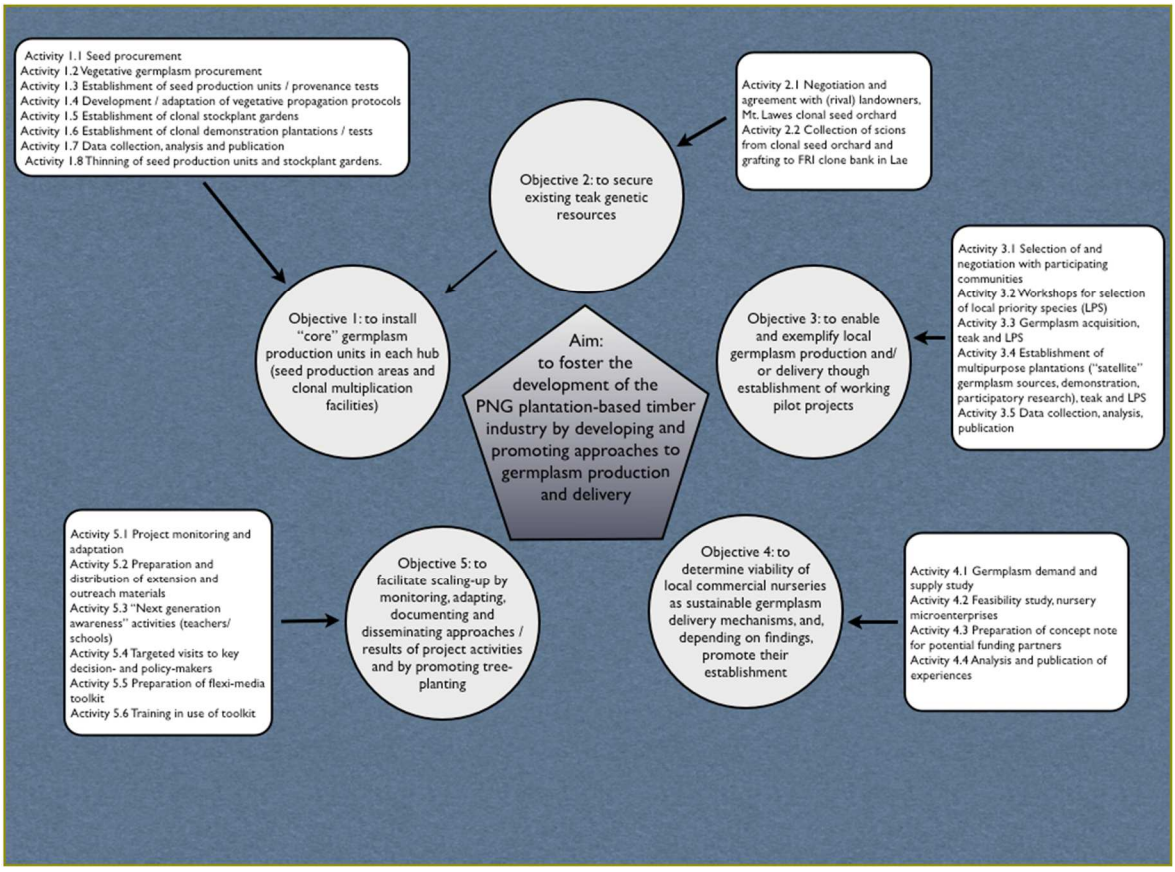

Figure 1: Project objectives and activities (arrows indicate flow of intermediate results)

5 Methodology

Objective 1: to install "core" germplasm production units in each hub (seed production areas and clonal multiplication facilities)

no.	activity	methodology
1.1	Seed procurement	Location Over 200kg of seed was distributed over the life of this project to both core and satellite nurseries in all three hubs: Madang/Morobe, East New Britain (ENB) and Western Province (WP). Method Seed sources from overseas were: Costa Rica (Hondores, Santa Alicia, Jicaro, Nambi, Mansion, Penas Blancas, Santa Cruz, Hojancha), Nellicutha (India), Maukal Karnataka (India), Nellicutha (India), Kokokendero (Ivory Coast), Morogoro (Tanzania), Perlis (Malaysia), Segama (Malaysia), Taliwas (Malaysia), Malaysia Bulk. Seed sources from PNG were Teak from the Mt Lawes clonal seed orchard at (CSO). Seeds were made available in 2010 and then annually in May & July 2012, July & October 2013, and July & August 2014. See Appendix 10.1 for the seed lot inventory and distribution to project partners. Participants: Tony Page and Jonathan Cornelius
1.2	Vegetative germplasm procurement	Location The vegetative propagation activities were conducted at FRI in Lae and UNRE in ENB. Facilities FRI has developed both misting and non-misting facilities. The non-mist propagators were developed by the project and based on a proven design (Longman 1993). The misting propagator comprises a greenhouse, irrigation components established by the project with a rainwater supply and misting controller established by another project managed by Oil Search. UNRE established basic non-mist propagators under a shade structure using project funding. Method FRI: This work used an adaptive research approach to teak cuttings by techniques developed by Goh and Monteuuis (1997) and Monteuuis et al. (1995). A total of 29 unrelated parents were sourced from three sources (1) Oomsis woodlot in Morobe Province, (2) Vunapalading-Kerevat plantation in East New Britain Province, and (3) Kuriva plantation and CSO, in Central Province. Stems with a diameter of 1.8-2.0cm, a length of 40 to 50 cm and at least 2 dormant buds (truncheons) were collected from each of the selected tree. Participants Anton Lata, Sylvester Kulang, Neville Howcroft and Tony Page.
1.3	Installation of seed production units / provenance tests	Location ENB: OISCA hosted the provenance-based seed production area at Warangoi and UNRE established a provenance-based clonal trial in Vudal Morobe: Imported provenance-based teak resources were established in collaboration with Ramu Agroindustries and a freehold-title landowner in Situm. Western Province: It was established during the project that OTDF and landowners had little interest in planting teak, as they were largely focused on the production of eaglewood (*Gyrinops* and *Aquilaria* spp.). The project assisted the importation of *Aquilaria crassna* seed to be incorporated into existing OTDF initiatives aimed at establishing smallholder eaglewood plantings. Method Seed Production Areas have were established using high quality seed sources from local sources (for teak and LPS) and around the world (for Teak) as formal provenance experiments to distinguish between form and performance of different sources. ENB: Teak and *Eucalyptus deglupta* (ENB priority species) were planted at OISCA in East New Britain in late 2011. OISCA have established a Seed Production Area with an area of 3.38 hectares comprised of a diversity of teak seed sources (TG5-TG18) as well as other species (Kumarere, Mahogany, Calophyllum and Taun). All have been established at wider spacing of 4 x 4m (625 stems per ha). PIP assisted OISCA to prepare Core Monitoring Forms (see Appendix 3) in MS Excel for each planting area. During 2014, OISCA's field schedule included weekly (every Thursday) trips to the PIP office in Rabaul to

		provide their technical officer with project administration and reporting (e.g. satellite data entry) support. Morobe: Ramu Agroindustries (RAIL): A Material Transfer Agreement (MTA) between RAIL and FRI permitted the transfer of 30kg of seed from Mt Lawes (TG5) in 2013. This was followed by transfer of introductions from Costa Rica and Solomon Island in 2013 & 2014 and successfully germinated seed lots were established at a site known as Jacob's Creek. FRI: Several sites were pursued by FRI during the project to host the Core Seed Production Area for the Morobe/Madang hub. These include those at Oomsis, Leron, Umi Station, Mare, Tararan, Water Rise, Open Bay (ENB), and Kuriva Teak Plantations. In April 2014 FRI secured a site close to Lae (Situm). An agreement was signed between the land-title holder and FRI on 12 March 2014 for a 4 ha site at Situm. Proximity of the site to Lae is good although road access can be restricted during times of heavy rain due to the need cross the Situm River. Seedlots from Costa Rica (list provenances) sown in 2011 were uprooted in May 2015 and established as a replicated provenance trial Situm. The design is an incomplete block design (IBD) constituting 5 replicates, 7 plots per replicate and 9- tree plots. The initial spacing was 4 m x 4 m between and within planting rows. Size variation in the stumps from each seedlot was categorised as either small or large. Seedlots included in the trial include TG07 Laos (35 seedlings), TG08 Thailand (5 seedlings), TG09 China (45 seedlings), TG10 Honduras 72 (seedlings), TG11 Santa Alicia 63 (seedlings), TG12 Jicaro (90 seedlings in trial and 196 across all buffers) and TG13 (Nambi 5 seedlings). Teak seed introductions comprising a total of 45 seedlots from Malaysia, Costa Rica and Central Province were sown in Lae during 2014. Seedlots represented Kuriva (#15), Oomsis, Malaysia, Santa Cruz, Penas Blanca, Nambi, Hojancha and individual tree collections from the Mt Lawes CSO. Seeds were sown in three stages: late September, mid-November and mid-December 2014. WP: Initial teak seed distributed to OTDF as part of this ACIAR project were germinated at a smallholder nursery at Briompenai. The bulk of the seedlings remain at Briompenai (North Fly), with modest numbers being planted out at Komovai (Middle Fly) and Nakaku (South Fly). At Briompenai stumps from Mt Lawes (TG5) around about 1000 individuals with roughly 50% survival rate. At Komovai (Middle Fly) Awox Papoa established some 400 Mt Lawes (TG5) stumps. In July 2014 Awox received and additional seed from Costa Rica, 1.5kg each for each of the following seedlots Nambi (TG15), Nicoya (TG15), Penas Blancas (TG16) and Santa Cruz (TG17). In 2012 more than 450 Jicaro (TG12) stumps were planted out at Nakaku (South Fly) Participants Anton Lata, Gedisa Jeffrey, Samuel Famiok, Inter Vinarut, John Rabbie, David Spencer, Tony Page.
1.4	Development / adaptation of vegetative propagation protocols	Location Vegetative propagation experiments with teak were conducted at facilities at FRI (Lae), UNRE (ENB) and OISCA (ENB). Methods FRI: Three experiments were conducted to evaluate the effect of clonal genotype with each of (1) propagation system (mist and non-mist) (2) propagation media (coarse sand, fine sand, coarse sand:coconut husk 1:1v/v, perlite:coconut husk 1:1v/v and jiffy pellets) and (3) cutting length were examined. Based on this work FRI produced a conference paper (Lata *et al.* 2016) and a technical document outlining the process of truncheon collection and setting in misting propagators. "Teak Truncheons Collection, packing techniques and Propagation at FRI Nursery sourced from Mt Lawes Clonal Seed Orchard (CSO)". PIP prepared an A5 pamphlet for tree growers outlining recommended vegetative propagation protocols for teak. UNRE: Basic experimental propagation was undertaken with seedling explants to evaluate the effect of physiological maturity, by observations of relative stem thickness and lignification (softwood, semi-hardwood and hardwood). Participants: Anton Lata, Sylvester Kulang, Neville Howcroft, Tony Page.

1.5	Establishment of clonal stockplant gardens	Location A teak clonal archive was established at FRI nursery in Lae based on mature material collected during activity 1.2. Seedling hedges representing a range of provenances were established at the UNRE nursery in Vudal (ENB), and used as a source for clonal propagation. Method FRI: A total of 31 hedge plants were established in the clonal archive by the end of 2014 at a spacing of 2m x 2m. Date planted: Vunapalading-Kerevat (7 June 2012 & 21 December 2013), Mt Lawes CSO (planted May-Aug 2014) and Oomsis (planted December 2013). UNRE: Seedling hedge plants at UNRE comprised of the 15 provenance sources: Mt Lawes (TG5), Vunapalading (TG4), Solomon Island (TG27), Nellicutha (India) (TG18), Santa Cruz (TG17), Penas Blanca (TG16), Mansion (TG14), Nambi (TG13), Jicaro (TG12), Santa Alicia (TG11), Honduras (TG10), China (TG09), Thailand (TG08), Laos (TG07), India (TG06). Further clonal propagation of genotypes demonstrating high vigour and good form in the clonal trial (activity 1.6) commenced at the end of the project. Participants Anton Lata, Neville Howcroft, Sylvester Kulang
1.6	Establishment of clonal demonstration plantations / tests	Location A clonal trial was established at UNRE Vudal Campus (ENB) at 4 x 4 m spacing over a period of three days in January 2013. An extension to this trial was completed in 2015. Methods ENB: The UNRE trial represents 576 individuals, comprising 159 clones, from 10 Seed Sources: China, India, Thailand, Honduras, Laos, Costa Rica (Jicaro, Nambi, Santa Alicia) and PNG (Vunapalading and Brown River). The trial was established as 16 tree plots for each of the 9 seed sources, each of the 16 genotypes/ortets were then replicated as clones four times across the site (although replication was not consistent across ortets, due to the availability of ramets). The trial therefore comprised 162 Ortets (genotypes), 576 Ramets, 1-8 Replicates (depending on availability of ramets at establishment). The extension to this trial was established as 4-tree clonal line plots for 162 clones from 10 provenances. The number of clones for each provenance are China (16 clones), Honduras (17), India (16), Jicaro (21), Laos (20), Nambi (18), Santa Alicia (16), Thailand (15), Vunapalading (11), Mt Lawes (12). Participants Sylvester Kulang, Daniel Waldi, Neville Howcroft, Inter Vinarut and Tony Page.
1.7	Data collection, analysis and publication	Methods The clonal trial was assessed in August 2014 (Age 1 year and 8 months). Trees were measured for total tree height (m) bole length (m) and stem diameter over bark @ 1.3m (DBHOB). Stem form and branch size were assessed for trees over 2m following the classification system outlined for teak in (Keiding *et al.* 1986). The plot was affected by strong winds in early February 2014, although the trees have largely recovered, form has been adversely affected. Another measure of height, diameter and form was be conducted just prior to year 3 (late 2015) to gain a clearer understanding of those genotypes, which offer the greatest potential for further development as clonal selections. Participants Daniel Waldi, Sylvester Kulang, Neville Howcroft, Inter Vinarut and Tony Page.
1.8	Thinning of seed production units and stockplant gardens	Due to the delayed establishment of the SPA at OISCA the trees were not of sufficient size for thinning during the life of the project, therefore this task is not applicable. The trees at the UNRE clonal plot have exhibited rapid growth, and selections will be made in 2016 followed by thinning at age 4.

Objective 2: To secure existing genetic resources of teak and other species

no.	activity	Methodology
2.1	negotiation and agreement with (rival) landowners, Mt. Lawes clonal seed orchard; six-monthly monitoring visits	**Location** Access to the Mt. Lawes clonal seed orchard has continued throughout the project period with materials regularly collected. **Methods** There were some issues early on with relating to poor viability of seed from the Mt Lawes and Kuriva Teak stands, which were resolved and they have since been producing high quality germplasm. **Participants** Gedisa Jeffrey, Anton Lata, Wake Yelu, Francis Vilamur and Tony Page
2.2	collection of budwood in Mt. Lawes clonal seed orchard, grafting to Clone Bank at FRI, Lae	**Location** Truncheons collected from the Mt Lawes CSO, Kerevat and Oomsis were distributed to the FRI nursery for propagation. **Methods** Four separate collection expeditions were conducted by FRI. Cuttings were collected as leafless truncheons (large diameter woody cuttings), which were wrapped in wet hessian, packed in coolers and airfreighted to Lae for propagation. **Aug 2011:** A collection of 10 truncheons from each of 6 candidate (genotypes) trees in the Vunapalading-Kerevat district of ENB was made on 12th August 2011. These were air-freighted to Lae for propagation **Jun 2012:** A collection of 10 teak truncheons from 6 candidate trees were harvested on the 21 June 2012 from Oomsis following the removal of the Vunapalading truncheons from the mist house. An additional 6 randomly selected trees were not harvested as per the original proposal. **Jul 2013:** A second collection of truncheons for the 6 plus trees at Oomsis was undertaken. A total of 135 truncheons were collected and set in the mist (84 truncheons) and non-mist (51 truncheons) propagators. The truncheons were collected just after the trees had been ringbarked, ready for harvesting. Additionally seeds were collected and packed per tree with labels and transported to National Tree Seed Centre in Bulolo for storage. **Oct 2013:** A total of 270 truncheons were harvested from 27 clones at Mt Lawes CSO in October 2013. Truncheons were collected from dormant material, transported to Lae and set as cuttings within the misting system at FRI. **Oct 2014:** Representatives were collected from 9 clones at the Mt Lawes CSO and 6 clones from Kuriva. Truncheons were inserted into sand in pots and placed under mist sprays in the misting facility. All collections have at least one truncheon alive. Variable numbers of truncheons were collected for each clone. Most material collected was quite large in diameter and age. **Participants** Anton Lata, Gedisa Jeffrey, Wake Yelu, Brian Gunn, David Spencer & Tony Page.

2.3	Maintenance of existing trials	**Location** The walnut and *Calophyllum* trials at Bumsi were maintained during the initial years of this project. **Methods** Of the 20 trials established across seven locations under FST/2004/009 by FRI and Ramu Agro-industries, 11 were still in existence in 2012. The others were written off either as a consequence of fire, lack of maintenance resulting in excessive tree losses or deemed inappropriate. Brian Gunn inspected the Lae Botanical Gardens and Bumsi site in November 2012 where *Calophyllum euryphyllum* progeny trial and *Dracontomelon dao* (walnut) provenance trial were established. The results were included in the 2013 Annual Progress Report. The species trial (105A-2-360) was established between 2001 and 2003 within the Lae Botanical Gardens as part of the ACIAR FST/1998/115 project. Seedlings were planted in 2001, 2002 and 2003 when seedlings were raised and supplied by NTSC in Bulolo. The trial was spaced at 3 x 3 m in a randomised complete block design (RCB) comprising 3 replicates, 23 species per replicate and 25-tree plots for each species. Trees were assessed in November 2015 diameter at breast height (DBH) total height, bole height, form, branching form, and survival. A qualitative 4- point scale (4=very good, 3=good, 2=fair, 1=poor) was used to assess form, straightness, crown cover and branching form. **Planted 2001:** At Anisoptera thurifera, Ep=Emerillia papuana, Pp=Pometia pinnata form glabra, Tk=Terminalia kaernbachii, Tc=Toona ciliata. **Planted 2002**: Ce=Calophyllum euryphyllum, Aa=Artocarpus altilis, Em=Endospermum medullosum, Tr=Terminalia complenata, Ah=Araucaria hunstenii, Dd=Dracontomelon dao, Ib=Intsia bijuga, Cy=Cyptocarya sp., Ag=Aglaia cuculata **Planted 2003:** Sm=Swietenia macrophylla, An=Adenanthera pavonina, Ach=Anthocephallus chinensis, El=Elaeocarpus sphaericus, Eu=Eucalyptus pellita, Am=Aleurites molucana, Fp=Firmiana papuana, Ga=Garcinia sp., Ca=Castanospermum australiensis. **Participants** Anton Lata, Brian Gunn

Objective 3: to enable and exemplify local germplasm production and/or delivery though establishment of working pilot projects

no.	activity	methodology
3.1	Selection of and negotiation with participating communities / clans	**Location** **ENB**: OISCA worked actively with communities in five LLGs in the Gazelle Peninsula including Bitapaka, Raluana, Reimber/Livuan, Sinivit, Toma/Vunadidir. **Madang:** agreements were made with community nursery sites at Aronis, Ohu and Erima. **WP:** An agreement was made with one community nursery at Briompenai. **Methods** Nursery locations were selected based on extensive community consultation and criteria included the experience of the farmers and personnel, the level of interest to participate and the availability of a designated leader. **Participants** Gesley Rivan, John Rabbie, Inter Vinarut, Simon Rollinson, Samuel Famiok, Linzon Zamang.
3.2	Workshops for plantation design and selection of local priority species (LPS)	**Location** All LPS workshops were completed in Madang and East New Britain. It was decided in 2013 that Western Province would not implement the LPS workshops largely due to OTDF identifying a strong demand for Eaglewood only. The tree planting & prioritisation workshop held in Kiunga in December 2012 also confirmed this. **Methods** **ENB:** LPS surveys, desktop research and final species selection/ landownership mapping /land-use planning workshops were conducted in four of the five focal areas. LPS work was not conducted in Sinivit LLG as it was included late in the project as an additional area to the original four. • Vanakaur for Toma/Vunadidir Zone 3 LLG in November 2010 • Malapau Co-operative Society for Raluana LLG in October 2011 • George Brown Pastors College for Reimber/Livuan LLG in November 2012 • Togoro Group for Bitapaka LLG in November 2013. **Madang:** FPCD conducted an abbreviated version of the LPS work, which did not include desktop research on the species. The LPS workshops were conducted in Aronis, Erima and Ohu during June 2013. At least 20 different community participants (both households and individuals) were surveyed at each site. **Participants** Simon Rollinson, Simon Passingan, Gesley Rivan, John Rabbie, Inter Vinarut, Linzon Zamang.
3.3	Germplasm acquisition	**Location** Germplasm of teak and LPS have been collected from various sources and planted with focal communities in ENB and Madang. **Methods** **Teak** was sourced from 31 sources originating from 11 countries through local sources and overseas introductions. The sources include those categorised as natural populations (3 sources), cultivated (10) and improved (18). These sources were distributed among project partners FRI, OISCA, UNRE, OTDF and FPCD. Ramu Agroindustries were also recipients of introductions made after the Material Transfer Agreement with FRI. **LPS:** Gesley Rivan, Inter Vinarut (OISCA), Linzon Zamang (FPCD) and Samuel Famiok (OTDF) attended the CSIRO, AusAID-funded Tree Seed Technology Training Course in Bulolo. This built capacity of project partners to make seed collections of the LPS identified by focal communities. LPS were sourced across a number of populations in East New Britain (*Canarium indicum* from NARI germplasm sources, *Eucalyptus degulpta* from collections made around the Intake Area, *Intsia bijuga* sourced from Mt Varzin, *Calophyllum inophyllum* from planted sources around the Gelagela area) and Madang (*Canarium indicum* collected from Karkar Island, *Terminalia kearnbachii* from Aronis area, *Pometia pinnata* from south coast of Madang).L

3.4	Establishment of "satellite" germplasm sources, teak and LPS	**Location** The satellite germplasm sources were established with the candidate communities identified in activity 3.1. **ENB**: OISCA worked actively with communities in five LLGs in the Gazelle Peninsula including Bitapaka, Raluana, Reimber/Livuan, Sinivit, Toma/Vunadidir. **Madang:** Satellite plantings of teak & LPS were established at sites at Aronis, Ohu and Erima. **WP:** Given the lower community interest in tree planting in WP compared with ENB and Madang, the Briompenai nursery became the focal nursery in WP for distribution of teak to other areas. Teak plantings were established at customary landowner sites in Briompenai, Samagos and Komovai. **Methods** Tree planting ("Diwai") workshops were conducted in each of the three hubs (ENB, Madang and WP) with participants including project partner staff, students (OISCA) and community members from each of the participating communities. These three-day workshops covered a range of topics including tree products, nursery establishment and management, plant propagation, tree crop establishment and maintenance as well as specific information on the silviculture and markets of focal species teak and, in WP eaglewood. Video tutorials were also used to demonstrate the lessons raised during each of the sessions. The workshop also included field visits to smallholder tree farmers with problem solving and practical activities. Project partners in each of the three hubs (OISCA, OTDF and FPCD) worked with the focal communities to establish nurseries suitable for the production of teak and LPS. **Participants**: Gesley Rivan, John Rabbie, Inter Vinarut, Linzon Zamang, Simon Rollinson.

3.5	Data collection, analysis, publication	**Location** East New Britain and Madang **Methods** **ENB:** PIP assisted OISCA to create a Satellite Monitoring Form (see table below), as well as recruit and train community members to collect: • Satellite nursery data comprising GPS location /elevation, germplasm source/type, planting date, number planted, number supplied and supply location. • Seed production area/demo plot data comprising (i) planting data (GPS location /elevation, species, label number, germplasm source/type, planting date, number planted) and (ii) growth data height, diameter, quality, flower production, fruit production and maintenance needed) • Satellite farmer data comprising (i) planting data for all teak and LPS (species, farmer name, germplasm source/type, planting date, no planted, planting arrangement and reasons for planting) and (ii) growth data for 10% sample (label number, GPS location/elevation, height, diameter, quality and maintenance needed). A total of 7 enumerators were selected based on their demonstrated level of interest in tree planting, as well as their active participation within their respective communities. OISCA has two forestry technical officers that provided the main point of contact for the enumerators. Enumerators participated in two single-day workshops with the first day a refresher of the earlier 'Diwai' workshop outlined in activity 3.4 silvicultural practices for establishing and maintaining woodlots and the second day was field-based training covering tree measurement, data collection and critical thinking. Enumerators were responsible for conducting (i) a census of all smallholder teak plantings within each of the four focal communities and (ii) an inventory of six plots in each of their respective four communities (n=24 plots), for which they were remunerated. This approach was partially successful since all were able to complete the inventory but not able to complete the measurement of the six plots independently. The yield plots were eventually measured and recorded by enumerators when accompanied by Inter Vinarut and Tony Page. Each yield plot consisted of 20 trees (four rows of five trees) located randomly at least two rows from the edge of the woodlot. Total tree height (m) bole length (m), stem diameter over bark @ 1.3m (DBHOB) were measured for all trees. Stem form and branch size were assessed for trees over 2m following the classification system outlined for teak in Keiding et al. (1986) Site suitability was assessed according to the appropriateness for growing teak and grower management trees and classified according to a simplified three-point scale (1-low, 2-Med, 3-High). **Madang:** Linzon Zamang and Tony Page worked directly with community members to collect growth and form data (as outlined above), identify high quality trees, and build community understanding of the process of tree improvement. **Participants** Inter Vinarut, Tony Page, Linzon Zamang, Simon Rollinson

Objective 4: to determine viability of local commercial nurseries as sustainable germplasm delivery mechanisms, and, depending on findings, promote their establishment

no.	activity	methodology
4.1	study of current germplasm supply and demand for agricultural and forestry germplasm	**Location** In ENB were established and three of these have agreed to participate in the Supply and Demand surveys; Bitapaka, Malapau, Vunakaur Village (John Gesling's) and George Brown Pastors College. The SD surveys were not held in Madang. Western Province did not participate in the LPS or SD surveys, as OTDF had previously identified strong demand for Eaglewood seedlings. **Methods** **ENB:** A supply and demand (SD) survey was pilot-tested at Vunakaur in 2012 using the local surveyors who took part in the previous LPS surveys. SD data was collected for (i) food and cash crop germplasm; (ii) tree germplasm (teak and local priority species); and (iii) agricultural and forestry services. The pilot-test work (including training of local surveyors) was carried out with on-site support from Julio Ugarte (JCU), Simon Passingan (Barefoot Community Services) and Linzon Zamang (FPCD) as part of his 2-week capacity building field trip to ENB. This was used as the basis for further SD surveys conducted by Julio Ugarte (JCU) in 2013 and 2015 of another 4 wards Raluana and Toboina (Reimber/Livuan LLG), Papalaba and Ravata (Toma/Vunadidir LLG) **Participants:** Julio Ugarte (JCU), Simon Passingan (Barefoot Community Services), Simon Rollinson (PIP) and Linzon Zamang (FPCD)
4.2	feasibility study of local commercial nurseries	**Location** East New Britain focal communities **Methods** A nursery survey was conducted with 5 micro-nurseries (<1000 seedlings year-1), 26 smallholder nurseries (1-10,000 seedlings) and 2 commercial nurseries across the Gazelle Peninsula. The survey included structured questionnaire on the demographic characteristic of nursery owner, plant species produced, capital equipment and consumable materials, production method(s) and volumes produced, transport, prices and sales. The information was used to develop a financial model based on the work of Harrison et al. (2008). Financial viability of the tree nurseries was assessed using indicators such as the Internal Rate of return (IRR) and Net Present Value (NPV). The sensitivity of these financial indicators was tested by changing input prices for seed, wildings, and daily wage rate (DWR), as well as seedling sale price (SSP). Based on these variables analysis was conducted on three scenarios i) base-line (BLS) ii) worst-case (WCS) and iii) best case (BCS) scenarios that is based on average, highest and lowest input costs respectively and average, lowest and highest seedling sale price (SSP) respectively. **Participants** Julio Ugarte, Inter Vinarut, Benjamin Western, Braden Jenkin, Tony Page.
4.3	Promotion of nursery microenterprises	**Location** East New Britain province **Methods** Gesley Rivan was the ACIAR project co-ordinator when he was working with OISCA in the early stages of the project until 2012. Gesley left OISCA to pursue his private interests in tree planting. The project worked collaboratively with Gesley to commence two projects funded by the PNG National Government. These include the Soil Erosion Mitigation project in the Gazelle District (Rivan 2013) and the Tree Planting Project in the Kokopo district (Rivan 2014). Both these projects have very significant requirements for tree seedlings for both revegetation and community development purposes. These demands have stimulated the plant nursery sector and many new smallholder private nurseries have been recently established to meet the demand. Several of the ACIAR project smallholder nurseries are now suppling these two projects with tree seedlings. **Participants** Gesley Rivan, Tony Page.

Objective 5: to facilitate scaling-up by monitoring, adapting, documenting and disseminating approaches /results of project activities and by promoting tree-planting

no.	activity	methodology
5.1	Project monitoring and adaptation	Regular visits were conducted by the project leader six-monthly to each hub and field reports prepared and circulated post-visit to local partners, containing an agenda, activities undertaken and follow-up recommendations. A Facebook page was launched in December 2014 to utilise social media in outreach activities and to provide networking facilities for all participants from all regions on PNG.
5.2	Preparation and distribution of extension and outreach materials	**Methods** To support the outreach activities of this project, a Tree Growers Toolkit is being administered and maintained by Pacific Island Projects (PIP) that, houses educational materials for tree growers and encourages the exchange of information and ideas throughout the community. The project contributed significant printed, and video resources to the Tree Growers Toolkit. The resources in the Toolkit were launched during the week of the project final workshop. **Participants** Inter Vinarut, John Rabbie, Gesley Rivan, Simon Rollinson, Tony Page
5.3	"awareness" activities (teachers/school students)	**Location:** ENB **Methods:** Many of the project partners met with school representatives to engage students. Project personal established good working relationships with school teachers and conducted awareness activities with students. The awareness activities covered the elements of the ACIAR project, the need for and benefits from tree planting, and practical activities culminating in tree planting of both LPS and Teak. OISCA organised school visits for visiting international project personnel. A series of education-related resources (School Resource Pack) was developed and collated for elementary and primary school levels. The Resource Pack was followed the structure of the outcome-based curriculum of PNG, to enable teachers to access content required for the syllabus. The resources comprise lessons, demonstrations, activities, presentations, quizzes, images and videos related primarily to forest and environmental awareness. The resources were 'piloted' with three schools in East New Britain, to determine the appropriateness of the materials to the PNG syllabus and the uptake by and thoughts of teachers. **Participants** OISCA, PIP, Tony Page
5.4	Targeted visits to key decision- and policy-makers (government and industry)	**Methods:** Project leader and PNG partners have actively engaged with the Provincial Administration in East New Britain, Madang, Gulf and Central Provinces. The project leader participated in the ACIAR Forest Policy Workshop in Port Moresby in 2013, which offered the opportunity to communicate the project to and liaise with senior management within the Forest Authority. **Participants** Linzon Zamang, Simon Rollinson, Wake Yelu, Jonathan Cornelius, Tony Page
5.5	Preparation of flexi-media toolkit	**Methods:** All project training, extension and outreach materials have been included in the multi-media toolkit. All video content was recorded in Tok Pisin, with versions containing English subtitles. The toolkit has been distributed in the form of a USB flash and embedded within the PIP website and promoted through the PIP email list. The toolkit, represents the main technical/extension information produced by the project, with extension practitioners and smallholder farmers the primary audience. **Participants:** PIP, Tony Page
5.6	Training in use of toolkit	**Methods:** Training of key stakeholders in the content and use of the tree grower's tool-kit was conducted in conjunction with the project final workshop. Participants in the training event included project collaborators, FA technical staff, Provincial extension officers, Ward rural development officers and smallholders. The training activity was held over one day and covered the different types of resources contained within and how different audiences may use them. Opportunity for stakeholder input was given throughout the training activity, with feedback encouraged about the appropriateness of the material for the intended audience. **Participants** Simon Rollinson, Anton Lata, Tony Page.

Objective 6: Determine feasibility of sandalwood agroforestry in Central and Gulf Provinces

no.	activity	methodology
6.1	Resource owner consultation and awareness activities on sandalwood conservation and growing by landowners.	**Location:** Consultation Provincial and District Administrators as well as landowners in the 3 target areas (Rigo, Kairuku, Malalaua Districts) conducted. **Methods:** Gain support across all stakeholder levels for the project. The project needs a statement from the Hasu Family as to their expectations of the project. Comments during the visit about 'giving the site to PNGFA to do the project' require further clarification. The ACIAR project can provide equipment and help establish the trial resources, but only with the co-operation and active participation of landowners. A significant time commitment from landowners, particularly in site maintenance during establishment would be required for success. A statement of intent for this input of landowners is necessary. This will avoid any potential issues due to mismatch in expectations between landowners and project staff. The project also requires a formal written statement from the leaders of the Iokea community about their perspectives about the potential introduction of exotic species of sandalwood at Iokea. **Participants:** Tony Page, Anton Lata, Francis Vilamur, Ruth Turia, Guduru Rome, Linden Oa.
6.2	Selection and establishment of 3 model centres in the target sites.	**Location & Methods:** Conceptual agreements for model centres with the District and Provincial Administrations. Consultation Provincial and District Administrators as well as landowners in the 3 target areas (Rigo, Kairuku, Malalaua Districts) conducted. **Participants:** Tony Page, Anton Lata, Francis Vilamur, Ruth Turia, Guduru Rome, Linden Oa.
6.3	Preliminary assessment of the current state of the resource and potential seed sources.	**Location & Methods::** A total of 66 seed bearing trees identified across the three Districts through the consultation process. Iokea village indicates seed production is high and germination percentages approach 70%. **Participants:** Tony Page, Anton Lata, Francis Vilamur, Ruth Turia, Guduru Rome, Linden Oa.

6 Achievements against activities and outputs/milestones

Objective 1: To identify suitable germplasm sources and install regional germplasm production capacity in the form of secure "core" teak germplasm production units

no.	activity	outputs/ milestones	completion date	comments
1.1	Seed procurement	Seed collections from 6-8 local provenances completed Broad-based seed collections from 3-4 non-PNG sources	31.5.2015 31.7.2014	Final seed collection occurred in May-June 2014 and distributed to project partners. Teak seed originating from 31 different sources from 11 countries was introduced into PNG during this project. See table below for summary of introductions. Refer to Appendix 10.1 for full inventory and distribution

The 31 sources of seed were broadly categorised into one of three categories based on their level of domestication: wild= natural populations, cultivated = those from cultivated sources and improved = from improved seed orchards.

	Countries	# Sources	Wild	Cultivated	Improved
Seed Sources	11	31	3	10	18
Details	Burma, Costa Rica, Honduras, India, Ivory Coast, Laos, Malaysia, PNG, Solomon Is, Tanzania, Thailand,	TG01-TG31	India, Laos, PNG	Costa Rica, Little Vudal, Oomsis	Malaysian & ATSC, Mt Lawes, Vunapalading
Planted			0	15,549	2,094

1.2	Vegetative germplasm procurement	Material for propagation supplied to each involved partner	31.5.2015	FRI collected branch cuttings from six candidate trees at Vunapalading in August 2011 and established them as hedge plants in 2012. Since then, ongoing propagation work has been done to distribute materials to partners.

1.3	Installation of seed production units / provenance tests	Adequate nurseries in each site Experimental designs documented, 10,000 stumps or seedlings Sites ready for planting Teak seed stands established in each hub (8ha hub-1, 1-3 ha stand-1) Continued high survival and fast growth	12.2012 2011-2015 continuous	Establishment of the project partner nurseries occurred during 2010. A total of 240 kg teak seeds were distributed to partners over the life of the project. Commencement planting of core seed production areas (SPA) occurred at Warangoi in ENB (OISCA 2011) and Situm in Morobe (FRI 2015). The SPAs comprised an area of 3.38ha (OISCA) and 0.42 (FRI) by project end. The design of the SPAs were based on provenances introduced and planted as blocks (OISCA) and incomplete randomised block design was used for Situm. The trials demonstrated the effectiveness of establishing teak within food gardens (including legumes such as peanuts) combined with manual weeding (slashing grass by hand and ring-weeding). Good survival and growth was found with this method
1.4	Development / adaptation of vegetative propagation protocols	Propagation units ready for test runs Functionality of veg prop systems established; staff familiarized	2011-2013 2014/15	Non-mist propagators were established at FRI and UNRE. A misting system at FRI was established Both FRI and UNRE are proficient at propagating teak via stem cuttings. Further refinement of aspects related to media and hygiene are required to further optimise the methods. Technical documents outlining the process of truncheon collection and setting in misting propagators has been prepared by FRI.
1.5	Establishment of clonal stockplant gardens	≥1 rooted cutting of ≥80% of selected trees generated by each partner In each hub, ≥5 rooted cuttings of each clone Stockplant gardens, adequate for production of clones for trials and operational plantings	2011-2015 12.2014	Seedlings hedge plants were established at UNRE, using teak from most provenances introduced. Many of these ortets were replicated as clonal plants and formed the basis the replicated clonal trial established at UNRE (see task 1.6). By the end of 2014, 35 hedge plants comprising of clones of PNG plus trees from Mt Lawes, Vunapalading and Oomsis have been planted at FRI Nursery, known as the ‘clonal archive’ (Table 1).
1.6	Installation of clonal demonstration plantations / tests	Designs documented Planting stock ready for outplanting Sites ready for planting Clonal trials / demos established in each hub (1ha hub-1) Continued high survival, fast growth	10.2011 1.2013 1.10.2012 31.1.2013 continuous	A randomised complete block design developed for the clonal trial, with clonal provenance plots comprised 16 clones replicated four times. A total of 576 individuals representing 159 clones from 10 Seed Sources were established at UNRE in Jan 2013. An extension to the trial was planted in late 2014 according to a row-column design developed by UNRE. Clonal ramets surplus to the UNRE trial were established in rows according to provenance at OISCA. This trial is colloquially known as the ‘progeny trial’ despite it being a small provenance planting.

1.7	Data collection, analysis and publication	Complete set of data at due dates Adequate sources identified	1.5.2014 1.5.2015	Measurements of growth and form across the clonal trial were conducted at year 1.5 and 3. Data has been analysed and scientific manuscript drafted.
1.8	Thinning of seed production units, removal of inferior clones in stockplant gardens	Seed stands / stockplant gardens production ready	n/a	Due to the delayed establishment of the SPA at OISCA the trees were not of sufficient size for thinning during the life of the project.

PC = partner country, A = Australia

Objective 2: To secure existing high-priority genetic resources of teak in PNG

no.	activity	outputs/ milestones	completion date	comments
2.1	Negotiation and agreement with (rival) landowners, Mt. Lawes clonal seed orchard; six-monthly monitoring visits	Written or verbal agreement	2010	Agreements with landowners at Mt. Lawes were made early during the project to provide ongoing access to the CSO during the life of the project. Landowners are seeking to conclude these agreements to commence commercial harvesting.
2.2	Collection of scions in Mt. Lawes clonal seed orchard, grafting to Clone Bank at FRI, Lae	Genetic resources secured	1.10.2013	Collections of truncheons from plus trees at Mt Lawes were conducted in 2013, Plus tree clones from Mt Lawes (18 clones), Vunapalading (4) and Oomsis (1) were successfully established in a clonal archive (FRI-Lae) by August 2014. The techniques used to propagate the teak truncheons formed the manual 'Protocols in Propagating Mature Teak'.
2.3	Maintenance of trials established under FST 2004/009	"Site capture" achieved	2011-2015	The two important trials at Boomsi (Calophyllum and Walnut) are being maintained. The species trial (105A-2-360) established in 2001 at FRI Botanical Garden in Lae was measured and thinned in 2015. The trial was established under the auspices of ACIAR project FST/1998/115.
The species trial provided information about the suitability of different tree species within a wet equatorial climate. Seven species were recorded with an annual diameter increment of between 1 and 1.2 cm including *Emerillia papuana*, *Pometia pinnata form glabra*, *Calophyllum europhyllum*, *Artocarpus altilis, Endospermum medullosum*, *Swietenia macrophylla* and *Adenanthera pavonina.*				

PC = partner country, A = Australia

Objective 3: To enable and exemplify local germplasm production and/or delivery though establishment of working pilot projects

no.	activity	outputs/ milestones	completion date	comments
3.1	Selection of and negotiation with participating communities	Verbal or written agreements; 5-10 individual collaborators per community	1.5.2010	In ENB, agreements were made with communities in Bitapaka, Sinivit and Toma/ Vunadidir LLGs. In Madang, three community nursery sites were planted; Aronis, Ohu and Erima. In WP, one community nursery was established in Briompenai (Upper Fly), with teak plantings also established at Komovai (Middle Fly) and Nakaku (South Fly).
3.2	Workshops for selection of local priority species (LPS) and plantation designs/sites	1-3 secondary species community-1 chosen plantation locations, designs, documented (teak+LPS)	1.6.2013	All LPS workshops were completed in both Madang and East New Britain. LPS planting sites were within selected satellite communities as well as OISCA in ENB.
3.3	Germplasm acquisition	Germplasm in hands of communities Seed / vegetative material ready to sow	1.6.2012 to 1.12.2014	Teak seed was distributed from the Mt Lawes CSO and Vunapalading provenance trial to all recipients from 2012. In Madang, Taun and Galip were distributed to the satellite communities. In ENB, the communities were supplied with Galip, Kumarere, Rosewood & Kwilla.
3.4	Installation of "satellite" germplasm sources, teak and LPS	4 activated nurseries hub-1 Planting stock ready for 4 ha per hub of plantation or equivalent, of which ≥3ha is teak Continued high survival, fast growth	1.7.2012 1.6.2012 1.6.2014 continuous	Community nurseries were established within all three hubs by 2012. Planting stock has been produced since 2012. Teak stumps occupying around 2.7 hectares of land have been supplied to 18 lead satellite farmers and a further 0.7 hectares of teak Seed Production Areas/Demonstration Plots have been occupied in ENB. Site maintenance and continued survival has been good overall with some exceptions.
3.5	Data collection, analysis, publication	Complete set of data at due dates Scientific paper ready for submission	1.8.2011, 1.8.2012, 1.8.2013 1.2.2014	PIP has assisted OISCA to implement the Satellite Monitoring Form which is used to collect data at regular due dates. Intensive data collection was conducted in mid-2015 with publication of conference paper in Small-Scale Forestry conference in October 2015

PC = partner country, A = Australia

Objective 4: To determine viability of local commercial nurseries as sustainable germplasm delivery mechanisms, and, depending on findings, promote their establishment

no.	activity	outputs/ milestones	completion date	comments
4.1	Study of germplasm supply and demand	Documented results	03.2014	Projected demand for tree seedlings in ENB was determined through smallholder survey (see below for summary).
Just over 50% of households were interested in or engaged with planting of trees. Greatest demand was recorded for *Tectona grandis, Canarium indicum* and *Eucalyptus deglupta*. Projected total demand for planting material comprised of seed, seedlings and wilding. A significant proportion of the projected total demand would be expected to be satisfied through self-supply of seed, wildings, or subsistence micro-nurseries. Commercial demand for tree seedlings was calculated at 39% of total demand and estimated to be 408,000 for *T. grandis*, 354,000 for *C. indicum* and 484,000 for *E. deglupta* annually. Significant commercial demand also existed for wildings of both *C. indicum* (15,000) and *E. deglupta* (156,000). Similar demand for teak wildings would be expected as smallholder woodlots mature. The market price for tree seedlings varies considerably between different species and markets, ranging from K0.5 for balsa to K4 for grafted cacao.				
4.2	Feasibility study of local commercial nurseries.	Documented study	10.2015	Survey work conducted in 2012, 2013 and 2015 reveal that tree seedling production is a commercially feasible option for smallholders. It is evident that well managed nurseries producing at least 1,000 units and selling at K1 per unit can achieve a return to labour above the minimum wage of K25/day.
4.3	Prep. concept note for potential donors (microenterprise development)	Concept note	2013-2015	The implementation of the two forestry related projects by Gesley Rivan has led to improved ACIAR project impacts. It has benefited the fledgling ENB nursery sector and stimulated greater demand for tree seedlings. These projects have engaged commercially with several tree nurseries established in this ACIAR project. This has contributed to the scaling-out of project results
4.4	Preparation of article documenting results	Scientific paper	10.2015	A paper entitled “Feasibility of Smallholder Nursery Microenterprises as Sustainable Germplasm Delivery Mechanisms in Papua New Guinea” was presented by Julio Ugarte at the IUFRO Small Scale Forestry Conference in October 2015.

PC = partner country, A = Australia

Objective 5: To facilitate scaling-up by monitoring, adapting, documenting and disseminating approaches and results and by promoting timber tree planting

no.	activity	outputs/ milestones	completion date	comments
5.1	Project monitoring and adaptation	Modifications to annual operating plans Quarterly progress reports (one-pagers) Modified OPs, where applicable Recommendations for future actions	n/a Continuous n/a n/a	Adjustments to the project operating plans were made during the implementation of the project. The clonal approach to propagation at OISCA was modified to seed production only. In WP, where eaglewood was the focus, the project facilitated contacts with international seed suppliers. Progress updates and work plants were provided by project leader in the Annual Reports. Work plans were detailed in field reports of project leader and other
5.2	Preparation and distribution of extension and outreach materials	Population-at-large better informed about project 2 press articles per year Calendars & posters distributed	5.2015 5.2014 N/A	See below for more detail
ENB farmers preferred individual information sheets on each LPS rather than a single calendar. PIP prepared and distributed the factsheets online, via CD and hard copies using the project budget for the calendar. In ENB two community extension officers in Takubar/Vunakaur distributed the existing factsheets for among growers. The project contributed to UNRE regular 20-minute radio program broadcast across ENB (Uni Tokoaut) with John Gesling (Lead Farmer) and Neville Howcroft (UNRE) being featured in two of the shows. The topics covered included general premise and opportunity in tree planting, and concepts of domestication/tree improvement, as well as technical information on tree growing. While the project had organised for participation in an additional 10 programs (including transcripts) this was not completed by the end of the project. In 2014 a project Facebook page was established, originally for communication between project partners on their activities. By November 2015 the page was 'liked' by 270 users with the primary audience extending beyond the project and consisting mainly of employed PNG nationals. This page has offered a new avenue for communicating with a broader audience about the outputs and importance of plantation and community forestry in PNG. Through this page the project has secured some new additional contacts growing teak in PNG.				
5.3	"Next generation awareness" activities (teachers/schools)	Good working relationships Book published Schedule of field-days and school visits Teachers informed, equipped with classroom materials Students informed about benefits of growing teak and other timber species	1.4.2014 Continuous	The project has actively engaged with the education sector primarily in East New Britain. These have been through participation in World Environment Day Celebration each year of the project, Development and Testing of the School Resource Pack and Establishment of woodlots within school grounds. Details on each of these activities are provided below.

World Environment Day Celebrations have been organised each year at the 7 schools in ENB's 4 pilot communities, namely: Bitapaka, Kabagap, Tauran, Papalaba, Vunalir, Totovel and Vunairima as part of OISCA's Children's Forest Program. In Madang, FPCD organised a stall at World Environment Day event. FPCD co-ordinated satellite nursery owners to hold a stall on tree planting with small sales of teak seedlings being made in 2014/15. Participation in these events was broadcast over the radio, which resulted in a high level of interest. Project teak farmers shared their collective experience with other smallholders interested in timber tree planting. School Resource Pack was developed for elementary and primary school teachers in consultation with the ENB Division of Education and representatives from the 7 pilot schools. The pack contains over 100 digital resources (i.e. files for printing, slideshows, audios and videos) arranged according to PNG's outcome based school curriculum (see Table 2 and Figure 3). School Resource Pack has been introduced and evaluated at Bitapaka and Tauran schools. Three CDs and 5 evaluation forms were given to each school. The pack will be launched and monitored at all 7 pilot community schools under the Teak and Sandalwood Project. Teak and LPS seedlings have been planted by school teachers and children at Bitapaka, Tauran and Papalaba schools with training and support from OISCA. There were 50+ seedlings given to each school. Teak stumps have been planted in woodlots of 50+ trees at Tauran, Papalaba and Vunalir schools.				
5.4	Targeted visits to key decision- and policy-makers (government and industry)	Briefs published ≥ 1 visit hub-1 yr-1		The project has actively engaged with the Provincial Administration in East New Britain, Madang, Gulf and Central Provinces. The project has also engaged with various industry stakeholders
The engagement of relevant Provincial Administration authorities has led to greater involvement of the Department of Primary Industry in East New Britain in tree planting and culminated in the support for two government supported tree planting projects in ENB. Participation in the ACIAR policy workshop led to the exploration and development of the sandalwood component of this project, and participation in the PNGFA initiative "Painim Giraun na Plannim Diwai' that aims to increase tree plantations across PNG. This project has liaised with key project personnel to build a strategy for germplasm supply for plantation sector. The project has also communicated with the ITTO community teak project in Central province and led to the adaptation of community engagement within the sandalwood component of this ACIAR project, which works in similar areas of Central Province.				
5.5	Preparation of flexi-media toolkit	Video / audio footage Tool-kit ready for distribution Launching event held	2011-2014 5.2014 08.2015	Completed in 2014. The toolkit will be produced as a CD/DVD and/or USB flash drive for distribution to those without internet access. The video content of the flexi-media toolkit was embedded to the PIP website and was announced through PIP email list during the visit. The toolkit was launched in mid 2015
5.6	Training in use of toolkit	Documented curricular framework Course imparted	08.2015	A launching of the Toolkit was conducted in conjunction with the project final workshop in Port Moresby in August 2015.
Participants in the Toolkit launch included project collaborators, FA technical staff, Provincial extension officers, Ward rural development officers and smallholders. The event was publicised through national TV and print media. Participants were introduced to the structure of resources contained in the toolkit, trained in the application of different types of resources (1.Choosing the right trees, 2.Growing the best trees 3.Making money from trees and 4. Extension Materials) and encouraged to provide feedback. Each of the participants was provided with a USB-flash drive containing all the resources. The launching was well received by all participants but particularly extension offices and development officers, who thought it could increase their capacity and some of the tools could be used directly in their engagement with smallholders, particularly during Ward meetings.				

PC = partner country, A = Australia

Objective 6: Determine feasibility of sandalwood agroforestry in Central and Gulf Provinces

no.	activity	outputs/ milestones	completion date	comments
6.1	Resource owner consultation and awareness activities on sandalwood conservation and growing by landowners.	Gain support across all stakeholder levels for the project.	2014-2015	See below for details
Consultation Provincial and District Administrators as well as landowners in the 3 target areas (Rigo, Kairuku, Malalaua Districts) was conducted in 2014. Tore Ovasuru advised that we need to increase our engagement with the necessary authorities at the Province, Ward and Village level. Tore is now retired from the public service, having worked in both Kerevat and Stewart Research station during his career at CCI and has a particular interest in the sandalwood as a development option for not only his home village but also other areas of the Province. A significant time commitment from landowners, particularly in site maintenance during establishment would be required for success. A statement of intent for this input of landowners is necessary. This will avoid any potential issues due to mismatch in expectations between landowners and project staff. The project also requires a formal written statement from the leaders of the Iokea community about their perspectives about the potential introduction of exotic species of sandalwood at Iokea.				
6.2	Selection and establishment of 3 model centres in the target sites.	Conceptual agreements for model centres with the District and Provincial Administrations.	2014-2015	Three project centres have been established within the scope of the project. See below for details
The three project areas that work with the project are Iokea (Gulf Province), Girabu and Kairuku (Central Provinces). The social structure within participating clans in each community is very different (i) Iokea comprises many people across a number of clan groups working on a single site, (ii) Girabu consists of two clans working on their own adjacent sites and (iii) Kairuku involves several family units planting as small-scale woodlots close to their house sites.				
6.3	Preliminary assessment of the current state of the resource and potential seed sources.	Field survey and resource owner interviews	2014-2015	See below for details
From initial surveys of wild sources and discussions with local resource owners it is clear that PNG sandalwood (S. macgregorii) populations have been severely affected by uncontrolled harvesting. This confirms its IUCN status as an endangered species (Eddowes 1998). The most recent significant harvesting activity took place during the 1990s and early 2000s, with many reports of people harvesting illegally from non-customary land. While a systematic survey of recruitment has not been undertaken, initial inspections and discussions reveal very little recovery, due to a lack of productive seed trees and regular burning of the areas. Despite this a total of 66 seed bearing trees were reported across the three Districts through the consultation process. In Iokea, many planted seed trees can be found within the village but few within the surrounding savannah vegetation. In Kairuku many seed bearing trees can be found around family dwellings. In Girabu, very few sandalwood have been planted, and although trees of seed bearing age can be found in surrounding areas, their productivity is low and community members find it difficult to collect sufficient seed for planting.				

PC = partner country, A = Australia

7 Key results and discussion

7.1 Core teak plantings

ENB

One of the most important outputs is the 'core' teak plantings in ENB with OISCA (Provenance trial) and UNRE (Clonal Provenance Trial). Over the life of the project OISCA received 51kg of teak seed representing 19 provenances from 10 countries (PNG, Laos, Thailand, Burma, Costa Rica, India, Ivory Coast, Tanzania, Malaysia, Solomon Is). They have established approximately 3.36 hectares of provenance block plantings on their grounds in Warangoi in ENB ranging in age from 0.5 to 4 yrs. Good site maintenance has continued throughout the project.

A clonal teak trial was established at UNRE Vudal Campus in East New Britain during January 2013. The trial represents 576 individuals, comprising 159 clones, from 10 Seed Sources: China, India, Thailand, Honduras, Laos, Costa Rica (Jicaro, Nambi, Santa Alicia) and PNG (Vunapalading and Brown River). The buffer rows surrounding the trial and 'refills' were planted between February and May 2013. The site has been well maintained since establishment and most trees are growing vigorously

A measure of survival, vigour and form was conducted during 2015 for the seedling (OISCA) and clonal (UNRE) provenance plantings. Height and diameter vigour was very good for all source provenances across both sites, with greater diameter growth in the clonal site (6 to 7 cm yr^{-1}) compared with seedling sites (3.5-5.5 cm yr^{-1}) (Figure 2). The exact mechanisms for the improved growth in the clones compared with the seedling stock is not yet clear, although variation in site and establishment techniques cannot be discounted. The seedling provenance plantings were generally on sites with a steeper slope than the clonal site at UNRE. Weed control was good at both sites, although manual slashing and gardening was practiced for the seedling sites compared with manual slashing and herbicide for the clonal site.

Form was not found to be provenance related with marked variation among all individuals ranging from poor to very good. Better form in seedlings compared with clones was found across all measures of form (Figure 3). Much of this variation was caused by multiple stems and early branching in the clonal stock, suggesting that form-pruning interventions are required at an early age. It is expected that this would improve general form in the clonal grown stock.

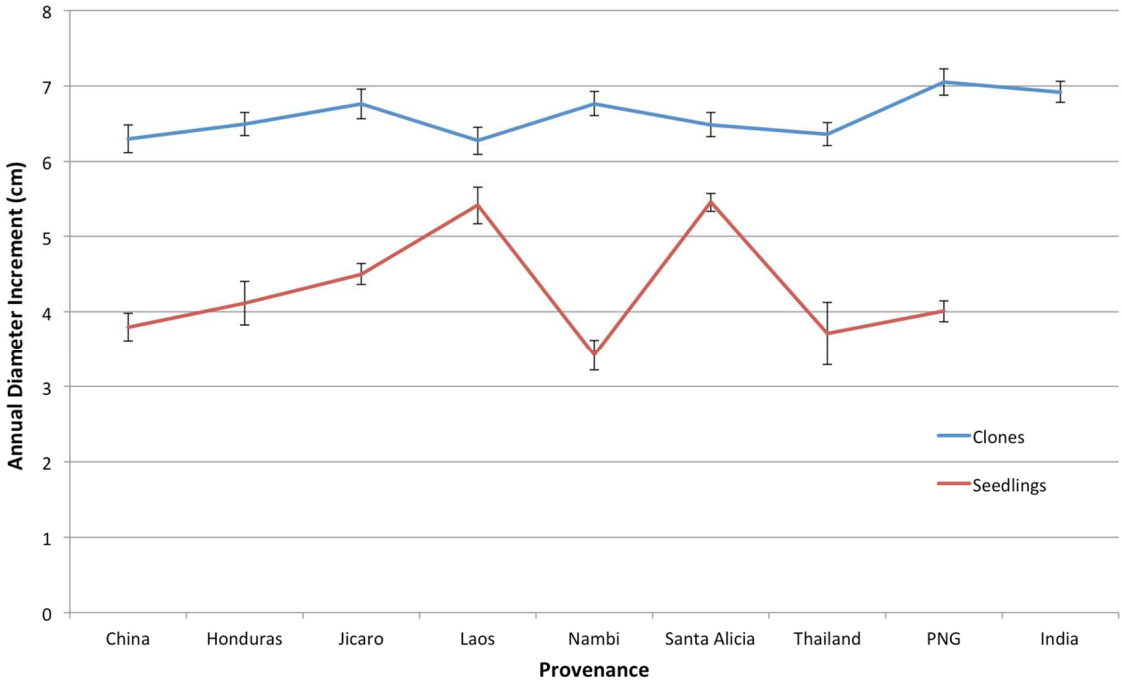

Figure 2: Annual diameter increment variation between teak source provenances for clones clones (UNRE) and seedlings (OISCA). Error bars are standard errors of the mean.

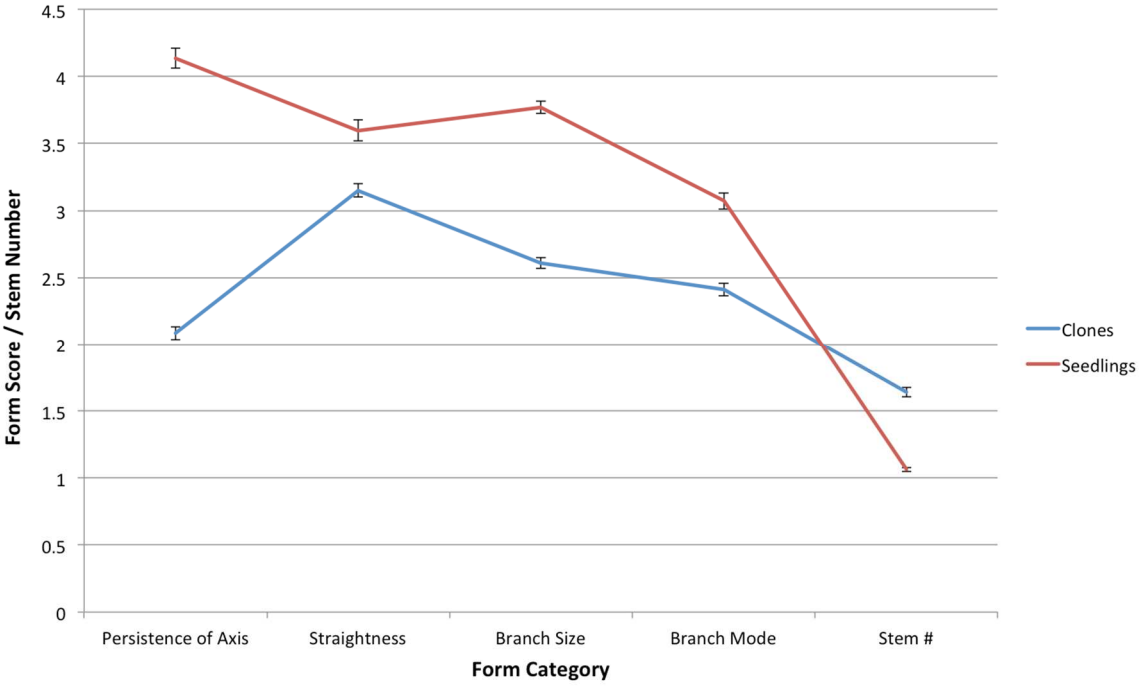

Figure 3: Form variation between teak clones (UNRE) and seedlings (OISCA) across ten provenances. Form scores range from 1-6 (1=poor & 6=good) for persistence of axis and 1-5 (1=poor & 5=good) for straightness, branch size and branch mode. Error bars are standard errors of the mean.

Lae

Teak seed introductions to FRI in Lae were made from 2010-2015. Issues with locating a secure and suitable site for a core planting persisted until 2014, when an agreement between FRI and local landowner at Situm (~12km east of Lae City). The trial was planted in June 2015 with stumps from seeds originally sown in 2011. The trial included seven seedlot introductions (Laos, Thailand, China, Honduras, Santa Alicia, Jicaro & Nambi) planted as an incomplete block design. The site had a slight and consistent gradient towards the creek at the southern end of the plot. The site was blocked for variation due to this slope and dominant vegetation (*Imperata cylindrica*, *Saccarum robustum* and garden crops).

The site was assessed at six months after establishment (November 2015) for survival, height and number of coppice. Multiple shoots were pruned and dead stumps were replaced by rooted cuttings of the same provenance. Survival was 89.5% across the site, ranging from 75 to 100% between provenances. Main factors for mortality were (i) suppression by weeds (before weed control at 3 weeks), (ii) partly burned by landowners clearing dry debris to plant food crops, (iii) suppression by food crops after planting, and (iv) water logged area at the first two plots of replicates 4 and 5. Mean tree height ranged from 24.5 (Thailand) to 45.9 cm (Laos). Number of shoots ranged from 1.6 (Honduras) to 2.7 (Thailand)

In Nov 2015 various food crops planted among the teak stumps were mapped to determine the distribution of food crops growing in the trial and the potential influence on current survival and future tree growth. Food crops such as taro, giant taro, banana, peanut, sweet potato, bean, pumpkin, cucumber and cassava, and area cleared were recorded including various combinations of these crops. The findings demonstrate a potential negative impact of giant taro on survival of adjacent teak stumps with higher mortality recorded. While initial observations suggest giant taro to be competitive with teak further evaluation is required.

Teak introductions from Malaysia, Costa Rica and Mt Lawes during 2014 were sown at FRI in three stages: late September, mid-November and mid-December 2014. These represent 45 teak seedlots from Kuriva, Oomsis, Malaysia, Santa Cruz, Penas Blanca, Nambi, Hojancha and individuals from the Mt Lawes CSO. Seedlots were pre-treated (wet and dry treatment for 7 days) before being sown directly into the prepared beds at 1cm in the row and rows 5cm apart. While germination results were variable and low approximately 1200 stumps are suitable for planting. These will provide the basis for the extension of the provenance planting at Situm in 2016.

7.2 Cloning selected teak in PNG

The PNG Forest Research Institute (FRI) commenced a clonal program for selection of elite trees identified around the country. The technical aspects of vegetative propagation of teak has been reported in literature (Monteuuis *et al.* 1995; Goh and Monteuuis 1997). This project used an adaptive research approach to teak cuttings using locally available materials. The project established non-mist propagation boxes and revitalised a misting facility at FRI. Experiments were conducted during the project to determine the effect of (i) timing of cutting collection and transport procedures in truncheon cuttings as well as (ii) genotype, propagation media, cutting length and propagation environment (mist vs. non-mist) in teak leafy stem cuttings.

A total of 29 unrelated parents were sourced from three sources (1) Oomsis woodlot in Morobe Province, (2) Vunapalading-Kerevat plantation in East New Britain Province, and (3) Kuriva plantation and CSO, in Central Province. Stems with a diameter of 1.8-2.0cm, a length of 40 to 50 cm and at least 2 dormant buds (truncheons) were collected from each of the selected trees.

Vunapalading (ENB province)

Collection and propagation

Ten truncheon cuttings were collected from each of six selected trees from Vunapalading (ENB) in Jun 2012. Truncheons with a mean diameter of 2.5 and length of 41 cm were harvested from mature branches. Immediately after cutting each end of the truncheons were sealed with petroleum jelly to prevent desiccation. Truncheons were then placed in moistened sawdust and covered with moistened newspaper within a plastic insulated box. For the truncheons collected from Vunapalading 35% (21/60) developed epicormic shoots after 4 weeks but only 10% were successfully rooted after 9 months. The rooted truncheons represented 4 of the 6 selected trees (Trees #1, 3, 4 & 5), which were planted out as hedges in the FRI clonal archive in June 2012 (Table 1).

Replication

Cutting experiments using leafy stem cuttings collected from Vunapalading stock plant clones were conducted during 2014. Initial experiments evaluated the effect of different propagation media and propagation environment on rooting percentage. Five media were used including: (1) fine sand (2) coarse sand, (3) coarse sand:coconut husk 1:1v/v, (4) perlite:coconut husk 1:1v/v, and (5) jiffy pellets. Jiffy pellets are a commercially prepared medium composed of compressed cocopeat. The first experiment was conducted under an intermittent (10 sec. every 10 mins) misting propagation system and the second within non-mist propagation environment.

High rooting percentage was attained in both jiffy (85% ± 0.05se) and coarse sand:coconut husk medium (77.2% ± 3.95se). Intermediate rooting success was found in fine (65.3% ± 0.06se) and coarse (52.3 to 64.6% ± 2.85se), both of which were significantly greater than those set in a mixture of perlite and coconut husk (42%). Variation in rooting percentage between the propagation systems was negligible, with 65.3 and 62.1% for misting and non-mist systems respectively.

At the conclusion of the project in 2015, a total of 209 ramets from the four Vunapalading clones had been successfully produced and ready for outplanting. The clones represented were T1=76, T3=46, T4=57 and T5=30.

Oomsis (Morobe Province)

Collection and propagation

Ten truncheon cuttings were collected from each of six selected trees from Oomsis Forestry Station (Morobe) in Jun 2012. Truncheons with a mean diameter of 1.8 cm and length of 47 cm were harvested from mature branches. Truncheons were prepared in a similar manner as those collected from Vunapalading. A total of 36.7% developed epicormic shoots after 4 weeks. While none of the 'sprouted' truncheons had developed roots after 3 months, all were planted in the FRI clonal archive in August 2012, and subsequently died. The study demonstrated that successful rooting of field-collected mature truncheon cuttings in teak requires a propagation period of at least 6 months.

Truncheon cuttings were recollected from the six selected trees from Oomsis Forestry Station (Morobe) in July 2013. The number of truncheons collected from each tree was dependent on availability of suitable material and ranged between 12 and 29. A total of 135 truncheons were collected overall with 84 propagated in the mist house and 51 in non-mist propagators. Epicormic shoots were recorded in 86% and 90% of truncheons after four weeks within mist and non-mist propagators respectively. This level was reduced to 37% and 0% respectively after 5 months within the propagation environment with only one truncheon from selected tree #5 developing roots and successfully planted in the FRI clonal archive (Table 1). All teak trees at Oomsis were harvested in mid 2013 and are no longer available for further collections. This demonstrates the insecurity of existing teak germplasm sources in PNG and the need for continued activity to secure all remaining resources.

Mt Lawes (Central Province)

Collection

As part of early teak improvement efforts in PNG the Forest Department established a grafted seed orchard at Mt. Lawes (DoF 1970) based on genotypes selected for timber volume, branching habit, log length and stem form (Cameron 1966). While the genetic source of the clones was not described, the orchard currently consists of 29 replicated clones. The project sought to secure all representative clones in the FRI clonal archive before customary landowners gain the right to harvest the trees.

Ten truncheons were harvested from each of 27 clones at Mt Lawes in October 2013. Truncheons were not collected from two clones (# 28 & # 33), as they were no longer dormant, having commenced vegetative growth. Truncheons were collected and prepared as previous collections in Vunapalading and Oomsis; they were placed in moistened sawdust and covered with moistened newspaper within a plastic insulated box. The truncheons were stored in this state for a period of 7-9 days, as it took 4 days to collect, 2 days to transport (Mt. Lawes to Lae) and a further 3 days to plant the truncheons in the misting propagator. Once the truncheons arrived in Lae the box was opened and left in the mist house. Bud growth was recorded in 83% of truncheons prior to planting, which was substantially quicker than for previous collections from Vunapalading and Oomsis. Furthermore, truncheons stored for 9 days had noticeably greater bud growth than those stored for 7 days. Representatives of 18 clones were successfully rooted using this method and were planted out in the FRI clonal archive between May and August 2014. The clone numbers represented are as follows: 1, 5, 7, 8, 9, 12, 13, 14, 15, 23, 24, 26, 27, 29, 30, 31, 39 & 41 (Table 1).

Replication

In December 2013 cuttings were collected from epicormic shoots in, as yet, unrooted cuttings. A total of 34 cuttings with a mean length 9.7 cm were taken from eleven clones (#C2 = 4, C5 = 5, C7 = 1, C8 = 6, C9 = 1, C12 = 1, C16 = 1, C27 = 9, C29 = 2, C39 = 1, C41 = 3) and set in non-mist propagators. Seven of these clones were successfully replicated using this method (C1 = 1, C29 = 1, C5 = 2, C27 = 3, C41 = 1, C31 = 1, and C39 = 1). This demonstrates that mature materials can be further replicated. Initial ramets were planted out in the clonal archive to increase the number of hedge plants per clone.

Based on the positive propagation results using jiffy pellets as a rooting medium, further propagation work was conducted using four Mt Lawes clones (C# 5 15, 27 & 41) and four random genotypes (R#01, 02, 03, 04) within a misting system. The experiment was conducted to determine the effect of cutting length (6, 8 10, & 12 cm) on rooting percentage. Four cuttings per clone for each cutting length were randomised within a propagation tray containing jiffy pellets; a second complete replicate tray was also set. The experiment was assessed for rooting success after 12 weeks in the misting system. Results indicate that cutting length influences rooting success in teak leafy stem cuttings with longer 10 and 12cm cuttings (93% and 74% rooting respectively) outperforming the shorter 6 and 8cm cuttings (50% and 52% respectively).

At the conclusion of the project in 2015 a total of 39 ramets from seven Mt Lawes clones had been successfully produced and ready for outplanting. The clones represented were C1 = 1, C5 = 4, C14 = 8, C15 = 4, C26 = 3, C27 = 17, C41 = 2.

Clonal Archive (FRI - Lae)

The clonal archive represents a secure resource for selected teak germplasm from PNG. The archive provides the basis for further replication and establishment of replicate clonal seed orchards. The establishment of reliable protocols for propagating mature teak clones and the establishment of the FRI clonal archive are important outputs of this project. During the project FRI staff also surveyed plus trees identified at Kuriva plantations, for later inclusion in the clonal archive. Much of the seed used to establish the plantation was sourced from the Mt Lawes clonal seed orchard, and as such represent selected progeny. While clones of these trees will make a valuable addition to the archive and subsequent seed orchards, inclusion of additional clones of different genetic origin will be important for the overall long-term improvement of teak in PNG.

Table 1: Plus trees represented in the FRI clonal archive in Lae at the end of 2014.

Source	Hedge plants	Plus Trees Represented	Yet to be secured
TG4 (Vunapalading)	8	T1, T3, T4, T5	T2 & T6
TG5 (Mt Lawes CSO)	26	1, 5, 7, 8, 9, 12, 13, 14, 15, 23, 24, 26, 27, 29, 30, 31, 39, 41	2, 16, 20, 28, 33, 34, 35, 36, 37, 38, 40
TG15 (Oomsis-Morobe)	1	T#5	T#1, 2, 3, 4 & 6*
Kuriva^	0	-	Bp1 – 15, 16, 17, 19 StC2 - 21, 24, 25, 26, 29, 30, 31, 32, 33, 37 Cmp1 - 34, 35, 36
Total	**35**	**23**	**30#**

*Clones not yet secured from Oomsis have been harvested and are no longer available for collection, # total clones yet to be secured do not include those from Oomsis. ^ Plus trees from Kuriva were surveyed during 2014 and no collections were made during this project. Codes for Kuriva relate to their location in the plantation Bp1 = Block Planting 1, StC2 = Station Compartment 2, Cmp1 = Compartment 1.

7.3 Satellite plantings

The establishment of smallholder managed satellite plantings was to provide a decentralised source of tree germplasm to allow direct access by customary landowners. This approach to germplasm distribution and establishment was conducted in each of East New Britain, Madang, and Western Provinces in cooperation with NGOs OISCA, FPCD and OTDF respectively. In each province the project engaged with individual communities grouped largely by Local Level Government (LLG) areas (satellites) and collectively known as provincial 'hubs'. The objective was to establish at least 4 ha per hub, of which ≥3 ha = teak in groups of ≥50 trees, for seed production. Typically each of the LLG satellites had a lead farmer, who provided the main point of contact for our partner NGOs. The lead farmer was the host of the project 'satellite nursery' and established a minimum of 1ha of teak. In several satellites the lead farmer also hosted the first plantings of Local Priority Species (LPS). Most hubs also had other participating farmers that planted smaller teak woodlots of at least 50 trees each. In Western Province (WP) a single satellite nursery was located in Briompenai, from which teak stumps were distributed to other communities in WP.

Over the life of the project a total of 50, 34 & 27 kg of teak seed were distributed to OISCA, FPCD and OTDF respectively for further distribution to satellite nurseries in each of the community hubs. The lead farmer was responsible for further dissemination of seed/stumps and information to the other participating farmers in the community. Based on this approach and distribution, just over 11,000 teak trees were planted by 128 smallholder farmers across the three Provincial hubs (Table 2).

Table 2: Smallholder teak planted across three provinces of PNG (Madang, East New Britain and Western) as part of FST/2007/078. * Area is calculated based on a mean stocking rate of 625 stems / hectare.

Province ('hub') / LLG ('satellite')	Teak Planted	Area (ha)*	Farmers	Mean Planted
Madang				
Aronis	665	1.59	2	332
Bilbil	300	0.36	2	150
Erima	882	2.11	1	882
Milhanag	500	0.60	10	50
Ohu	300	0.36	1	300
Subtotal	2647	5.03	16	165
East New Britain				
Bitapaka	1662	2.65	14	87
Raluana	315	0.50	3	105
Reimber/ Livuan	801	1.28	12	67
Sinivit	400	0.64	6	80
Toma/ Vunadidir	4291	6.86	66	58
Subtotal	7469	11.95	101	74
Western Province				
Briompenai (N. Fly)	450	1.08	8	56.25
Komovai (Middle Fly)	50	0.12	1	50
Nakaku/Suki (S. Fly)	420	1.00	1	420
Kautru (S. Fly)	238	0.57	1	238
Subtotal	1158	2.77	11	105
Total	**11274**	**19.8**	**128**	**115.9**

East New Britain

In the East New Britain hub almost 12 hectares of satellite plantings have been established across 101 growers, each planting an average of 74 teak trees. For teak growing in suitable sites with adequate maintenance the mean annual DBH increment was 3.6 cm for East New Britain. Assessment of teak woodlots across the five LLGs in ENB was undertaken using a participatory research approach with local 'enumerators'. This approach was taken to build the capacity of progressive farmers to monitor teak woodlots and potentially influence growers through peer-mediated learning.

OISCA has developed strong links with the satellite communities over many years and conducted the selection of enumerators. A total of 7 enumerators were selected based on their demonstrated level of interest in tree planting, as well as their active participation within their respective communities. OISCA has two forestry technical officers that provided the main point of contact for the enumerators. Enumerators participated in two single-day workshops with the first covering silvicultural practices for establishing and maintaining woodlots and the second covering tree measurement, data collection and critical thinking. All enumerators were then involved in the measurement of 12 yield plots in the core teak planting at OISCA. Yield plots were measured as outlined below in the inventory.

Site Selection

Enumerators conducted a census of all smallholder teak plantings within each of the four focal communities. The census included basic information related to owner identity, locality and number of trees planted. In consultation with the enumerators, woodlot

owners were categorised into one of three broad occupational categories i) community leader, ii) employed or iii) farmer. The results of the census were used to apply a random sample of six sites per community stratified for socioeconomic category with 2, 1 and 3 sites for community leader, employed and farmer respectively.

ENB smallholder teak summary

The census revealed a total of 101 smallholder teak plots with an average of 74 trees/plot for a total of 7469 trees planted across four communities. The relative proportion of the three socioeconomic categories were 33% Leaders, 17% Employed, 60% Farmers. The trees ranged in age between 1 to 3.75 years. Enumerators participated in the measurement of the 12 yield plots in the OISCA planting (categorised as non-government organisation NGO) and survival, but all were not able to implement the measurement of their six plots independently. The yield plots were measured and recorded by four of the original seven enumerators when accompanied by the project leader. The height and diameter data collected by enumerators were highly correlated with a correlation coefficient (R^2) of 0.79 to 0.93 across each of the four enumerators and the trees measured by the group at OISCA.

Site suitability

The site suitability index was greatest for the NGO grower category (3.0) and lowest for Community Leader (2.0). While the Farmer (2.58) and Employed (2.5) growers were intermediate for site suitability index, they contrasted in their distribution. Employed growers were found to have a skewed bimodal distribution whereby 75% of growers were categorised as having high (3) site suitability 25% as low (1). All Farmer growers had sites considered to be of either High (3) or Moderate (2) suitability.

Tree survival

Percent survival was significantly ($P<0.05$) greater in the NGO (91%) and Farmer (86%) yield plots compared with both Community Leader (68%) and Employed (68%) plots (Figure 4). Percent survival was also found to be significantly greater ($P<0.05$) in sites of high (87%) and moderate (81%) suitability compared with that of low (55%) suitability (Figure 5). No statistical interactions were found for survival between grower socioeconomic category and site suitability.

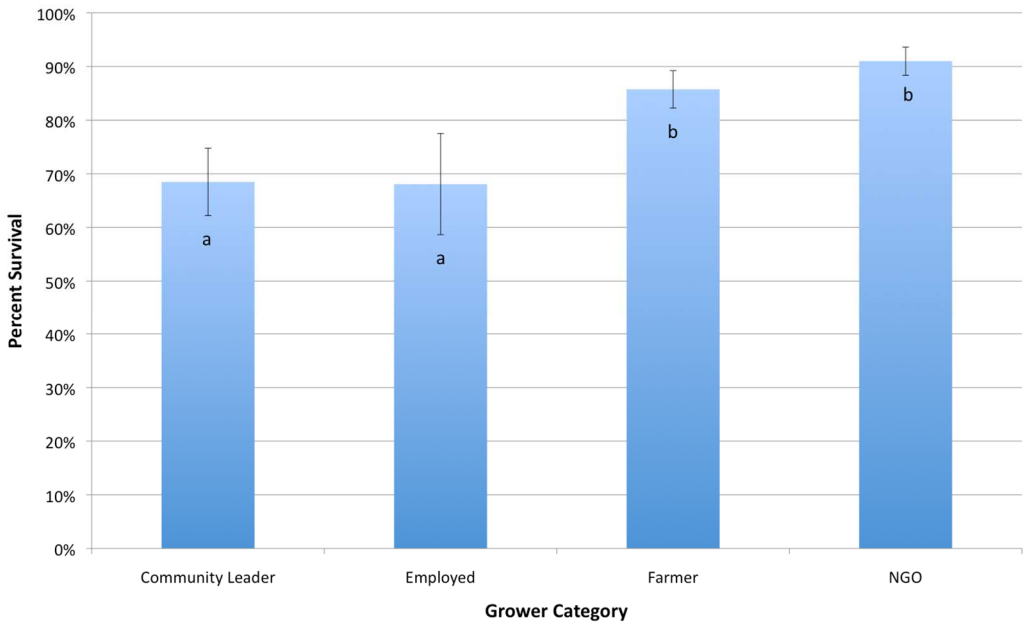

Figure 4: Percent tree survival measured in 36 yield plots across four grower socioeconomic categories (Community Leader, Employed, Farmer and Non Government

Organisation- NGO). Vertical error bars represent standard errors of the mean. Grower categories that share lower case letters are not significantly different (0.05 level).

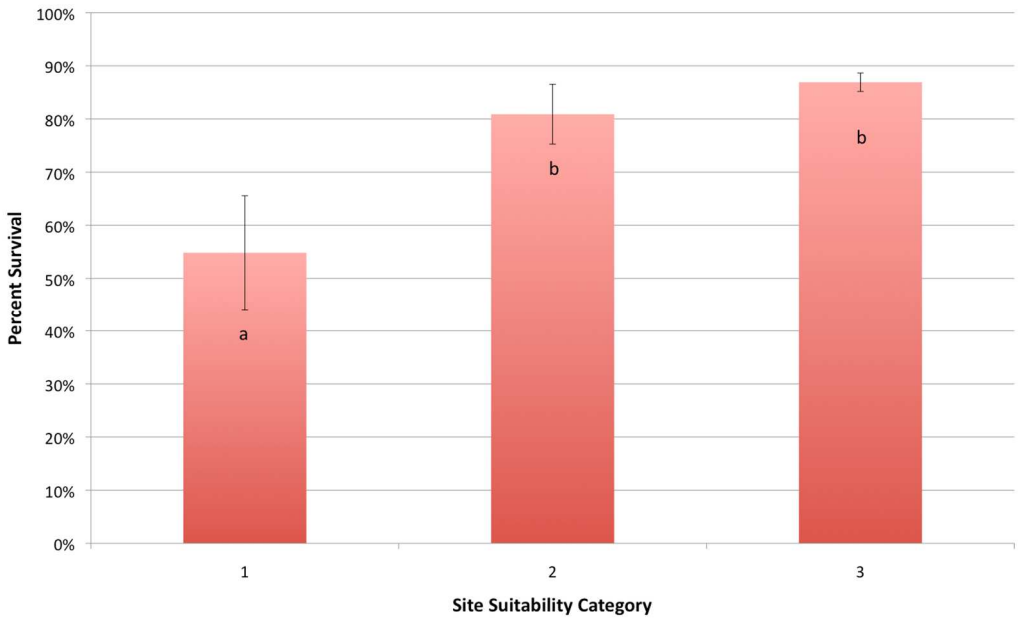

Figure 5: Percent tree survival measured in 36 yield plots across three site suitability categories (1-Low, 2-Moderate 3-High). Vertical error bars represent standard errors of the mean. Site suitability categories that share lower case letters are not significantly different (0.05 level).

Annual diameter increment

Annual diameter increment was significantly ($P<0.05$) greater in the NGO (4.5cm) yield plots compared with all remaining plots. Farmer (3.2cm) plots had a significantly ($P<0.05$) greater annual diameter increment than Community Leader (2.6cm) plots, with Employed (2.9cm) being intermediate between and not significantly different from either (Figure 6). Annual diameter increment was found statistically ($P<0.05$) different between all three site suitability categories in descending order high (3.6cm), moderate (2.5cm), and low (1.6cm) suitability (Figure 7). No statistical interactions were found for annual diameter increment between grower socioeconomic category and site suitability.

The annual diameter increments of trees grown by the NGO were over 1cm greater than all smallholder farmer plots. The growth in the NGO plots provides a demonstration of the growth potential of teak in this area of PNG and should be used to highlight the advantages of good silvicultural practice for smallholder growers. Given the resource constraints for smallholder forestry extension, exploring options such as peer-mediated extension is important so that future woodlots can attain their yield potential and maximise benefits to the growers.

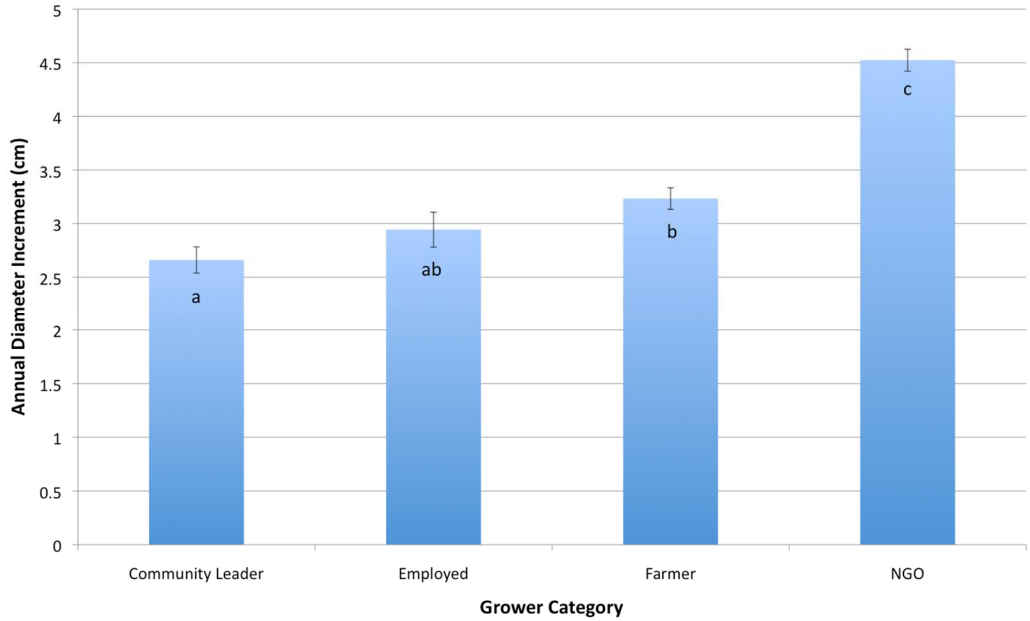

Figure 6: Annual diameter increment (cm) measured in 36 yield plots across four grower socioeconomic categories Community Leader, Employed, Farmer and Non Government Organisation- NGO). Vertical error bars represent standard errors of the mean. Grower categories that share lower case letters are not significantly different (0.05 level).

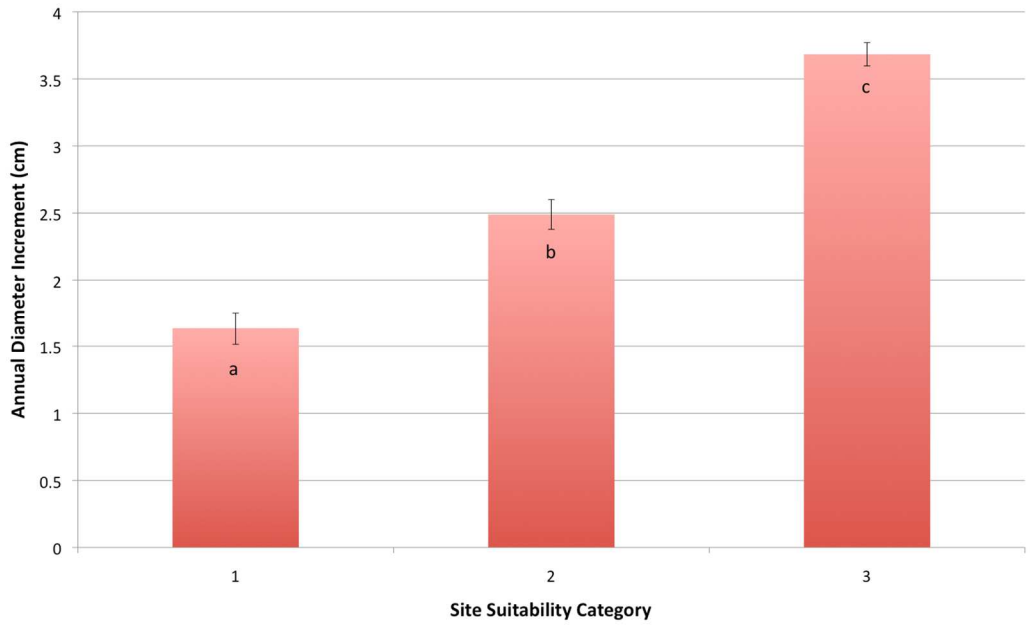

Figure 7: Annual diameter increment (cm) measured in 36 yield plots across three site suitability categories (1-Low, 2-Moderate, 3-High). Vertical error bars represent standard errors of the mean. Site suitability categories that share lower case letters are not significantly different (0.05 level).

Discussion

An aim of this project activity was to understand the effect of involving enumerators in participatory research on their capacity to monitor teak woodlots. The study demonstrated that enumerators can independently and successfully carry out a basis census of growers and the numbers of trees planted in their woodlots. Collection of this data requires only discussion with the relevant tree planters and doesn't require enumerators to visit the site.

While this data enabled the planning of the inventory work with the enumerators, it does not build capacity of enumerators to assess woodlots and develop an understanding of the different issues for smallholder tree growers. The response to initial training activities was positive and enumerators demonstrated a good capacity to assess and measure teak woodlots. This is supported by the strong positive correlation between height and diameter measures for each of the enumerators, as well as the statistical differences in survival and diameter increments for the three site suitability categories. It is clear however, that greater support of enumerators is required before they have confidence to conduct woodlot surveys independently.

The survival, growth and form of teak grown under smallholder conditions were influenced by measures of site suitability. Lower measures of site suitability were largely determined by maintenance of the planting (weed competition and fire) and site selection (old gardens, under cash crops, under secondary regrowth and waterlogging). Growers categorised as Community Leaders and Employed had a higher proportion of sites with the lowest site suitability measure (37.5% and 25% respectively) compared with Farmers (0%). This was largely due to lower follow up maintenance of the sites, which was a consequence of less available time for woodlot maintenance. This demonstrates the importance of matching the size of the woodlot with the time and resources available to maintain the site after planting. Interestingly all three smallholder categories (Community Leaders, Employed and Farmers) had sites categorised with the highest suitability score (37.5%, 75% and 58.3% of sites respectively). This finding is important as it shows that all types of smallholders in ENB can potentially manage woodlots.

Morobe

RAIL

Teak plantings have been established by RAIL at one of their sites located at Jacobs Creek. The site is a remnant riverbed of the Markham and is 10-15m below the ground level of the alluvial plain. Originally the site was a swampy area with a spring at one end of the site forming a small creek that flows into the Markham River. The site has had some engineering works to improve drainage although the water table might be 1-2 meters under the surface of the soil, giving reliable water supply to the growing trees regardless of rainfall. Plantings of teak include seed sourced from local Markham sources planted in April 2013 and introductions from Penas Blancas (TG16) and Santa Cruz (TG17) planted in February 2014 and Mansion (TG14) and Nambi (TG15) planted April 2014. The planting with local Markham teak was affected by wildfire in late 2014 leading to high mortality in many of the younger seedlings. The mean annual increment of this source was measured at 1.9cm/yr. Survival and MAI for the project introductions have been affected by waterlogging in part of the site with Mansion (26% and 0.92cm/yr.) and Penas Blancas (31% and 0.3cm/yr.) being more affected than Nambi (78% and 2.1cm/yr.), Santa Cruz (69% and 2.4cm/yr.). The growth of the teak in the less waterlogged parts of this site had surpassed any of the earlier RAIL teak plantings in the rocky areas of the alluvial plain, which demonstrates that teak does benefit from access to constant soil water.

Madang

In the Madang hub approximately 5 hectares of satellite plantings have been established across 16 growers, each planting an average of 165 teak trees. FPCD Technical Officer Linzon Zamang worked closely with three lead farmers from the communities of Aronis, Erima and Ohu. In 2013/14 Costa Rican seedlots from Penas Blanca (TG16), Santa Cruz (TG17) and Hojancha (TG29) were introduced into each of the three communities but for various reasons had not been sown until mid-2015 and planted out in late-2015. Approximately 1500 seedlings were planted across the three communities, but were not inventoried before the conclusion of the project. Also towards the end of the project, considerable interest in planting teak had been raised within families related to these lead farmers and adjacent villages. This led to the establishment of additional smallholder woodlots in Bilbil/Danben and Milhanag in central Madang (see below). Teak growing in

suitable sites with adequate maintenance in the Madang hub was found to be highly productive with a mean annual DBH increment of 4.4 cm.

Aronis

Aronis is located along the north coast of Madang and the nursery managed by Jonah Barumtai. Jonah has established the first teak planting in early 2013 with 283 and 182 seedlings of two Costa Rican seedlots (Santa Alicia (TG11) and Jicaro (TG12) respectively). Survival, recorded at year three was 87.5% and DBH mean annual increment ranged from 4.5 to 5.5 cm. In the first 18 months the trees were pruned regularly and it was evident that they had been over pruned and become top heavy. Pruning was discontinued at this time and they have made a full recovery. The trees are planted on quite a steep slope and a landslip had affected a small section of the southwestern corner of the block in late 2014.

Erima

Erima is located along the south coast of Madang and the Sioba family manages the nursery. Sioba have established two significant plantings with seed of Costa Rican origins. The first planted in mid-2012 of 383 seedlings and comprised seedlots from Honduras (TG10), Santa Alicia (TG11), Jicaro (TG12), and Nambi (TG13). Maintenance of this site was very good with excellent survival (~93%) and growth (mean annual DBH increment of 4.1 to 4.4 cm) measured at year three. Pruning was conducted over the site at year 1 and 2, with good bole formation. A second planting was established in early 2015 with 200 seedlings of Mansion (TG14) and 299 of Santa Cruz (TG17). The planting was followed by a significant drying event, resulting in 20-30% mortality, but these were refilled in mid-2015 with surplus stumps remaining in the nursery. Growth and performance of this second planting was not determined before the end of the project.

Ohu

Ohu is located in central Madang approximately 10km from the centre of town. Ogab E'el manages the nursery and teak woodlot. Teak stumps originating from seed collected Mt. Lawes (TG5) were supplied by FRI and 150 were planted at the Ohu site in late 2011. Another 150 stumps of Costa Rican origin (Santa Alicia TG11) were established in mid-2012. Survival of these trees was between 50-70%, with losses due largely to inadequate weed maintenance. Irregula weed management and little early pruning also negatively affected tree form. In terms of tree growth, those from Santa Alicia outperformed Mt Lawes with respective DBH mean annual increments of 2.8 and 4.6cm. This difference in performance may be more reflective of rainfall following establishment rather than genetic differences. Ogab is a very active community leader and has been a proponent for tree planting in his area. His community has hosted two important project events, the tree planting workshop in 2013 and business planning workshop in August 2014 (Zamang 2014). His activities have motivated other communities to become involved in the project (see below).

Bilbil/Danben & Milhanag

The community of Bilbil/Danben commenced participation in the project through project participation in the Madang Festival 2014. The planting of teak commenced in early 2015 with seed sourced from Costa Rica (Penas Blancas TG15). Three hundred seedlings were established with very good initial survival recorded at around 85-90%.

The participation of the Milhanag community commenced with its participation in a Business Planning Workshop conducted by the project within the community of Ohu. Immediately following the workshop the Milhanag community established its own nursery for production of teak stumps (Penas Blancas TG15). Within six months of establishing their nursery they had distributed 500 seedlings across 10 different smallholder farmers.

Western Province

Close to 3ha of teak have been planted across several communities in the north, middle and south Fly River regions. The project worked with a limited number of growers that registered some interest in trialling teak.

North Fly (Briompenai)

At Brompenai village (35km north of Kiunga) Dudu Orowa is the satellite nursery manager and has established a small plantation of teak (*Tectona grandis*), klinki (*Araucaria hunsteinii*) and agarwood (*Aquilaria crassna* from Vietnam). The teak includes introductions from Mt Lawes (TG5) and Honduras (TG10). Much of the lower part of the site, where most of the trees are planted, appears to have shallow and acidic soil. Teak trees planted in this area have highly variable growth across the site with the best trees attaining an annual DBH increment of ~2.5 cm, but most much below this. Some teak were pruned up to 2m with some form pruning evident, although further pruning is required. The klinki planted in 2009 is also variable in growth but, while slow in growth, is coping with the shallow soil better. Agarwood is also planted between the teak and klinki with some 3 year old trees approaching a mean annual DBH and height increment of 2.6cm and 1.3m respectively. Further work on pruning the agarwood is required since most trees having multiple stem crowns and short boles. In this part of Western Province the agarwood have flowered in late June to early July.

Middle Fly (Komovai)

At Komavai, Awox Papoa is the lead farmer and began participating in the project in 2010. His land is on the edge of a lagoon on the western side of the main Fly River channel. The oldest teak trees (Mt. Lawes TG5) were planted in 2010 at a 6 x 4m spacing with the best trees having a diameter increment of ~2cm/year. Losses in the rows were replanted with agarwood with most trees 2-3m tall at age 2 yrs. Competition from the kunai grass (*Imperata cylindrica*) is a major growth inhibiting factor in his current plantation. Most trees have been lightly pruned. Awox received Costa Rican teak seed introductions in July 2014 (~ 1.5kg of each of TG15, TG16 & TG17). Detail on the planting of these introductions is unclear, due to the passing of OTDF contact officer Samuel Famiok in 2015, and therefore not included in the summary in Table 2.

South Fly (Nakaku & Kautru)

The project worked co-operatively with the Nakaku Field Station which has an OTDF-supported nursery managed by Ganga Naio. Teak seedlings represent a minor component of the nursery production, with agarwood production dominating. A teak woodlot comprising a Costa Rican introduction (Santa Alicia TG11) was planted adjacent to the nursery in 2012. The teak experience high competition from the kunai grass (*Imperata cylindrica*), which grows right to the base of the trees. Growth rates have been poor and variable with just a few reaching 4-5m and the rest stunted. Annual grass burning may have depleted nutrients and the trees would benefit from fertiliser additions. Project officer David Spencer provided training for the knapsack application of herbicide to the Kunai in mid-2014. Agarwood seedlings on the site were planted in 2013 and at 1.5 years appear to be growing well.

The nearby village of Kautru had received teak stumps from both Briompenai satellite nursery (Mt Lawes TG5) and Nakaku Field station (Jicaro TG12). In total 238 seedlings were planted in early-2013 within a small woodlot adjacent to the village, with refills planted in mid-2013. Growth was highly variable, like many teak woodlots established in Western Province. This variation in growth can be attributed to the competition from kunai grass, low soil nutrition and low soil pH. While teak can be grown in Western Province, higher management inputs are required to develop productive woodlots with commercial potential. These additional inputs include herbicide control of widespread kunai grass, fire management, fertilisation and liming. Given these additional inputs and village preference for planting agarwood, the wider adoption of teak planting in Western Province is not likely in the short term.

7.4 Local Priority Species

LPS Consultations

Local Priority Species (LPS) setting activities were conducted in ENB to identify which species of trees are most valued by the communities in these regional hubs. LPS consultations followed a participatory, step-by-step, approach designed with reference to Franzel et al. (1996). Selection tools (guidelines and forms) were prepared to assist project collaborators undertake three discreet activities.

- **Household and group surveys** to identify and compare popular tree products and services, leading to the selection of promising local trees (maximum 10) with limited local availability. Respondents were prompted to compare the importance of each product, service and selected species using the pairwise ranking method. The data collected within each community was then compiled in a desktop tally sheet.
- **Desk-top research** to produce a ranked list of up to 10 popular tree products, services and promising local trees for each community with reference to their desk-top tally sheet findings. The desktop research report included a 1-page assessment of each promising local species prepared by project staff and community leaders with reference to 8 local suitability criteria. Final ranking was based on summing of the instances of priority listings, no weighting for higher priorities were given at this stage.
- **Community workshops** to select 2-3 local priority trees per community for the project to work with in addition to teak. These were conducted over a period of three days using a standard structure (Appendix 10.4). Participatory exercises were used to facilitate discussion among stakeholders, and to allow their participation in (1) the finalisation of the priority species with reference to the desk-top research findings, and (2) the preparation of a community land-use sketch map

ENB

The household and group surveys were conducted in four LLGs across the Gazelle Peninsula (Table 3). These were conducted within a central location in each of the LLGs, George Brown Pastors College (Reimber/ Livuan), Togoro (Bitapaka), Malapau Co-Operative Society (Raluana) and Zone 3 (Toma/Vunadidir). A total of 170 household groups were surveyed using the LPS surveys in Appendix 10.3.

Table 3: Summary statistics for the LPS surveys conducted in four LLGs in East New Britain Province

LLG	Survey Period	Groups/ Households	People	M	F
Reimber/ Livuan	Mar-May 2011	27	194	59%	41%
Bitapaka	Jun 2013	26	150	51%	49%
Raluana	Apr-May 2011	96	536	55%	45%
Toma/ Vunadidir	Jul-Nov 2010	21	197	70%	30%
	Total	170	1077	59%	41%

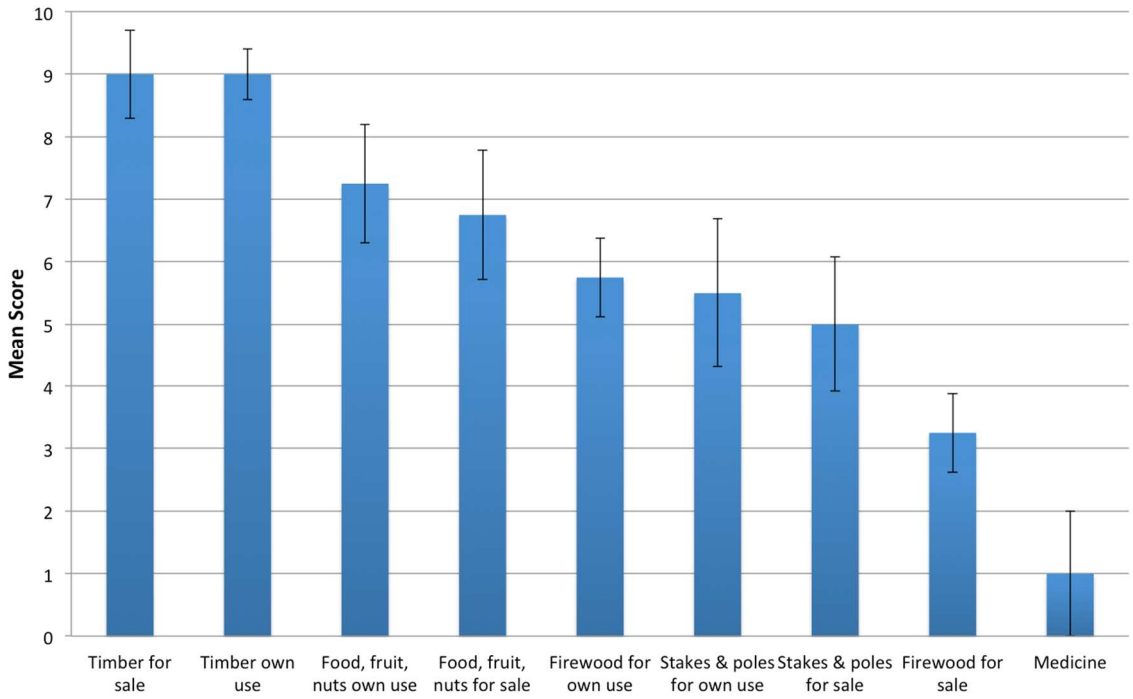

Table 4: Most desired products from planted trees as listed across four survey areas (Reimber/ Livuan, Bitapaka, Malapau, Raluana and Toma/Vunadidir). Higher mean priority scores represent a greater priority across the survey areas. Error bars denote standard errors of the mean.

Consistently across all four LPS surveys, smallholder primary motivation for growing trees was for the production of timber, both for sale and own use (Table 4). This was followed by growing trees for food (fruits & nuts), firewood and small rounds (stakes and poles). Growing trees specifically for medicinal use was mentioned by three groups in Toma/Vunadidir, two groups in Raluana and five groups in Reimber/Livuan. The prominence of timber reflects the localised timber shortage in parts of East New Britain.

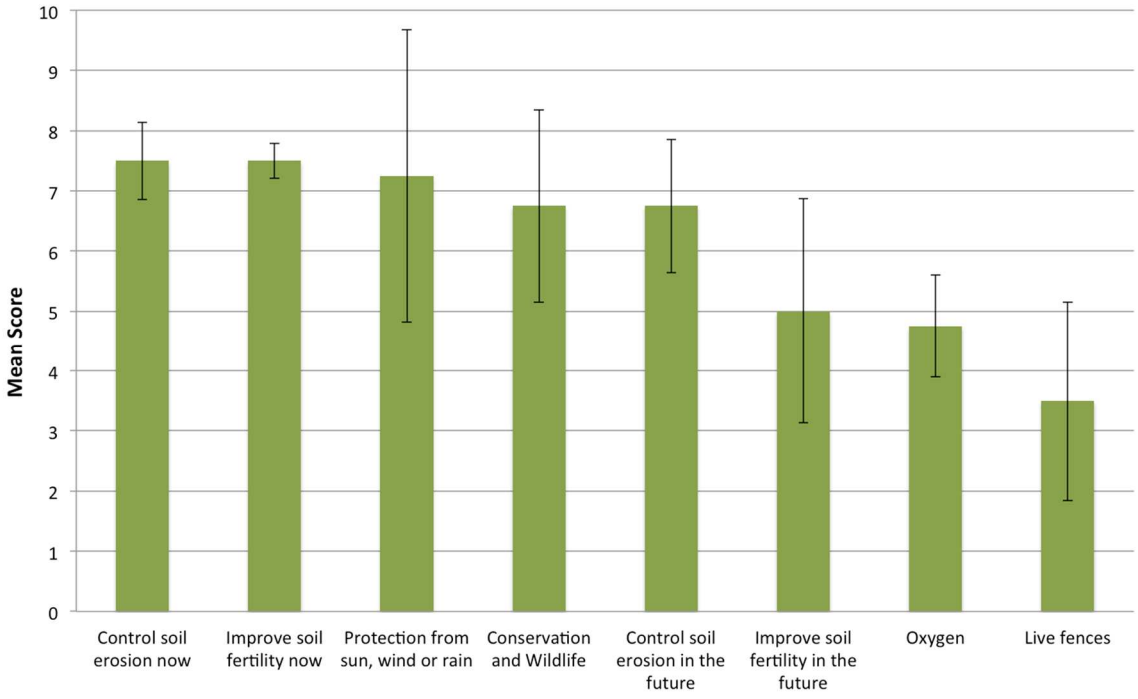

Table 5: Most desired environmental services from planted trees as listed across four survey areas (Reimber/ Livuan, Bitapaka, Malapau, Raluana and Toma/Vunadidir). Higher mean priority scores represent a greater priority across the survey areas. Error bars denote standard errors of the mean.

The environmental services that were the most consistent motivating factors for planting trees across the four survey areas were for controlling existing soil erosion issues and improving current soil fertility (Table 5). This is not surprising given that soil erosion on steep slopes is a major environmental issue in this part of East New Britain. Improving soil fertility is of interest in an environment with naturally fertile volcanic soil. This may be indicative of the high population density in most of the areas surveyed and the short rotation for gardens and prevalence of cash cropping. Trees may be used in these areas to improve fallow, or alternatively be used in areas of marginal fertility for agriculture. For the remaining environmental services substantial variation in the priorities were found between communities. In Reimber/Livuan and Bitapaka for instance an equal preference was given to most of the remaining services. In Malapau a preference for protection from sun, wind or rain featured prominently. And in Toma/Vunadidir controlling erosion in the future was of importance.

Table 6: Local priority species (LPS) as identified through surveys in four LLGs. Species are ordered in order of highest to lowest priority for each LLG. Numbers in parentheses are the mean score. Final LPS were determined after further consultation during community workshops

Toma/ Vunadidir	Reimber/ Livuan	Raluana	Bitapaka
Rosewood (10)	Kwila (10)	Galip (10)	Kumarere (10)
Kwila (9)	Malas (9)	Taun (9)	Kwila (9)
Walnut (8)	Mahogany (8)	Kumarere (8)	Taun (8)
Galip (7)	Kumarere (7)	Malas (7)	Malas (7)
Taun (6)	Calophyllum (6)	Kwila (6)	Rosewood (6)
Calophyllum (5)	Klinki Pine (5)	Calophyllum (5)	Walnut (5)
Aiting (4)	Blackbean (4)	Walnut (4)	Babap (4)
Breadfruit (3)	Aipi (3)	Rosewood (3)	Amarleadik (3)
Rambutan (2)	Durian (2)	Bukubuk (3)	Aipi (2)
Kumarere (1)	Galip (1)	Terminalia (1)	Angaro (1)
Local Priority Species (LPS) finalised during workshop			
Galip	Kwila	Galip	Kumerere
Kwila	Malas	Bukubuk	Kwilla
Rosewood	Kumerere	Kwila	Calophyllum
	Calophyllum		

Madang

FPCD field officer Linzon was provided training in delivery of LPS workshops in East New Britain, with the view to replicating them in each of the three communities in Madang. After consultation with the communities, FPCD decided to hold a workshop with the participation of all tree growers from each of the three communities participated in priority setting workshop to identify the LPS. The results of this engagement resulted in the identification of Talis (*Terminalia* spp.), Galip (*Canarium indicum*) and Taun (*Pometia* spp.) across all three communities. LPS collection and distribution in Madding was based on these three species.

LPS Distribution

ENB

In ENB a total of 18,000 LPS seedlings have been distributed across the four satellite communities (4,000 Kumerere, 4000 Galip, 10,000 Kwila).

- Toma/Vunadidir LLG (Village Vunakaur/Sikut): Galip (2,000 seedlings distributed), Kumerere (2,000 distributed from bulk collection from Intake Area), Rosewood (None distributed as rosewood is easily collected from cuttings and the farmers don't require assistance for this – two forms of Rosewood).

- Toma/Vunadidir LLG (Village Malapau): Galip (2,000 seedlings distributed), Kumerere (2,000 distributed from bulk collection from Intake Area), Bukabuk (Burkella: Never supplied as the trees are very rare).
- Reimber/Livuan LLG (Village - George Brown Pastors College): Kwila (6,000 wildings from Mt Varzin supplied), Kumerere (not yet supplied), Calophyllum (not yet supplied – potential sources Napap Kerevat, CPL Coconut Producers Ltd, and possibly Dixon Private Nursery).
- Bitapaka LLG (Village Togoro): Kwila (4,000 wildings from Mt Varzin), Kumerere (not yet supplied), Calophyllum (not yet supplied)

Madang

Collections of the following LPS were made and distributed to Madang nurseries during 2014.

Galip (*Canarium indicum*)

50+ seeds of *Galip* from Karkar Is were collected in June 2014 from each of 10 trees with each tree being more than one kilometre from the next. Trees were selected on being in a good stand, having good stem form and high nut quality. This collection covered the full perimeter of the Island. Distribution was as follows: Erima - 4 parents, Ohu - 3 parents, Aronis – 3 parents. Seedlings were produced and planted by the start of 2015.

Talis (*Terminalia kaernbachii*)

Talis seeds were collected by the end of August 2014 from the coastal occurrences around Aronis along the north coast of Madang. Further collections were to be made along the south coast closer to Erima, but these weren't completed by the conclusion of the project. Seed from Aronis were bulked and propagated the respective community nurseries at Aronis, Erima and Ohu. Single observation plots of 36 trees (6rows x 6 trees) at 4x3 were planted at Aronis and Erima.

Taun (*Pometia pinnata* – white and *Pometia tomentosa* – red)

After discussions with the satellite community members, it is apparent there are two forms of Taun with both having equal quality timber. *Pometia tomentose* (Papa or Red Taun) has red timber, good/straight form and rapid growth. *Pometia pinnata* (Mama or White Taun) has edible fruit, form less straight with a lower vigour compared with *P. tomentose*. Aronis prefer *P. tomentose*, while Erima would like to plant both. Seeds from *P. pinnata* were collected by Linzon Zamang in Nov/Dec 2014 around the Madang area. These were distributed to Ohu village.

Western Province

Consultations with landowners across the Fly River communities were conducted by OTDF during the early stages of the project. Based on these consultations, together with further engagement with lead farmers at the Tree Growers Workshop in December 2012 it was concluded that most communities were interested primarily in growing agarwood (*Aquilaria* and *Gyrinops* species). The project facilitated contacts with international seed suppliers resulting in significant introductions during 2014. In Aiambak, an OTDF-supported nursery comprised a fully shaded germination building with about 15m^2 of bed space as well as about 30m^2 of shaded, temporary stand down bed space. In mid-2014 80,000 agarwood seedlings (ex Vietnam) were potted and growing for dispatch to communities up and down the Fly River. The project assisted with refinement of seed handling and germination techniques and formulation of suitable germination media. The nursery in Nakaku has covered and shaded germination area and a stand down nursery including 15m x 15m of high shade (50% shade cloth). Community women are engaged to do all the soil sterilization and filling of polybags. The nursery is operating and producing primarily agarwood seedlings (~70,000 in 2014) for distribution around the South Fly area, as part of OTDF agarwood initiative.

Eaglewood / agarwood

The interest in plating eaglewood is 'fever pitched' in PNG, owing to widespread rumours about its very high value. While the tree has potential for smallholder production, there are potential issues with respect to the need for inducing an infection to produce the valuable resin-infused wood. With eaglewood identified as an LPS in Western Province and the associated seed introductions to support it there was opportunity to make small introductions for project partners in East New Britain, Madang and Lae. The seed was of the species *Aquilaria crassna* and imported from Vietnam in 2014. In this project and report we use the common name eaglewood when referring to local species of *Aquilaria* and *Gyrinops* and agarwood when referring to exotic species of *Aquilaria*. Small woodlots (~50-100 trees) and plantings (~5-20 trees) of agarwood were established in ENB (OISCA, UNRE and a smallholder grower in Gelagela), Madang (Ohu, Erima and Aronis) and Lae (FRI and Situm). These planting offer the potential for assessing the appropriateness eaglewood/agarwood as a smallholder cash crop in PNG.

7.5 Supply and Demand Surveys

To determine which species of trees have the greatest demand in regional communities and to estimate the quantities required, smallholder and nursery surveys were carried-out in East New Britain. The most sought-after trees for planting and cultivating in ENB are Kumarere (Eucalyptus deglupta), Teak (Tectona Grandis), Galip (Canarium Indicum), Rosewood (Pterocarpus indicus) and Kwila (Intsia bijuga).

District	LLG	Study Site (Ward)	Numbers of Village	Farmers Interviews
Gazelle	Reimber/ Livuan	Raluana	5	5
		Toboina	8	18
	Toma/ Vunadidir	Papalaba	1	55
		Ravata	1	1
		Vanakaur	1	35
	Total	5	16	114

Demand for forestry species.

The mean household size for the respondents of the Demand Questionnaire was 5.7 people. The mean area for total area available including infrastructure, roads and areas not suitable for agriculture like swamps, creeks and other water bodies (available land) was 5.56 ha, with cash crops and vegetable production being the principal economic activity representing 57% and 16% of total household respectively. The level of education varied among the respondents, with 58% primary, 28% secondary, and 14% tertiary education. The households interviewed in this study managed an average of 4.65 crops. The most common crops include cacao (95% household respondents), coconut (44%), banana (48%) and coffee (10%). Calculated market demand for seedlings obviously greatest for cacao followed by teak, kumerere, galip and rosewood (Figure 8). It is suggested that the demand for teak (~970,000) is the future potential rather than current. This is because that most communities interviewed were either associated with or aware of the ACIAR project and familiar with teak. Demand for teak in these communities is likely to be greater than in other communities where teak is not prominent. As more teak is planted across the Gazelle and more communities become aware of teak, the potential demand would approach the 970,000 calculated in this study.

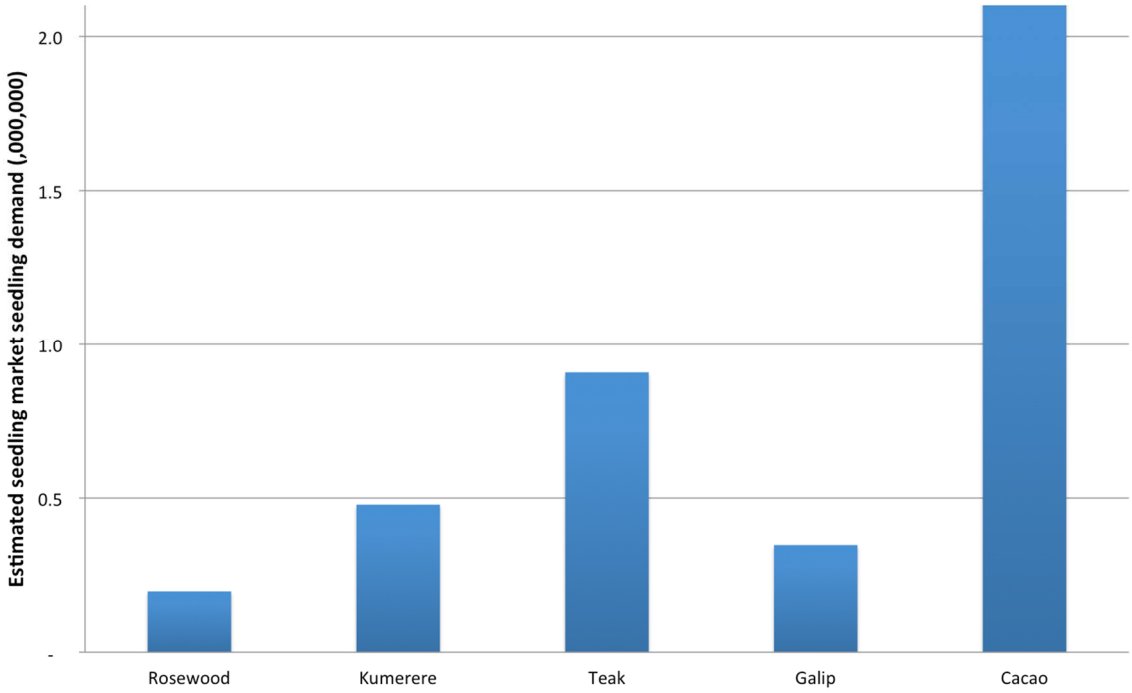

Figure 8: Calculated market demand in the Gazelle District of ENB for nursery seedlings of five different perennial species based on interviews with 114 farmers (Rosewood *Pterocarpus indicus*, Kumerere – *Eucalyptus deglupta*, Galip- *Canarium indicum* and Cacao- *Theobroma cacao*)

Table 7: The broad types of crops produced in temporary micro-nurseries (TMN) for subsistence consumption among household respondents to the Demand Questionnaire.

Crops produced in nursery	% farmers produced	Note:
Cash crops only	56%	Cocoa, coconut, coffee
Both crops and trees	29%	Only seasonal
Trees only	4%	Fruit, nuts and timber trees
None	11%	No nursery reported

A total of 89 % of interviewed households operated temporary micro-nurseries (TMN) to meet their demands for both crop and tree seedlings (Table 7). The TMN of most households interviewed (56%) were used exclusively to produce crops such as cocoa, coconut and coffee. Almost a third of households interviewed (29%) used their TMN to produce both crops and trees, while only 4% of households produced only trees. No nurseries are reported for 11% of the Household interviewed.

Smallholder farmers were questioned regarding the price they would be willing to pay for tree seedlings of different species. Given the high variability in responses within each species they were categorised as either tree or cacao seedlings, and the mean prices were K1.17 and K1.31 respectively. According to a survey of farmgate prices for tree seedlings conducted under ACIAR Balsa project (FST/2009/016) the following prices were recorded (i) Provincial Administration Landcare project - K5/unit, (iii) Balsa seedlings - K0.30 (PNGFA) to K0.5 (CPL) per unit (iv) Kumerere K1 per unit (PNGFA) (iv) grafted cacao clone K4 per unit (AgMark), (v) blackbean seedling K3 per unit (AgMark) and (vi) tree seedlings K3 per unit (OISCA).

Tree species used

Farmers report a wide range of species used on the farm, but they rely also on natural and secondary forest for forestry products as firewood, building material and fibre. Nut trees are also mentioned as one of the most valuable tree products. Cacao is the most important cash crop and is planted in agroforestry systems. Planted trees in this landscape are most often used to provide shade to new plantations of cacao. The expansion of cocoa areas is positively related to farmers demand for shade trees. The most planted forestry species are *Eucalyptus deglupta* (Kumarere), *Canarium indicum* (Galip), *Pterocarpus sp.* (Rosewood), *Intsia bijuga* (Kwila) and *Tectona grandis* (Teak). Kumarere is a native species and almost pure stands can be found in forested areas, during seed season farmers collect the seeds and wildings to introduce the tree to the farm as the natural population is decreasing rapidly due to commercial and non-commercial extraction. The popularity of Kumerere is based on ease of collecting wildings, their high growth rate and its utility as firewood and round wood to build houses.

Nursery supply.

Over two survey periods in mid- 2013 and 2015 a total of 27 different nurseries were interviewed. Questionnaires containing questions related to nursery production systems, species produced, production volumes, input and labour costs and sale price. Responses to questions were used to build a financial model to compare relative business performance between individual nurseries. Nurseries were categorised according to the broad species produced (i) natural forest tree species (kwila, malas, mahogany taun & galip, (ii) plantation species (balsa & kumerere) (iii) teak seedlings (iv) teak stumps or (v) grafted cacao. Where one nursery produced multiple species, production costs specific only to a single species, including apportioning capital costs were used for each species. The relative contribution of various costs were compared between similar nurseries and the main costs associated with production include collecting media, filling polybags with media and in some instances sowing seed. Seed collection costs were also high in nurseries where seed source was distant from their community. Plant production per seedling unit was compared with nursery output for a batch of seedlings (Figure 9). Within a product category it was demonstrated that unit production costs decrease with greater nursery output. This is consistent with many nursery operations where there are cost efficiencies associated with economy of scale. It is also clear that production costs for grafted cacao plants is considerably higher than for all other seedling types. This result is obvious given the higher labour costs associated with the process of budding. For all other seedling categories, nurseries of sufficient efficiency exist to produce seedlings at between K0.5 and K1 per unit. Interestingly teak stumps production at very low numbers could be produced for a price at around K0.5.

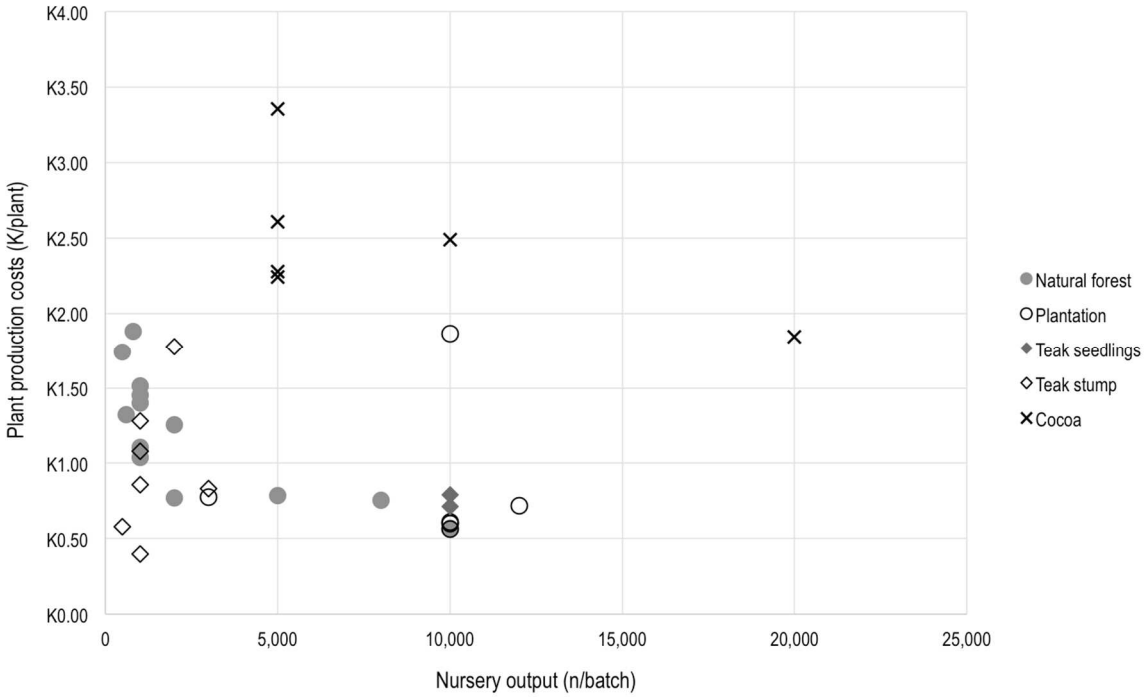

Figure 9: Plant production costs and its relationship with nursery output for different categories of nursery plants including natural forest seedlings, plantation species seedlings, teak seedlings and bare rooted stumps and grafted cocoa seedlings.

The most relevant metric to smallholder nursery production is the return to labour for a given seedling sale price. In this model the return to labour represents the daily wage rate where gross profit is equal to zero. The return to labour was calculated for each nursery for the sale price of 1.00, 2.50 and 5.00 Kina per unit. At K5.00 per unit the returns to labour for all nurseries was above the minimum wage rate of K25/day, with the lowest return to labour at K43.50/day for one of the cacao nurseries. Even when the seedling sale price was reduced to K2.50 all nurseries maintained a positive return to labour, although three of the five cacao nurseries now had a return to labour of less than the current minimum wage of K25/day (Figure 10). With seedling sale price reduced to K1 all but one cacao nursery had a negative return to labour value. A further 12 nurseries producing various seedling types had return to labour under K25/day. 15 nurseries across all but the cacao category, maintained a return to labour above K25 at seeding sale price of K1 per unit (Figure 11). Interestingly teak stump nurseries producing 500-1000 units still maintained a return to labour above the K25/day minimum wage rate.

Given that these nurseries can be potentially sustainable at K1/seedling and that smallholders declared they were willing to pay above this rate in the demand survey, this demonstrates that tree seedling production is a commercially viable business option for smallholder farmers. The high variation in the cost of production between nurseries also demonstrates that there are opportunities for improving nursery efficiencies in many underperforming nurseries. Labour inputs for collecting seed, media collection, filling polybags and sowing seeds can be reduced with introduction of more efficient ways to conduct these tasks. The approach of this project to establish seed satellite seed stands with smallholders is an obvious way to permit access to seeds, but also to improve efficiency of nursery operations. It is clear that smallholder production of tree seedlings is a feasible method for delivering tree germplasm to smallholder farmers seeking to grow trees.

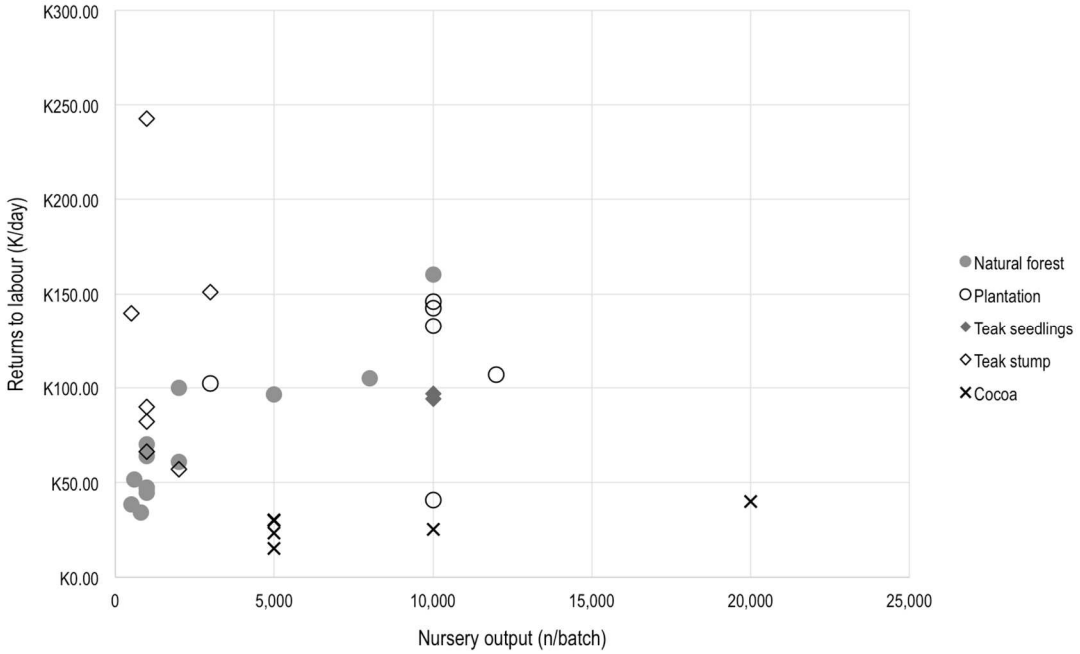

Figure 10: Return to labour at a seedling sale price of K2.50 for different sized nurseries across four nursery plant categories including natural forest seedlings, plantation species seedlings, teak seedlings and bare rooted stumps and grafted cocoa seedlings.

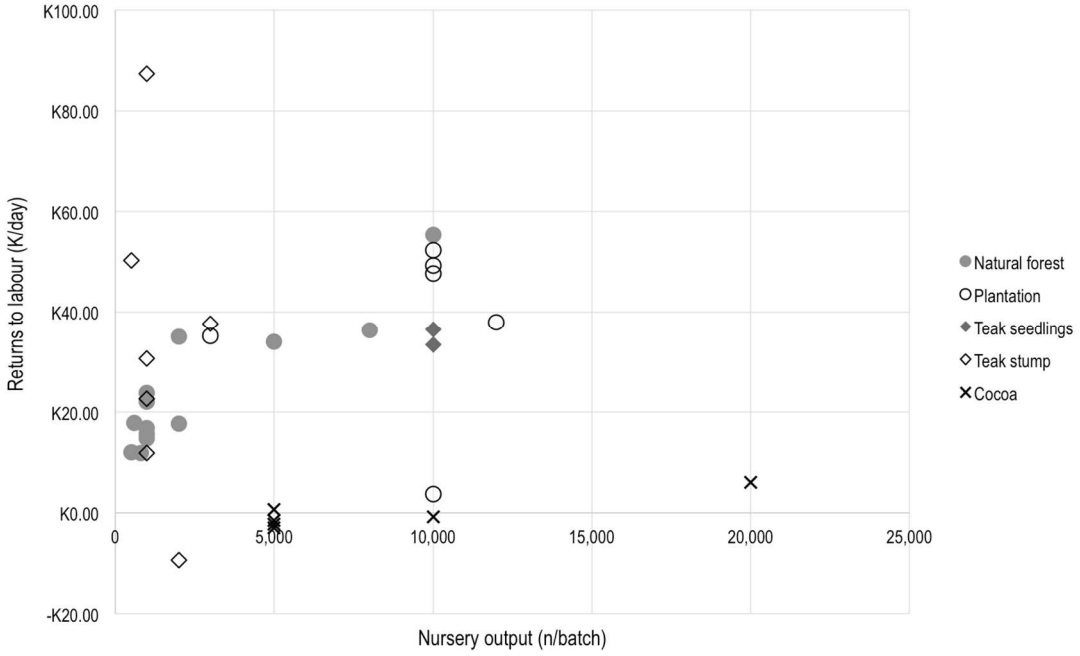

Figure 11: Return to labour at a seedling sale price of K1 per unit, for different sized nurseries across four nursery plant categories including natural forest seedlings, plantation species seedlings, teak seedlings and bare rooted stumps and grafted cocoa seedlings.

7.6 Flexi Media Toolkit

The preparation of the flexi-media toolkit has been an important advancement in broadening the capacity of this project. The toolkit encompasses over 30 short educational videos filmed in PNG covering a wide range of training activities. The toolkit increases the reach of this project by allowing communities all over PNG to access technical information on tree growing. Videos have been translated into English in addition to the local language the videos were recorded in. All responses have been positive. The toolkit comprises video, audio and written content, that combined makes a course in tree planting management, with lessons from seed collection, nursery construction/management to tree planting, pruning and maintenance. The toolkit is continually being added to when new materials become available.

The flexi-media toolkit is complimented by the 'Tree Growers Tool-Kit' (compiled under FST/2007/050) hosted by Pacific Island Projects (www.pip.com.pg). The Tree Growers Tool-Kit provides a one-stop source of information for tree-growers and their extension partners and improves overall awareness of the project. It also links-up with similar research and development initiatives at local, national and international levels.

7.7 School teacher resources

The development of school resources commenced during introductory meetings held in mid-2013 with the ENB Division of Education, and teachers and children from 2 of the project's 7 target schools (Tauran and Papalaba). In these meetings project staff introduced the project, and discussed teaching resource specifications (content, format and layout). The scoping exercise found that (i) schools were in short supply of training resources for all subjects; (ii) trees and forests related to a number of sub-strands for all grades within the learning areas of science, culture and community; (iii) it was difficult for the schools to look after interesting/attractive resources (e.g. booklets); (iv) both schools had access to printers, copiers and computers and (v) many children wanted pictures & videos of living things from PNG & overseas.

A meeting was held at Kokopo Primary School in April 2014 with the ENB Education Division and representatives from the all 7 target schools in the 4 demonstration areas to discuss the scoping study findings and options for meeting their teaching aid requirements with reference to PowerPoint slides and a selection of existing teaching aids. Meeting participants agreed the project should assemble a collection of existing resources from different sources that matched PNG's elementary and primary school curriculum and promoted the benefits of growing trees (e.g. videos, photos, pamphlets, booklets, illustrations, stories, poems). To simplify access to the resources, they should be organised in folders and copied to CDs for school use (all schools have access to a CD player, screen and printer / copier).

Based on the initial consultations with the ENB Division of Education and target schools, a School Resource Pack was prepared for elementary and primary school teachers containing over 100 digital resources arranged according to PNG's outcome based school curriculum (Appendix 10.5). The pack contains freely available material collected from a variety of online sources including www.tes.co.uk: the world's largest network of teachers.

A follow-up meeting was held at Kokopo Primary School in August 2014 with the ENB Division of Education and target school representatives to present and discuss the preliminary School Resource Pack. Meeting participants agreed the School Resource Pack on the value of the resource pack and communicated that the pack should be completed and pilot-tested at the project's target schools. In March 2015 the completed School Resource Pack was introduced to Bitapaka and Tauran schools through open sessions organised by school principals using laptops together with the project brochure, the contents sheet (Appendix 10.5) and the summary sheet (Table 8). Three CDs were given to each school.

Eight months after the resources were introduced to the schools an evaluation form was issued to seek teacher input about the learning areas, subjects, strands and sub-strands they taught which were related to the topic of trees and forests. Their responses indicated that most sub-strands included in the pack were being taught by one or more teachers at both schools (except for “Changes in natural and human communities” which was omitted at Bitapaka) (Table 8). This result indicates that the layout of the School Resource Pack was relevant to both schools that received the Teaching Resources.

The second part of the evaluation form sought teacher assessment of the quality and relevance of teaching resources provided. Only one of the evaluation respondents received a copy of the CD containing the School Resource Pack; indicating the need to improve the way in which the pack and evaluation form are introduced and distributed to community school teachers. The fate of the remaining five CDs distributed to the school is not clear. While obviously the sample size is limited the response of this teacher suggested the School Resource Pack was a potentially valuable teaching aid. Subsequent discussions with the ENB Division of Education, community representatives and teachers have concluded the pack should be distributed through community school boards with a letter of support from the ENB Division of Education. It is clear however that greater consultation with school Principals about equitable distribution of the resource pack within the schools is required.

Table 8: The School Resource Pack contains the elements of PNG's outcome based curriculum that relate to forests and tree planting activities at elementary and primary levels. Text in italics indicates the number of resources allocated to each selected sub-strand and their relevance to those sub-strands being taught by the survey respondents. * A tick-box needs to be added to the Evaluation Form / Question 9 for this sub-strand. **Resources need to be added to this sub-strand

PNG'S OUTCOME BASED CURRICULUM	Elementary	Lower Primary		Upper Primary	
Selected learning area:	Science	Science		Culture and Community	
Selected subject:	Culture and Community	Environmental Studies	Science	Making a Living	
Selected strand:	Me and my Environment	What's in my Environment	Caring for my Environment	Living Things	Managing Resources
Selected sub-strand	Using and caring for resources *Taught by 5 / 10 respondents* *Pack contains 12 resources*	Plants and animals *Taught by 7 / 10 respondents* *Pack contains 14 resources*	Managing resources *Taught by 4 / 10 respondents* *Pack contains 22 resources*	Nature of living things *Taught by 4 / 10 respondents* *Pack contains 9 resources*	Land and water management *Taught by 3 / 10 respondents* *Pack contains 13 resources*
	Exploring environments *Taught by 3 / 10 respondents* *Pack contains 11 resources*	Changes in my environment *Taught by ?* / 10 respondents* *Pack contains 3 resources*		Ecology, relationships and interactions *Taught by 3 / 10 respondents* *Pack contains 7 resources*	Environment *Taught by 3 / 10 respondents* *Pack contains 0** resources*
	Changes in natural and human communities *Taught by 3 / 10 respondents* *Pack contains 3 resources*	Links in the environment *Taught by 5 / 10 respondents* *Pack contains 11 resources*			
Selected Indicator	Germinate seeds	Weed, water, mulch, drain plants *Teak and LPS seedlings were planted at3primary schools*		Develop small garden *teak and LPS seedlings were provided to 3primary schools*	
	Charts *Included in pack*	Diagrams *Included in pack*		Diagrams *Included in pack*	
	Maps *Included in pack*	Illustrations *Included in pack*		Illustrations *Included in pack*	
	Illustrations *Included in pack*	Pictures *Included in pack*			
	Pictures *Included in pack*	Posters *Included in pack*			
	Seasonal calendars *Included in pack*	Stories *Included in pack*			
	Graphs, Murals	Poems *Included in pack*			

7.8 Determine feasibility of sandalwood agroforestry in Central and Gulf Provinces

This component of the project was included in 2014 as part of an official variation to include a feasibility component for sandalwood. This variation came at the request of the PNG Forest Authority. Work on this part of the project commenced in mid-2014 and included consultations with communities identified as being interested in developing planted sandalwood as a commercial activity. The three areas selected for further development include Girabu (Rigo District, Central Province), Kairuku (Kairuku-Hiri District, Central Province) and Iokea (Malalaua District, Gulf Province). All areas have natural sandalwood stands, although preliminary surveys reveal they have been heavily impacted by historic harvesting. Following initial consultations, key leaders from each of the areas participated in a joint workshop in Port Moresby, to explore the development goals and direction for sandalwood in PNG. This consultation led to planning the next phase of ACIAR involvement in sandalwood in PNG and laid the foundation for a broader project visit to the Iokea community in late-2014 which led to the establishment of a community woodlot in Iokea during this project (see below).

The community and social structure for the sandalwood developments differ between the three sites and offer scope to examine the success of different models in PNG. The establishment of Incorporated Land Groups (ILG) is important in both Girabu and Iokea and awareness activities have commenced for eventual ILG.

Girabu Village (Rigo, Central): Two relevant clans will be involved in this project, Vasira Clan (Mabua and Baina families) and Gea Clan (Mara family). Several project sites have been proposed, but based on access and suitability, a project site close to the school has been selected. The site contains adjacent customary land of both clans, thus permitting registration of an ILG.

Kairuku: Individual land owners will be the participants rather than clans, so there is no requirement for ILG registration for the project.

Iokea village (Malalaua, Gulf), The proposed site at Iokea will involve the participation of at least two clans (Ekavira and Hasu clans). The site was surveyed in late 2014 in preparation, and awareness activities for ILG registration will be held to secure the site for delivery of the project.

Planting at Iokea (Gulf Province)

Significant progress was made at Iokea in the establishment of multiple smallholder sandalwood nurseries during 2014. Many of the native trees in the hinterland of the village are root suckers from previously harvested trees, which have poor form, vigour and low seed production. Despite this there are many fine mother trees planted within Iokea village itself. Community members indicate that while seed production is variable between mother trees, most generally produce good crops of seed with germination approaching 70%. Seed production occurs sporadically but continuously through the dry season May-November.

The community identified a site for the development of their community sandalwood planting. This project site was surveyed and described for the potential for establishment of sandalwood. The site is an area where natural sandalwood could be found and while it is suitable for sandalwood production, many of the original hosts are absent. For sandalwood production to be viable on this site, host trees need to be re-established. During this visit, the local vegetation was surveyed for potential host species and based on availability and host suitability the project recommended seed collection be conducted from *Albizia* sp. and *Leucaena leucocephala* as primary and intermediate hosts. Two herbaceous species Lupinus sp. and Caesalpinia pulcherrima, were identified as being highly suitable as an immediate host. It is considered that careful attention to host

establishment and maintenance will be key to the viability of sandalwood production on the Iokea project site.

During these early consultations the project recommended that initial plantings be conducted as small woodlots close to the village within existing village vegetation. The clans participating in the project favour a larger-scale collective sandalwood planting on the allocated project site. While a planting on the project site represents a greater potential risk and lower productivity (with fewer natural hosts), the project will work collaboratively with the community on the project site. Despite the obvious risks, the community were strongly committed to planting the site. Given this, it was considered that this early planting could serve as a demonstration as to the specific requirements of sandalwood. The project therefore supported the establishment of a planting on the site, which was conducted in April-2015. An area of 0.5 of a hectare was cleared of kunai and baselines established. A total of 221 strong seedlings were planted at 3 x 6m following heavy rain earlier during the week. An estimated 800 seedlings remained in the village nurseries to be further hardened, before they could be planted out as either refills or extension to the existing plot.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project was successful in consolidating and securing the existing PNG-based improved teak germplasm. The planted resources were under very real threat of being harvested and lost, as was evidenced with the removal of the trees at Oomsis during the life of this project. The project was also successful in introducing new teak genetic resources from a number of different origins. This is of particular importance to broaden the genetic base that will permit evaluation and selection of performing trees with a background that is genetically distinct from existing selections in PNG. This will allow for introgression of these genetic resources for advanced generation selections and limit any potential for inbreeding into the future. While the most successful introductions from Costa Rica are the most prominent, good performing trees from all introductions are being observed during early growth. The potential impact of securing existing and introducing new teak genetic resources to PNG will be enhanced through another ACIAR project (FST/2014/069) continuing this aspect of teak development in PNG. This will give leverage to this scientific impact to improve economic outcomes for smallholders engaged in teak production.

The adaptive research for propagation of mature individuals will lead to another important scientific impact arising from the project. Vegetative propagation of mature trees offers scope for capturing additive genetic variation for further use in traditional breeding approaches including establishment of clonal seed orchards that take advantage of specific combining ability (i.e. parents or groups of parents that collectively produce exceptional progeny). Early results from propagation experiments using material from hedge plants in the FRI clonal archive indicates that the method may be further refined for deployment of clones for operational purposes. While this will be developed further in FST/2014/069 it can offer the potential for capturing and deploying genetic gains at each breeding cycle. The development of teak cutting propagation in this project is a major improvement on previous grafting technologies used to capture clones in PNG, and avoids rootstock suckering that led to the abandonment of earlier seed orchards.

8.2 Capacity impacts – now and in 5 years

Capacity building of project staff

This project worked closely with project staff to build project management and reporting capacity. Anton Lata completed his Masters Thesis (with James Cook University as part of his ACIAR John Allwright fellowship) at FRI Lae during the implementation of this project. FRI was generous to allow Anton to allocate work time to this task. Anton now has a demonstrated capacity to plan, implement and report on research outcomes both within the project and in his role as Tree Breeder at FRI. His thesis topic focused largely on propagation and silviculture of *Aquilaria crassna* in Australia, and he has now extended some of this background knowledge to the development of an Eaglewood grower's manual for PNG. Anton has produced many high quality progress and technical reports for this ACIAR project. FRI staff member Gedisa Jeffrey was awarded a John Allwright fellowship as part of this current project. At the end of the project, Gedisa commenced his enrolment in a Master of Forestry Science at Southern Cross University. Gedisa conducted teak resource surveys in both Sepik and New Ireland and produced high quality technical reports based on these activities. Before Gedisa's departure to Australia, he was preparing a draft teak silviculture manual that will be further developed and refined as part of FST/2014/069.

The project partners at UNRE through Head of the Forestry Department Neville Howcroft have worked hard to develop the clonal teak trial, which is a significant resource for teak

domestication in PNG. The project has actively engaged Sylvester Kulang who developed low-tech methods for propagating juvenile teak cuttings of a quality to give exceptional field performance after outplanting. Both Sylvester and Daniel Waldi are important contributors to the measurement and recording of growth and form in the teak clonal plots.

In ENB the project worked collaboratively with John Rabbie and Inter Vinarut who oversaw great advances in establishing teak provenance plots at OISCA and satellite plantings within the communities in ENB. Together we are building a better understanding of the need and value of research for development, which will continue in the follow on ACIAR project. In Madang the project worked with Linzon Zamang to achieve some very important community outputs including the satellite nurseries and community teak woodlots, various training and promotion workshops as well as LPS seed collections and planting. These outputs have been achieved through Linzon's dedication and persistence in an environment with few resources and support. In Western Province, Samuel Famiok was a very active project officer who facilitated the deployment of significant eaglewood genetic resources in the Fly River catchment, as well as supporting teak plantings with interested communities. Samuel tragically passed away towards the end of this project at a young age, and we were grateful to have worked closely with him through this project.

Through this project all partners have a much greater sense for the importance of tree domestication to improve the productivity and value of planted timber trees. They have also developed a critical understanding of broad traits that make a tree a potential candidate for selection. This understanding combined with an improved capacity within the partners for clonal propagation make it more likely that future candidate plus trees (regardless of location) will be captured in the PNG breeding population.

Bulolo Seed Technology Training Course

A weeklong seed-technology training course was run in 2013 in Bulolo, Morobe Province. Participants received training that would improve their knowledge and skills in all aspects of seed collection and seed handling for the purpose of tree breeding. The course ran from the 18th to 22nd of March 2013 and was attended by 19 participants from various organisations in PNG including government and non-government organisations such as; FRI, The University of Technology, Bulolo University of Forestry College, The University of Vudal/UNRE, PNG Sustainable Development Program, OISCA, Ok Tedi Development Fund (OTDF), Foundation for People and Community Development (FPCD) and Open Bay Company ENBP.

The training was developed as part of the "Strengthening Capacities in Tree Seed Technology in Pacific Island Communities" project to address the collection and sharing of timber, fruit and nut germplasm of high regional importance. The course was organised by PNG Forest Research Institute. The topics covered the entire seed collection process, from planning the collection right through to storage and seed dispatch. Activities included presentations, interactive exercises, group work and practical sessions.

Topics covered included:

- Seed collection planning;
- Provenance in detail (plant and population genetics);
- Record keeping and documentation;
- Genetically and physically fit seed;
- Collection methods and field handling;
- Extracting and cleaning seed;
- Seed storage and handling;
- Seed dormancy; and
- Bio-security aspects.

Diwai Planting Workshops

A series of Diwai Planting Workshops were held in both Western Province (at OTDF offices in Kiunga) in December 2012 and in Madang in May 2012. The workshop train smallholder farmers and NGO extension technicians in a range of nursery and silvicultural skills. Participants were taught nursery establishment and management, plant propagation, tree crop establishment and maintenance as well as specific information on teak and other LPS and teak silviculture and markets. Video tutorials were also used to demonstrate the lessons covered during each of the sessions. The feedback of the workshop was positive, with participants gaining increased awareness of the value of tree planting for multiple benefits. These planting workshops were followed in subsequent years with visits by propagation and forestry professional David Spencer. David provided additional in-field support for each of the communities across the three hubs, particularly with respect to problem solving tailored to the circumstances of individual woodlot and nursery owners.

Business Planning Workshop at Ohu, Madang

A Business Planning Workshop was conducted at the village of Ohu in early August 2014. The workshop was attended by 22 people from the three nursery villages. The workshop was held at Ohu as most of the nursery activities in the village were being undertaken by a single villager, with very little support from others in the village. The reason for running the workshop in Ohu was to create more interest among the rest of the villagers to support the nursery activity.

The workshop consisted of three parts; increasing awareness among community members and the nursery leaders of the information needed to run a nursery as a successful business, to discuss and demonstrate all the steps needed to propagate LPS and teak and to demonstrate planting techniques through a field exercise and give attendees the opportunity to participate in planting. A booklet “Start your Own Business” produced by Small and Medium Enterprises was bought for each nursery and discussed. A post-workshop report was produced by Linzon Zamang.

Nursery Owners Engagement (ENB)

A Nursery Owners Workshop was held in Kokopo Village (ENB) on Wednesday 15th October 2014 which sought to identify constraints to the development of tree nurseries in in ENB, seek input from nursery sector and government in ENB about approach for future tree planting development and identify constraints to development of teak sector in ENB. Recommendations from workshop participants covered four main areas:

1. Approach to teak development in ENB
    - The development of teak woodlots in ENB requires clear guidelines for establishment and management of planted trees, so that growers have a clear prescription.
    - The project needs to do some work on market chain: Identify the markets that we could sell. What sector or operator in the industry will spend money to develop the market. If a clear market is not identified then potential planters will look for other cropping options.
    - Intellectual property and access to Teak clones: make sure that the best planting material is not restricted, and is at all times available to growers (Nurseries must be certified to sell the improved stock).
2. Seed Orchard dissemination to participating nurseries
    - The project needs to identify the current nurseries and see how they are going, measuring productivity and assess adaptability. Identify who wants to participate in the nursery production and propose a certification of nurseries.
    - Monitoring and evaluation of the performance of the teak clones in the seed orchards and farmers’ fields. Assessment needs to be rigorous to ensure they are well adapted for production in ENB.

- The selections that perform best in ENB may not perform in other parts of PNG.

3. Willingness and capacity of nurseries in ENB to produce clonal and seed-derived seedlings
    - Evaluate the appropriateness of the imported teak vs. teak already growing in PNG.
    - The clonal material from the project should come from nurseries certified to produce, which can then be distributed to the 'satellite' nurseries. Nurseries that may be suitable include UNRE, OISCA, NARI, among other larger commercial nurseries.
    - Monitoring and evaluation: DPI and their Forestry Officer can be very important for monitoring in teak development in the communities.
    - Project document needs to be sent to the District and the Forestry Officer. If this project does not get their attention and then they will ignore it, undermining its overall sustainability.
    - Emphasising the government process to deal with such projects that Kiteni has described that system and mechanism in place. The government system must be the central player for the continuation of the project (Relevant laws, code of conduct, HVCF (high value conservation forestry).
4. Primary constraints to developing a teak nursery trade in ENB
    - Availability of seeds and seedling and the lack of certification of the seeds origins.
    - Knowledge and prescriptions for smallholder production of teak
    - Clear avenue for marketing teak at the end of the rotation (this may limit uptake in planting).

Multi-media toolkit

The launch of the multi-media toolkit during the year has been a significant advancement for capacity building for this project. Project partners have collaboratively created over 30 short videos filmed in PNG covering a wide range of training activities. The toolkit increases the reach of this project by allowing communities all over PNG to access technical information on tree growing. Videos have been translated into English in addition to the local language the videos were recorded in. The toolkit was launched in August 2015 with media. Based on this launch the PNGFA are utilising the tree selector resources tool-kit for their national initiative known as "Painim graun na planim diwai". As the initiative moves towards implementation of tree planting they will utilise the training resources for capacity building of project participants/partners.

The Pacific Island Projects (PIP) website (http://www.pip.com.pg) now hosts much of the educational materials for tree growers and encourages the exchange of information and ideas. Although not a direct product of this project, the objectives are very closely aligned and therefore materials such as the 'Tree Growers Tool-Kit' help to build awareness of this project. The Tree Growers Tool-Kit provides a one-stop source of information for tree-growers and their extension partners and has had significant visits during the life of the project (Table 9). The number of website visits is positively influenced by the issuing of PIP e-newsletters. The website is currently being updated, which will included more regular tree growers e-bulletins with news from the ACIAR projects, Forest Authority 'Painim graun na plannim diwai' initiative and promoting existing and new tools. PIP is also testing out a tree-grower registration form (in hard copy and mobile data collection formats) to make direct connections with farmers and identify their extension partners that we can also communicate work through,

Table 9: Online visits to the Tree Growers Tookit within the Pacific Islands Project website (www.pip.com.pg) over 4.5 years.

Website Area (Resources)	2012	2013	2014	2015	2016 (to June 9)
Welcome	45	120	174	23	16
Choosing the right trees	79	355	98	40	9
Growing the best trees	28	143	64	3	4
Making money from trees	24	153	63	8	24
Training videos	-	-	66	8	2
Communicating with you	14	26	6	2	0
TOTAL	190	797	471	84	55

Social media outreach

A <facebook.com/treegermplasmPNG> page was launched in December 2014 to improve intra-project communication within PNG. 37 participants followed the page by April 2015 (primarily staff affiliated with partner organisations) that grew to 270 users by November 2015. The project leader has updated content regularly. The audience extended beyond the original intention and now consists mainly of employed PNG nationals, with others from around the Pacific. This page has offered a new avenue for communicating with a broader audience about the outputs and importance of plantation and community forestry in PNG.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

The project actively established new and engaged with smallholder nurseries. The project provided materials and seed to many of these nurseries as well as training. While the outputs of these nurseries directly contributed establishment of the teak and LPS woodlots in participating communities, several also began to sell seedlings into other markets. This is evidenced in ENB where they are supplying seedlings to the Provincial Administration supported Erosion Control and Agroforestry projects. This represents a direct economic impact in these communities and a future positive environmental impact as planted trees begin to mitigate soil erosion. In Madang the participation of the three satellite nursery owners in the Madang Festival led to the sale of teak stumps for K5 each, and also facilitated the inclusion of more communities in the project at it later stage. These activities demonstrate the commercial value of seedling production, which have been adopted in ENB, and also potentially in Madang as the teak woodlots begin to produce seed.

The improvement and deployment of teak germplasm was a prominent component of this project. Measurements of early growth reveal that teak is very well adapted to the fertile lowlands of northern Papua New Guinea as evidenced by the high mean annual increments for stem diameter. Teak woodlots planted as part of this project on suitable sites, with adequate maintenance had a Mean Annual Increment (MAI) of 3.5 to 4.5 cm at age 3. In a brief survey of project teak introductions for candidate plus trees, the MAI ranged from 5.5 to 7.2 cm at age 3. It is recognised that the MAI in teak can be rapid at an early age and is likely to slow as the trees mature, and some ‘slow starters’ can catch up in later years. The relative difference in trees with high compared with average productivity is likely to persist in older trees. These very early results demonstrate that

teak is potentially responsive to domestication, with possibly up to 20% improvement in diameter growth in the first generation of selection.

We can determine the economic impact for continuing teak improvement in PNG based on modelled smallholder teak systems grown on a 20 year rotation and integrated into the family garden systems with teak planted at 625 seedlings ha^{-1} which is thinned to 200 stems ha^{-1} (with thinned trees used by families as round wood). With assumed productivity of the tree crops (teak sawlogs = 5 m^3 $ha^{-1}y^{-1}$) a conservative estimate of 10 m^3 per household can be produced per year from the smallholder plantings. With a 20% increase in overall diameter in selected trees and using the volume equation of Nunifu and Murchison (1999), a possible 40 to 45% increase in volume may be expected. Assuming 5000 smallholders growing teak, these scenarios would generate an overall annual production of 50,000 and 72,000m^3 for unimproved and selected teak sawlogs. With a farm-gate value of USD200 m^{-3} the gross present value (discounted at 10%) of household revenues equates to USD1,902 and USD2,726 for unimproved and selected teak respectively over the life of the harvest. The present value of the contribution of the project to PNG's gross domestic product (GDP) based on export of un-processed logs would increase from USD27.6 million to USD71.3 million (at USD580 m^{-3} fob).

8.3.2 Social impacts

This project has generated significant social impacts, largely associated with the establishment of the satellite teak and LPS plantings in ENB and Madang. In many communities the project has introduced the concept of establishing small woodlots for both commercial and subsistence use. In addition to this, the project has built confidence in these communities to establish and manage these planting, which has led to greater awareness of their capacity to take control of issues of erosion and timber shortage. This confidence has also been observed to spread to other communities, which was evidenced in the scaling out of tree planting in new communities in both ENB and Madang. Given that not all members of a given community are interested in planting trees, future projects will more likely with interested and active tree nurseries and planters across more communities. While it is difficult to quantify the impact of confidence (in tree planting), it has the potential to lead to increased tree planting across the project areas and lead to greater environmental and economic impacts. These initiatives have stimulated great interest in planting teak, particularly given the rapid early growth rates observed by growers and their families and friends. This interest has already generated community demand for more seed for planting.

The distribution of quality teak germplasm in ENB has being very well received by community nurseries and farmers. The lead farmers in ENB have indicated their interest in assisting other farmers with their own plantations. Through project engagement with these lead farmers it is clear that they still require external support for development of their skills, expertise and continunity of engagement with other teak farmers. It is important that the relationships with community extension officers are reviewed annually to determine issues and progress with respect to (i) monitoring smallholder woodlots and (ii) providing information and advice on development of their woodlots.

Annual celebrations and tree planting activities were organised each year at the 7 schools located within the 4 demonstration areas (Bitapaka, Kabagap, Tauran, Papalaba, Vunalir, Totovel and Vunairima) in conjunction with OISCA's Children's Forest Program (CFP). Events were structured informally to inform and inspire parents, teachers and the local community to engage in environmentally friendly actions on occasions such as World Environment Day and International Day for Biodiversity.

8.3.3 Environmental impacts

The environmental impacts of the projects are associated with the social impacts, such agricultural landscapes, and previously logged forests are being enriched with both local species and teak that will provide a timber resource for future generations. This will

ensure that the forests can once again support smallholder extraction of timber for local construction, and therefore reduce the rate of degradation in these forests.

In ENB, the ongoing cocoa pod borer issue has led to a decline in smallholder cocoa production, as well as a reduction in the area of land required for effective cocoa management. This situation continues to open up new opportunities for other crops that provide farmers with a reasonable return to labour, including trees.

8.4 Communication and dissemination activities

Formal communications with ACIAR

- 4 Annual Reports

In country project communication

- Trip reports by Australian personnel visiting Vanuatu and Cape York Peninsula
- A mid-project workshop in East New Britain
- Six monthly field visits by Tony Page with field/progress reports distributed to project collaborators
- Regular email and phone exchanges between PNG and Australian personnel.
- Project activities posted on project Facebook page

Conference presentations

Lata, W. Yelu, S. Kulang, N. Howcroft, T. Page. (2016). Clonal capture of mature *Tectona grandis* (teak) for improved germplasm deployment in Papua New Guinea (PNG). The IUFRO 3.08 Small-scale and Community Forestry and the Changing Nature of Forest Landscapes Conference, 11-15 October 2015, Sunshine Coast, Queensland.

J. Ugarte-Guerra, T.Page, J. Cornelius, J. Rabbie, I. Vinarut. (2016). Feasibility of smallholder nursery microenterprises as sustainable germplasm delivery mechanisms in Papua New Guinea. The IUFRO 3.08 Small-scale and Community Forestry and the Changing Nature of Forest Landscapes Conference, 11-15 October 2015, Sunshine Coast, Queensland.

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Multi-media toolkit (pip.com.pg). The following content was added to the PIP toolkit during the life of the project (i) 23 short video tutorials on aspects of nursery management, tree planting and silviculture, (ii) 8 growers fact sheets (see above) (iii) LPS Selection & Prioritisation Tools, (iv) Tree selector tool (choosing the right trees) and (v) school resources for Elementary, Lower- and Upper-Primary Schools.

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8.5 Conclusions

This project has made considerable progress in the development of existing and establishment of new germplasm resources for teak. Securing the plus tree clones from Mt. Lawes, Vunapalading and Oomsis in the FRI clonal archive represents a major achievement for the project and avoids the future loss of this important germplasm through commercial harvesting. The development of reliable methods for clonal propagation of mature truncheon stems circumvents the problems of earlier grafting activities conducted to secure teak genetic resources. It also builds capacity of local partners to capture future candidate plus trees for replication and clonal testing. This output shouldn't be underestimated as it can potentially increase the rate of genetic gain, during systematic improvement of this species in PNG. This gives teak domestication an advantage over many other tree species where clonal propagation is problematic.

Routine cutting propagation methods were also developed for juvenile teak material within this project. Extending this method to use with hedged mature material in the FRI clonal archive, has given good early results. The further refinement of this method can potentially make available existing clonal plus trees for deployment in clonal test experiments and ultimately for bulk propagation for operational purposes. Achieving such a high level of proficiency will depend on further support and resources to further refine methods for procedural use.

Substantial advances have also been made in establishing a basis for a smallholder based planted timber sector in East New Britain and Madang. This has included the establishment of smallholder satellite woodlot plantings across 12 hectares in ENB and 5 hectares in Madang. While this may be considered to be a modest area, it represents the start of a future decentralised seed supply. This is important since our work evaluating nursery production in ENB demonstrated that seed collection in many smallholder nurseries represents a significant labour input. Locally available supplies of teak seed improves smallholder independence and allows them to limit the cost of collection.

Across most seedling nurseries the main cost of production relates to the labour inputs or collecting media/soil, filling polybags and sowing seed. The cost and availability of polybags is another limiting factor for many smallholder-managed nurseries. The project introduced the technology of producing teak as bare rooted stumps. This has several development advantages (i) it eliminates the direct cash requirements for polybags, (ii) it reduces the labour requirements for media collection and filling polybags, (iii) reduces the risks associated with manual watering and (iv) reduces the transport costs to get plants to market and field. Eliminating cost of polybags and reducing soil related labour components were captured in the financial modelling, resulting in teak stump nurseries having comparatively low cost of production with seedling nurseries of similar size.

Facilitating the development of and organising the initial threads of an informal nursery network in East New Britain is an important step in the development of a viable planted timber industry, since good quality woodlots can only be possible with good quality nursery stock. The project held a meeting of nursery owners in Kokopo in October 2014, to facilitate awareness and better communication among participants, and chart a course for the development of the industry. The workshop also accelerated communication between nursery owners and the Provincial Administration (PA), who commenced two relevant projects (Erosion Control and Landcare) in 2015. While no data was collected on the growth of this sector during the life of the project, it was clear that existing and newly established nurseries were suppling the the seedling requiremets for the PA projects. This increase in nursery capacity provides the foundation for future development of a more significant planted timber industry.

In Madang province, considerable interest in planting timber trees exists among smallholders, particularly in areas where past logging operations have exhausted commercial supplies of timber. The project worked primarily with three communities who established an area of 5ha of small teak woodlots and smaller plantings of LPS species (*Terminalia*, *Canarium* and *Pometia*). The potential benefits of increased capacity and independent seed supply are similar to those already reported for ENB. The promotional activities conducted during the Madang Festival and Environment Day celebrations generated significant interest among other communities surrounding the township of Madang. Interest also from communities surrounding the three project-supported communities was also registered during the project. This led to the inclusion of two new community teak woodlots being established towards the end of the project. This demonstrates the genuine potential for establishing a smallholder-directed planted timber sector in central Madang. Progress in Madang was tempered due to resource constraints of project partners, and the achievements made are representative of the hard work of project officers.

In Western Province the project determined that interest in tree planting was directed towards the potentially lucrative tree crop eaglewood. Significant timber resources remain in many parts of Western Province and the level of interest in planting timber trees was isolated. The project worked with these interested individuals and established a number of teak woodlots in communities along the Fly River. Recognising the potential positive impact of agarwood the project also facilitated the introduction of significant *Aquilaria* genetic resources to support OTDF initiatives to establish a smallholder eaglewood production sector. Through a training workshop and targeted site visits, improved methods for agarwood nursery production and woodlot maintenance were developed in consultation with local stakeholders. The interest in plating eaglewood is ‘fever pitched’ in

PNG, owing to widespread rumours about its very high value. The project therefore facilitated the introduction of *A. crassna* seed for the establishment of small plantings with project partners in ENB, Madang and Lae.

The identification of local priority species and establishment of modest resources for most in each of the three hubs represents the first step to their development. It also provides regionally relevant information on smallholder tree planting objectives and species priorities as the PNG Government attempts to increase uptake of tree planting through the PNGFA initiative known as "Operation painim graun na planim diwai". The project multi-media toolkit represents smallholder-targeted resources for building capacity in establishing and managing tree planting. The resources provide information along a continuum from tree selection, nursery management, plantation establishment and management to harvesting and marketing.

For sandalwood development, the project commenced initial activities to determine the feasibility of sandalwood production in dry tropical savannah environments of southern PNG. The species offers great potential for a smallholder-based commercial activity, which can be achieved by directing resources to secure germplasm from a wider range of natural sources. Effort also needs to be made in building understanding in communities of the particular requirements for successful sandalwood productions, and building their capacity for their management. The project was successful in engaging with and establishing agreements with three communities (Girabu, Kairuku & Iokea) for further research and development. The project managed to conduct initial surveys of wild resources around these communities, leading to an improved understanding of the eroded and poor state of the resource, and need for intervention. One of the most important outputs was the establishment of many smallholder nurseries in Iokea that led to the production of seedlings of sufficient quality to establish a woodlot to meet community objectives and expectations.

8.6 Recommendations

To continue developing the planted timber sector in PNG and improvement in key species, activity in the following areas is recommended.

To maximise the potential economic impact of a teak industry in PNG it is of great importance to continue its genetic improvement. This can be achieved by further developing existing provenance-progeny plantings to transform them into first generation seedling seed orchards. It is also important to identify outstanding plus tree candidates and capture them through clonal propagation. These can then be used to establish clonal seed orchards and clonal tests to determine the relative value of ‘historic’ clones and those identified through early selection. The deployment of improved material will depend on the development of simple nursery protocols for commercial production and dissemination, and therefore more research and development work in this area is required.

To take advantage of genetic gains made in teak improvement there is a need to develop simple smallholder-appropriate silviculture systems. The development of a sustainable commercial planted forest industry, which is inclusive of both commercial and smallholder producers will depend on alignment of site and socioeconomic considerations with silviculture interventions. It is therefore important to identify appropriate silviculture prescriptions for the establishment and management of woodlots for both commercial and smallholder managers. Included in this research is the need to identify those silvicultural systems that optimise economic returns to growers.

To develop a viable planted sandalwood industry in PNG there is a need for genetic improvement activities and capacity building in sandalwood agroforestry. Given the depletion of the natural resources it is important to base a planted industry on genetically diverse and high quality germplasm. To achieve this, research is required to survey the remaining wild resources and systematically examine oil qualities and genetic variation.

This survey will form the basis of a selection strategy to advance the domestication and improvement of this species. The adoption sandalwood agroforestry will largely depend on nursery capacity for production of wild-collected and improved sandalwood germplasm. Community agroforestry trials based on systems developed in Australia elsewhere in the Pacific is recommended to identify locally relevant systems and locally adapted host species.

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10 Appendices

10.1 Appendix: Seedlot inventory

Code	Date YYYY.MM	Kg (total)	FPCD	FRI	UNRE	OISCA	OTDF	RAIL	Name
TG01	2010.07	6.1		6.1					Little Vudal
TG02	2010.08	10	1.7	1.7	3.3		3.3		Little Vudal
TG03	2010.09	1.5					1.5		Kiunga
TG04	2010.07	15.2	5	5.2			5		V'palading
TG05	2009.04	56	800 stumps		13	13		30	Mt Lawes
TG05	2014.07	18.5		14	0.5	4			Mt Lawes
TG06	2010	0.148			0.148				India
TG07	2010	4.3	0.72	0.72	1.43		1.43		Laos
TG07	2015.08	0.25		0.125	0.125				Laos
TG08	2010	1	0.17	0.17	0.33		0.33		Thailand
TG08	2015.08	0.614		0.3	0.3				Thailand
TG09	2010	4.3	0.72	0.72	1	0.43	1.43		China
TG09	2015.08	2		1	1				China
TG10	2010	2	0.5	0.5	0.5		0.5		Honduras
TG11	2010	2	0.5	0.5	0.5		0.5		Santa Alicia
TG12	2010	2	0.5	0.5	0.5		0.5		Jicaro
TG13	2010	2	0.5	0.5	0.5		0.5		Nambi
TG14	2013	12	2	2	0.5	3.5	2	2	Mansion
TG15	2013	12	2	2	0	4	2	2	Nambi/Nicoya
TG15	2014.08	1.5					1.5		Nambi/Nicoya
TG15	2014.08	1.5					1.5		Nambi/Nicoya
TG16	2013	10	2	2	0.5	3.5		2	Penas Blancas
TG16	2014	10	6				2	2	Penas Blancas
TG16	2014.08	1.5					1.5		Penas Blancas
TG17	2013	10	2	2	0.5	3.5	2		Santa Cruz
TG17	2014	8.5	4.5	0			2	2	Santa Cruz
TG17	2014.08	1.5					1.5		Santa Cruz
TG18	2014	1.6		0.8		0.8			Nellicutha
TG19	2014	1.3		0.65		0.65			Maukal
TG20	2014	1.3		0.65		0.65			Nellicutha
TG21	2014	1.2		0.6		0.6			Kokokendero
TG22	2014	1.6		0.8		0.8			Morogoro
TG23	2014	0.9		0.45		0.45			Perlis
TG24	2014	1		0.5		0.5			Segama
TG25	2014	1.1		0.55		0.55			Taliwas
TG26	2014	0.5		0.25		0.25			Malaysia Bulk
TG27	2014	4.5		1	0.5	2		1	Solomon Island
TG28	2014	1		1					Oomsis
TG29	2014	24	6	2	0.5	11.5	2	2	Hojancha

10.2 Appendix: Seedlots Distributed from 2011 to 2014

Recipient	*Iender*	*Quantity*
FPCD		
	FRI	TG1 (4.3kg received 2011), TG4 (7.1kg received 2011) TG5 (30kg received 07-2012)
	JCU	TG10 TG11, TG12 and TG13 (0.33kg of each received in 2011)
	UNRE	TG2 (1.7kg), TG7 (0.72kg), TG8 (0.17kg) and TG9 (0.72kg) each received in 04-2011
	FRI	Kerevat Teak (TG5?) (total 30kg split between Aronis (10kg), Erima (15kg) and Ohu (5kg) (received 10-2012)
	JCU	(Oct 2013) TG13 (2kg), TG14 (2kg), TG15 (2kg), TG16 (2kg), TG17 (1kg)
FRI		
	FRI	TG1 (5.0kg - use germination test seed), TG4 (7.1kg)
	JCU	TG10 TG11, TG12 and TG13 (0.33kg of each received in 2011)
	UNRE	TG2 (1.7kg), TG7 (0.72kg), TG8 (0.17kg) and TG9 (0.72kg) each received in 03-2011
	JCU	(Oct 2013) TG13 (2kg), TG14 (2kg), TG15 (2kg), TG16 (2kg), TG17 (1kg)
Ramu Agro-industries		
	FRI	TG5 (30kg received 07-2012)
	FRI	TG7 (10 stumps), TG8 (10 stumps), TG9 (11 Stumps) and 15 stumps from each of the four Costa Rican provenances (TG10, TG11, TG12 and TG13 – Tony to confirm?)
	FRI	(July 2013) TG7 (10 stumps), TG8 (10 stumps), TG9 (11 Stumps) and 15 stumps from each of the four Costa Rican provenances (TG10, TG11, TG12 and TG13)
	JCU	(Oct 2013) TG13 (2kg), TG14 (2kg), TG15 (2kg), TG16 (2kg), TG17 (1kg)
ENB Partners (OISCA / UNRE / PIP)		
	JCU	TG10 TG11, TG12 and TG13 (0.66kg of each received in 2011)
	FRI	TG4 (19kg, received 05-2012 by OISCA) and TG5: (14kg, received 05-2012 by OISCA)
	FRI	TG4 and TG5 (1kg of each, received 8-12 by UNRE)
	FRI:	TG4 & TG5 (??kg, received 11-12 by OISCA)
	JCU	(Oct 2013) TG13 (4kg to OISCA), TG14 (0.5kg to UNRE, 3.5kg to OISCA), TG15 (0.5kg to UNRE, 3.5kg to OISCA), TG16 (0.5kg to UNRE, 3.5kg to OISCA), TG17 (0.5kg to UNRE, 1.5kg to OISCA)
OTDF		
	FRI	TG1 (8.3kg received 2011), TG4 (14.1kg received 2011)
	JCU	TG10 TG11, TG12 and TG13 (0.66kg of each received in 2011)
	UNRE	TG2 (3.33kg), TG7 (1.44kg), TG8 (0.33kg) and TG9 (1.44kg) each received 10-2011

10.3 Appendix: LPS Survey

PART A: SURVEY DETAILS *Part A provides a record of the survey personnel, location, timing, methods and interesting observations.*			
Survey date:		Name of hub:	
Name of target group:		Population of target group:	
Name of district:		Name of LLG:	
Name of interviewers: *Appoint at least 2 experienced staff.* *Men should interview men. Women should interview women.*			
Name of household or group interviewed: *Insert household or group name together with names of persons interviewed.* *Use a new Survey Form for each household or group.*			
No. of males interviewed:		No of females interviewed:	
Interview method/s:	Household interview ☐; Group discussion ☐; Other (specify) ☐		
Interesting observations: *Remember to use your eyes and ears.*			

PART B: DESIRED TREE PRODUCTS AND SERVICES Part B provides a record of the type of products and services that people desire; both now and in the future. Each product and service is ranked in order of preference, and should satisfy identified needs within the target community.	
Desired products: *Yu laik kisim wanem kaen samting long diwai yu planim?*	Firewood for home / community use ☐; Firewood for sale; ☐ Food, fruit, nuts for home / community use ☐; Food, fruit, nuts for sale ☐ Stakes and poles for home / community use ☐; Stakes and poles for sale ☐ Timber for home / community use ☐; Timber for sale ☐ Other (specify) ☐
Desired services: *Na tu, wanem kaen halivim yu laik kisim long dispela diwai, long nau o long bihain taim?*	Control soil erosion now ☐; Control soil erosion in the future ☐ Improve soil fertility now ☐; Improve soil fertility in the future ☐ Live fences ☐; Protection from sun, wind or rain ☐ Other (specify) ☐

Desired products, ranked 'pair-wise'

Wanem kaen gutpela samting (long ol dispela ol samting yu makim pinis antap long bokis namba i) yu laikim moa long ol narapela?

Nau yu soim long dispela bokis.

Desired Product (letter and name)	Desired Product (letter)									
	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.

Desired services, ranked 'pair-wise'

Wanem kaen gutpela halivim (long dispela ol halivim yu makim pinis antap long bokis namba ii) yu laikim moa long ol narapela?

Nau yu soim long dispela bokis.

Desired Service (letter and name)	Desired Service (letter)									
	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.

PART C: PROMISING TREE SPECIES

Part C provides a record of up to 10 promising tree species that are locally available (pages 5-14).
Each species is then ranked in order of preference (page 15) with reference to the desired products and services (page 4)

1. SCIENTIFIC NAME:		**LOCAL NAME:**	

Important products provided: *Dispela diwai isave givim yu wanem kaen gutpela samting?*	Firewood for home / community use ☐; Firewood for sale; ☐ Food, fruit, nuts for home / community use ☐; Food, fruit, nuts for sale ☐ Stakes and poles for home / community use ☐; Stakes and poles for sale ☐ Timber for home / community use ☐; Timber for sale ☐ Other (specify) ☐
Important services provided: *Na tu, wanem kaen halivim dispela diwai isave givim yu?*	Control soil erosion now ☐; Control soil erosion in the future ☐ Improve soil fertility now ☐; Improve soil fertility in the future ☐ Live fences ☐; Protection from sun, wind, rain ☐ Other (specify) ☐
Local availability: *Dispela diwai em isi long painim o nogat?*	Very common ☐; Quite common ☐; Not common[1] ☐; None ☐ [1] *Igat narapela diwai iwankain olsem dispela diwai, we emi moa isi long painim?* Scientific or local name(s)…… Very common ☐; Quite common ☐
Germplasm source/s: *Long planim dispela diwai, yu save kisim pikinini bilong em long we?*	Seeds[2] ☐; Seedlings ☐; Cuttings ☐; Truncheons ☐ Own land / any tree ☐; Own land / selected tree ☐; Own land / selected fruit or nut ☐ Other land / any tree ☐; Other land / selected tree ☐; Other land / selected fruit or nut ☐ Nurseries ☐; Market place ☐; Other (specify) ☐ [2] *Yu save kisim dispela pikinini diwai long wanem mun?* Jan. ☐; Feb. ☐; Mar. ☐; Apr. ☐; May ☐; Jun. ☐; Jul. ☐; Aug. ☐; Sep. ☐; Oct. ☐; Nov. ☐; Dec. ☐
Ease of propagation: *Dispela pikinini diwai, emi isi long lukautim o nogat?*	Very easy ☐; Quite easy ☐; Not easy ☐; Impossible ☐
Planting arrangement/s: *Yu save planim dispela diwai olsem wanem?*	Around home ☐; Along boundary ☐; In block ☐; In garden ☐ In primary forest ☐; In secondary forest ☐ Other (specify) ☐
Regular tasks: *Wanem ol wok yu save mekim long lukautim dispela diwai?*	Manuring ☐; Fertilising ☐; Weeding ☐; Pruning / Coppicing ☐; Harvesting ☐; Processing ☐; Other (specify) ☐
Problems encountered with this species: *Wanem ol heve yu save bungim long dispela diwai?*	
Opportunities available for this species: *Wanem ol samting i ken halivim yu sapos yu planim dispela diwai, long nau o long bihain taim?*	

10.4 Appendix: LPS workshop Structure

SESSION PLAN: *DAY 1*

The first day helps the target group to produce a project cycle diagram, germplasm definition, draft mission statement and SWOT chart

Session	Activities	Responsibility	Methods and Materials	Outputs
Opening	Register participants	Community leader	Daily registration form	Daily list of participants to record workshop attendance.
	Opening prayer	Community leader	-	-
	Welcome speech(es)	Community leader	-	-
Introduction	Introduce participants	All participants	"What is your name and what does it mean?"	-
	Define project objectives	Facilitator	Butcher paper / board	-
	Define workshop objectives	Facilitator	Butcher paper / board	-
	Agree on workshop times and rules	All participants	Workshop discussion with reference to workshop program	-
	Ice breaker	5 participants	The "commander game"	-
Definitions	What is the project cycle?	All participants	Workshop discussion with reference to (1) organizational mission statement, (2) project planning, (3) project implementation, (4) project monitoring, and (5) project evaluation.	PROJECT CYCLE DIAGRAM showing what stage the project is at now.
	What is germplasm?	All participants	Group discussions and presentations with reference to Tokples definition and/or drawing	DEFINITION OF GERMLASM (e.g. a collection of genetic resources which may be stored as a seed collection or in a nursery).
	What is the group's mission statement?	All participants	Workshop discussion with reference to 6 Pointed Star comprising (1) who we are, (2) what we do, (3) what our overall objective(s) are, (4) who we benefit, (5) what our main activities are, and (6) why we do what we do.	DRAFT MISSION STATEMENT to be finalised after workshop
Present Situation	Assess strengths, weak-nesses, opportunities, threats	All participants	Group discussions and presentations	SWOT CHART(S) highlighting any factors which may affect or improve project progress
Daily Evaluation	Wanem samting yu bin / no bin laikim, long dispela skul?	All participants	2 different coloured slips of paper each	Daily evaluation summary to monitor progress and improve workshop delivery

SESSION PLAN: DAY 2

The second day helps the target group to select around 2-3 Local Priority Species for the project to work with (in addition to teak).

Session	Activities	Responsibility	Methods and Materials	Outputs
Day 1	Review day 1 activities and outputs	Facilitator	Presentation with reference to workshop outputs, followed by question and answers.	-
Local Priority Species Selection	Present survey activities and findings.	Community leader(s)	Presentation with reference to *Desk-Top Form* and Community File, followed by question and answers. Note: the Community File is a lever-arch folder containing the completed *Desk-Top Form, Tally Sheet* and *Survey Form* findings for the 10 most popular species. It provides the target group with a durable record of the survey/research findings and community decisions prior to the workshop.	
	Rank most promising species	All participants	Group discussions and presentations using Matrix Ranking and village materials (using colour and shape as symbols) with reference to *Desk-Top Form*, followed by questions and answers. Note: matrix ranking enables each species to be assessed with regards to different criteria (refer ICRA's *Ranking and Scoring Guidelines* for more information).	Around 2-3 LOCAL PRIORITY SPECIES selected 
Daily Evaluation	Wanem samting yu bin / no bin laikim, long dispela skul?	All participants	2 different coloured slips of paper each	Daily evaluation summary to monitor progress and improve workshop delivery

SESSION PLAN: *DAY 3*

The final day helps the target group to produce a draft Land-Use Plan for the project to work within, and also to plan ahead.

Session	Activities	Responsibility	Methods and Materials	Outputs
Day 2	Review day 2 activities and outputs	Facilitator	Presentation with reference to workshop outputs, followed by question and answers.	-

Land-Use Planning	Prepare clan land boundary map	All participants	Group discussions and presentations using village materials (using colour and shape as symbols), followed by participants "questioning" the map to ensure its contents are correct.	
	Prepare land-use map	All participants	Group discussions and presentations using village materials (using colour and shape as symbols), followed by participants "questioning" the map to ensure its contents are correct.	
	Prepare land-use plan	Community leader(s)	Overlay agreed clan land boundary and land-use maps using butcher paper.	Draft LAND-USE PLAN to be finalised after workshop
What Next?	Plan ahead (who, when, what, how)	Facilitator	Workshop discussion with reference to SWOT Chart and Project Document	Agreed WORK SCHEDULE to be finalised after workshop
Daily Evaluation	Wanem samting yu bin / no bin laikim, long dispel skul?	All participants	2 different coloured slips of paper each	Daily evaluation summary to monitor progress and improve workshop delivery
Closing	Closing speech(es)	Community leader	-	-
	Closing prayer	Community leader	-	-

10.5 Appendix: School Resource Pack Content

Level	Area	Subject	Strand	Sub-strand	Medium	Resource	Source
A. Pre-school	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	ACTIVITIES - PRE-SCHOOL 1: Whether in your own backyard, or in the tropical rainforest, your 5 senses help you learn more about your surroundings. During these lessons, students will begin to discover nature through sight, smell, taste, sound, and touch. After learning about the sights and sounds of their own neighborhood, students will begin to imagine what the environment is like in a lush tropical rainforest.	http://www.tes.co.uk/teaching-resources/
A. Pre-school	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	LESSONS PRE-SCHOOL 2: Come explore the mystical oak forests of the Cachalú Biological Reserve nestled high in the tropical Colombian Andes. With help from Fundación Natura, the Rainforest Alliance's partner group in Colombia, kindergarteners will learn about this special place, its interesting inhabitants and the connection between the rainforests and their supermarkets.	http://www.rainforest-alliance.org/curriculum/kindergarten
B. Elementary	Science	Culture and Community	Me and my Environment	Changes in natural and human communities	DOC (print)	CAUSES OF DEFORESTATION RESEARCH: Children use internet search engines in small groups to find out more about a specific threat to the worlds rainforests. Children collect information in the form of notes and present their concerns and solutions to the class.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Changes in natural and human communities	PDF (print)	LOGGING IN THE RAINFORESTS: A discussion with lesson ideas for young children about logging in the Atlantic Rainforest.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Changes in natural and human communities	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PPT (slides); PDF (print)	ALL ABOUT TREES: Where do we find trees? What lives in trees? An activity that lets your students think first.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	ANCIENT TREE HUNT: Go looking for fat, wrinkly, old trees where you live.Get kids outdoors exploring and bring the outdoors into your classroom with this fresh activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	DIFFERENT KINDS OF TREES: 4 trees to write sentences about and find out about. Children can then draw and label a tree.	http://www.tes.co.uk/teaching-resources/

B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	FUN MAZES - TREES: Can you find your way through the mazes? Learn about parts of trees and lifecycles on the way! Get kids outdoors exploring with this fresh activity from the Woodland Trust's nature detectives website. Bring the outdoors into your classroom with this inspiring activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	HABITATS GAME: This game is a fun way to get children learning about different habitats and the animals that live in them. The winner is the first player to collect all the animals hidden in their habitat game board (either rainforest, desert, Arctic or ocean). Note: We recommend printing the animal game cards out on card so the animals don't show through to the other side.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	JUNGLE FOLIAGE: Use this colouring activity from the Encyclopaedia Britannica to learn about rainforests.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PPT (slides); PDF (print)	LET'S FIND OUT ABOUT WOODLANDS: Examples of common trees and their leaves, bark, inside a tree, woodland animals, woodland fairies and model houses and furniture made from natural materials.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PPT (slides); PDF (print)	LIVING AND NON -LIVING: Powerpoint presentation giving information on what living and non- living means. Recap of objects at the end.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF / PUB (print)	RAINFOREST: Display lettering and posters for rainforest as well as writing frames for children to make their own booklet about the rainforest. Original writing frames made in publisher - I have added these so they can be edited to suit your class.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Exploring environments	PDF (print)	TREES - TREE MYTHS: Tree myths that can be acted out as short pieces of drama. Bring the outdoors into your classroom with this inspiring activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	A SUNFLOWER STORY: Colourful A5 pdf with detailed photos showing the growth of a sunflower. Could be used as a display or classroom sequencing activity.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	DOC (print)	JASPER'S BEANSTALK LABELLING PLANT: A worksheet for a cross curricular science/literacy about growth and Jasper’s Beanstalk.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PPT (slides); PDF (print)	JASPER'S BEANSTALK STORY CARDS: Picture cards or cut outs to aid in telling the story or ordering. Includes visuals for days of week.	http://www.tes.co.uk/teaching-resources/

B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PPT (slides); PDF (print)	LABELLING FLOWER WORDS AND SYMBOLS: Picture of flower obtained from http://www.kew.org/climbersandcreepers/home.html, cut and stick activity labelling parts of flower, flower with words of symbols.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	LESSONS - ELEMENTARY 1: Learn about the mystical forests of the Maya and the second largest barrier reef in the world! The Rainforest Alliance's partner in Belize, Toledo Institute for Development and the Environment (TIDE), is working with communities in southern Belize to protect a huge swath of the Selva Maya (or Maya forest) and the coastal ecosystems downstream. Students will learn about the jaguars, manatees, howler monkeys and loggerhead turtles that call this amazing place home.	http://www.rainforest-alliance.org/curriculum/first
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	LESSONS - ELEMENTARY 2: Nowhere on Earth is the rainforest more fascinating to children than the Amazon. In this unit, children will explore the rich culture of the Yanomami and compare their situation to the Amazon rainforest's newest arrivals: settlers seeking a better life. Students will learn about the work that The Oficina Escola de Lutheria da Amazônia (OELA), the Rainforest Alliance's Brazil-based partner, is doing to help the people of Boa Vista do Ramos improve their lives while ensuring the long-term health of the forest.	http://www.rainforest-alliance.org/curriculum/second
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PPT (slides); PDF (print)	LET'S FIND OUT ABOUT TREE HOUSES: A variety of tree houses with questions to provoke discussion.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	DOC (print)	PLANTS AND TREES - DECISION TREE: This is a sorting and organising activity focusing on Plants and Trees. This method of organisation is sometimes referred to as a branching database or a Key. A difficult concept to teach, this activity helps structure the sorting by allowing small numbers of items to be sorted first by asking yes/no questions. Introduce additional items by moving them down the tree, adding questions as required to further separate the items.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	MP4 (video)	RAINFOREST CONSERVATION: Exploring the rainforest by Emily Keller	http://www.teachertube.com
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PPT (slide); PDF (print)	RAINFOREST QUIZ - TRUE OR FALSE: Challenge your students to obtain ten out of ten in this interactive powerpoint quiz. These true or false questions give an overview of the importance of rainforests and what we can do to preserve them.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	TREES - TREE GROWTH CHART: Plant a tree, then measure it as it grows - mark the height, make notes and decorate with doodles! Get kids outdoors exploring with this fresh activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/

B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PDF (print)	TREES - TREE GROWTH CHART: Plant a tree, then measure it as it grows - mark the height, make notes and decorate with doodles! Get kids outdoors exploring with this fresh activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
B. Elementary	Science	Culture and Community	Me and my Environment	Using and caring for resources	PPT (slides); PDF (print)	WHAT PLANTS NEED: A simple presentation with animations and a quiz at the end. Very simple language throughout. Comic Sans Font (i will do it in Sassoon infant if requested).	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Changes in my environment	PPT (slides); PDF/DOC (print)	PLANT A TREE, FUND A DREAM: AWF have set up the 'Plant a Tree, Fund The Dream' Program to help rebuild our forests whilst funding children in Sierra Leone through education. Story, Crossword, Wordserch, Activity sheets, Fact Sheets, Rainforests, Deforestation, Endngered Species...	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Changes in my environment	DOC (print)	RAINFOREST ANIMALS PACK: This pack includes a double paged fact sheet on endangered animals found in the rainforest, a related worksheet with questions	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Changes in my environment	PDF / DOC / NOTEBOOK (print)	RAINFOREST TOPIC - PLANNING AND RESOURCES PART 1: Termly planning document with children's activities and resources.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Changes in my environment	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PPT (slides); PDF (print)	ALL ABOUT TREES: Where do we find trees? What lives in trees? An activity that lets your students think first.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PDF (print)	FUN MAZES - TREES: Can you find your way through the mazes? Learn about parts of trees and lifecycles on the way! Get kids outdoors exploring with this fresh activity from the Woodland Trust's nature detectives website. Bring the outdoors into your classroom with this inspiring activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	DOC (print)	LAYERS OF THE RAINFOREST: Children take a journey from the gloom of the forest floor to the bright sunshine at the top of the tallest tree, as they learn about the layers of vegetation.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	DOC (print)	PLANTS AND TREES - DECISION TREE: This is a sorting and organising activity focusing on Plants and Trees. This method of organisation is sometimes referred to as a branching database or a Key. A difficult concept to teach, this activity helps structure the sorting by allowing small numbers of items to be sorted first by asking yes/no questions. Introduce additional items by moving them down the tree, adding questions as required to further separate the items.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PDF (print)	RAINFOREST DISPLAY MATERIALS: This is a collection of labels, facts and information about rainforests that can be used as part of a display.	http://www.tes.co.uk/teaching-resources/

C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	DOC (print)	RAINFOREST FOOD CHAINS: An open ended activity involving sorting and classifying. Each link of the paper chain represents a transfer of energy in the food chain. This can also be extended to creating multiples chains as a food web. Edit as needed :)	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	DOC (print)	SEED DISPERSAL WORKSHEET: A worksheet with pictures (and names) of a variety of seeds. These are dispersed in different ways and can be sorted into the different ways (children look for clues about each one) under headings: wind, catching a lift, eaten by animals, water, exploding etc.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PDF (print)	TREES - TREE MYTHS: Tree myths that can be acted out as short pieces of drama. Bring the outdoors into your classroom with this inspiring activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	MP4 (video)	TROPICAL RAINFOREST BIOMES: The tropical rainforest environment	http://www.teachertube.com
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	ANCIENT TREE HUNT: Go looking for fat, wrinkly, old trees where you live.Get kids outdoors exploring and bring the outdoors into your classroom with this fresh activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	DIFFERENT KINDS OF TREES: 4 trees to write sentences about and find out about. Children can then draw and label a tree.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	HABITATS GAME: This game is a fun way to get children learning about different habitats and the animals that live in them. The winner is the first player to collect all the animals hidden in their habitat game board (either rainforest, desert, Arctic or ocean). Note: We recommend printing the animal game cards out on card so the animals don't show through to the other side.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PPT (slides); PDF (print)	HABITATS: A description of how animals are suited to their habitat and why animals chose particular habitats with questions. Topics also included: enviroment.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	JUNGLE FOLIAGE: Use this colouring activity from the Encyclopaedia Britannica to learn about rainforests.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PPT (slides); DOC (print)	RAINFOREST CLASS ASSEMBLY AND RESOURCES: Class assembly with accompanying song words and PowerPoint presentation	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	DOC (print)	RAINFOREST DISPLAY: Children create a piece of rainforest in the classroom in this session. After looking at images of rainforests and their trees, children use coloured papers to create trees and leaves for display.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	RAINFOREST FACT SHEETS: A collection of great rainforest resources to be used to support teaching about the rainforest.	http://www.tes.co.uk/teaching-resources/

C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	DOC (print)	RAINFOREST INFORMATION - CARDS AND WORKSHEETS: A set of 6 information cards which I printed onto coloured card and laminated. Each card has a set of questions for pupils to answer. The types of questions are - dictionary work, reading for information, setting questions for others to answer and deciding if statements are true, false or don't know based on the text only.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	RAINFOREST LAYERS - MATCHING ACTIVITY: This activity involves matching a variety of rainforest animals to the rainforest layers they live in. It can be differentiated by giving the children either picture clues or word clues to help them. They can also choose to draw, write, or cut and stick the answers on the layers diagram. Some starting points for group discussion have also been provided.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	RAINFOREST NECKLACE SCAVENGER HUNT: Through this scavenger hunt, students will learn that plants and animals depend on one another for survival and reproduction, such as through pollination and seed dispersal. Students will also learn that a rainforest has distinct layers, with life specially adapted to each layer.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF / DOC / NOTEBOOK (print)	RAINFOREST TOPIC - PLANNING AND RESOURCES PART 1: Termly planning document with children's activities and resources.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Links in the environment	PDF / DOC / NOTEBOOK (print)	RAINFOREST TOPIC - PLANNING AND RESOURCES PART 1: Termly planning document with children's activities and resources.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	RAINFOREST: Display lettering and posters for rainforest as well as writing frames for children to make their own booklet about the rainforest. Original writing frames made in publisher - I have added these so they can be edited to suit your class.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Environmental Studies	What's in my Environment	Plants and animals	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	A SUNFLOWER STORY: Colourful A5 pdf with detailed photos showing the growth of a sunflower. Could be used as a display or classroom sequencing activity.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	MP4 (video)	AMAZON RAINFOREST DEEFORESTATION: The causes and effects of deforestation	http://www.teachertube.com
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	DOC (print)	AWF'S TREE PLANTING PROJECT: The lesson plans use interactive learning to teach students about the importance of ecosystems, plant biology, climate change, carbon offsetting, global citizenship and the carbon cycle. Students will choose a tree to plant from the list provided.	http://www.tes.co.uk/teaching-resources/

C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	MP4 (video)	B-I-O-DIVERSITY: The secret of rainforest life is biological diversity.	http://www.teachertube.com
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	DOC (print)	CAUSES OF DEFORESTATION RESEARCH: Children use internet search engines in small groups to find out more about a specific threat to the worlds rainforests. Children collect information in the form of notes and present their concerns and solutions to the class.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	MP4 (video); PDF (print)	FSC AND FORESTS: Explore how forests are used and the many stakeholders involved in forestry.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	INVESTIGATION - HUG A TREE: In this activity from Wild About Plants your students learn about how to measure the age of trees.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PPT (slides); PDF (print)	LABELLING FLOWER WORDS AND SYMBOLS: Picture of flower obtained from http://www.kew.org/climbersandcreepers/home.html, cut and stick activity labelling parts of flower, flower with words of symbols.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	LESSONS - GRADE 3: Go into almost any backpack in your school and you will find empty chocolate wrappers or chocolate treats waiting to be eaten. Chocolate is a favorite candy of children all over the world. Where does all this chocolate come from? Who produces the ingredients for this treat? Students will explore the forests of Ghana and find that chocolate isn't the only interesting thing found underneath the canopy. Students will learn about the wealth of biodiversity that thrives within the forests and cacao farms of Ghana's Western Region.	http://www.rainforest-alliance.org/curriculum/third
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	LESSONS - GRADE 4: What is the most delicious thing to come from rainforests? Chocolate, of course! In four unique units children will explore chocolate, the food of the gods, and a native tree of the rainforests of Latin America. Students will learn about the Chachi of Ecuador, a small indigenous group who believe strongly in protecting the forest, and who are using cocoa farms to do it. But chocolate isn't the onl y interesting thing found in these wonderful forests. Students will learn about the wealth of biodiversity that thrives within the moist, green forests of a region of Ecuador known as the Chocó.	http://www.rainforest-alliance.org/curriculum/third
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	LESSONS - GRADE 5: Every year thousands of migratory birds make the long journey from North American forests, parks and backyards to the warm rainforests of Central and South America. Many of these birds will land in trees that shade coffee farms in Central America. Fifth- and sixth-graders will learn about the important work that SalvaNatura, the Rainforest Alliance's partner group in El Salvador, is carrying out to protect coffee forests and El Imposible, the first national park of El Salvador.	http://www.rainforest-alliance.org/curriculum/third
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PPT (slides); PDF (print)	LET'S FIND OUT ABOUT TREE HOUSES: A variety of tree houses with questions to provoke discussion.	http://www.tes.co.uk/teaching-resources/

C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PPT (slides); PDF (print)	LET'S FIND OUT ABOUT WOODLANDS: Examples of common trees and their leaves, bark, inside a tree, woodland animals, woodland fairies and model houses and furniture made from natural materials.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	LOGGING IN THE RAINFORESTS: A discussion with lesson ideas for young children about logging in the Atlantic Rainforest.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	MP4 (video)	RAINFOREST CONSERVATION: Exploring the rainforest by Emily Keller	http://www.teachertube.com
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PPT (slide); PDF (print)	RAINFOREST QUIZ - TRUE OR FALSE: Challenge your students to obtain ten out of ten in this interactive powerpoint quiz. These true or false questions give an overview of the importance of rainforests and what we can do to preserve them.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF / DOC / NOTEBOOK (print)	RAINFOREST TOPIC - PLANNING AND RESOURCES PART 2: Termly planning document with children's activities and resources.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	TEACHING WITH TREES: An introduction to using trees in the curriculum and advice on planting trees in your grounds.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	TREES - TREE GROWTH CHART: Plant a tree, then measure it as it grows - mark the height, make notes and decorate with doodles! Get kids outdoors exploring with this fresh activity from the Woodland Trust's nature detectives website.	http://www.tes.co.uk/teaching-resources/
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PDF (print)	WE PROTECT THE RAINFOREST TOGETHER: The Ito family's trip to the Amazon is an ITTO manga comic book that follows the adventures of the Ito family as they travel to the Amazon and learn about tropical forests and how ITTO is involved in the conservation, sustainable management as well as the rehabilitation and restoration of the world's tropical forests.	http://www.itto.int/cep_detail/id=2236
C. Lower Primary	Science	Science	Caring for my Environment	Managing resources	PPT (slides); PDF (print)	WHAT PLANTS NEED: A simple presentation with animations and a quiz at the end. Very simple language throughout. Comic Sans Font (i will do it in Sassoon infant if requested).	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Living Things	Ecology, relationships and interactions	DOC (print)	LAYERS OF THE RAINFOREST: Children take a journey from the gloom of the forest floor to the bright sunshine at the top of the tallest tree, as they learn about the layers of vegetation.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Living Things	Ecology, relationships and interactions	PPT (slides); PDF/DOC (print)	PLANT A TREE, FUND A DREAM: AWF have set up the 'Plant a Tree, Fund The Dream' Program to help rebuild our forests whilst funding children in Sierra Leone through education. Story, Crossword, Wordserch, Activity sheets, Fact Sheets, Rainforests, Deforestation, Endngered Species...	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Living Things	Ecology, relationships and interactions	DOC (print)	RAINFOREST ANIMALS PACK: This pack includes a double paged fact sheet on endangered animals found in the rainforest, a related worksheet with questions	http://www.tes.co.uk/teaching-resources/

D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Ecology, relationships and interactions	DOC (print)	RAINFOREST FOOD CHAINS: An open ended activity involving sorting and classifying. Each link of the paper chain represents a transfer of energy in the food chain. This can also be extended to creating multiples chains as a food web. Edit as needed :)	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Ecology, relationships and interactions	PPT (slide); PDF and DOC (print)	RAINFOREST LAYERS: Rainforest layers canopy emergent card sort undercanopy forest floor shrub	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Ecology, relationships and interactions	DOC (print)	SEED DISPERSAL WORKSHEET: A worksheet with pictures (and names) of a variety of seeds. These are dispersed in different ways and can be sorted into the different ways (children look for clues about each one) under headings: wind, catching a lift, eaten by animals, water, exploding etc.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Ecology, relationships and interactions	MP4 (video)	TROPICAL RAINFOREST BIOMES: The tropical rainforest environment	http://www.teachertube.com
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PPT (slides); PDF (print)	ALL ABOUT TREES: Where do we find trees? What lives in trees? An activity that lets your students think first.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PPT (slides); PDF (print)	HABITATS: A description of how animals are suited to their habitat and why animals chose particular habitats with questions. Topics also included: enviroment.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PPT (slides); DOC (print)	RAINFOREST CLASS ASSEMBLY AND RESOURCES: Class assembly with accompanying song words and PowerPoint presentation	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PDF (print)	RAINFOREST DISPLAY MATERIALS: This is a collection of labels, facts and information about rainforests that can be used as part of a display. Hope that they prove useful and please leave feedback if used.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PDF (print)	RAINFOREST FACT SHEETS: A collection of great rainforest resources to be used to support teaching about the rainforest.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	DOC (print)	RAINFOREST INFORMATION - CARDS AND WORKSHEETS: A set of 6 information cards which I printed onto coloured card and laminated. Each card has a set of questions for pupils to answer. The types of questions are - dictionary work, reading for information, setting questions for others to answer and deciding if statements are true, false or don't know based on the text only.	http://www.tes.co.uk/teaching-resources/

D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PDF (print)	RAINFOREST LAYERS - MATCHING ACTIVITY: This activity involves matching a variety of rainforest animals to the rainforest layers they live in. It can be differentiated by giving the children either picture clues or word clues to help them. They can also choose to draw, write, or cut and stick the answers on the layers diagram. Some starting points for group discussion have also been provided.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	PDF (print)	RAINFOREST NECKLACE SCAVENGER HUNT: Through this scavenger hunt, students will learn that plants and animals depend on one another for survival and reproduction, such as through pollination and seed dispersal. Students will also learn that a rainforest has distinct layers, with life specially adapted to each layer.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Living Things	Nature of living things	DOC (print)	TREES WORKSHEET: A great worksheet about plants and food	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	MP4 (video)	AMAZON RAINFOREST DEEFORESTATION: The causes and effects of deforestation	http://www.teachertube.com
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	MP3 (audio)	ARE TREES READY TO TAKE ON GLOBAL WARMING: While humans make attempts to control carbon dioxide levels that contribute to global warming, is it possible that trees have already taken on the task? Smithsonian Tropical Research Institute scientists studying African forests think that's what's happening.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	DOC (print)	AWF'S TREE PLANTING PROJECT: The lesson plans use interactive learning to teach students about the importance of ecosystems, plant biology, climate change, carbon offsetting, global citizenship and the carbon cycle. Students will choose a tree to plant from the list provided.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	MP4 (video)	B-I-O-DIVERSITY: The secret of rainforest life is biological diversity.	http://www.teachertube.com
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	MP4 (video); PDF (print)	FSC AND FORESTS: Explore how forests are used and the many stakeholders involved in forestry.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Comm unity	Making a Living	Managing Resources	Land and water management	PDF (print)	INVESTIGATION - HUG A TREE: In this activity from Wild About Plants your students learn about how to measure the age of trees.	http://www.tes.co.uk/teaching-resources/

D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PDF (print)	LESSONS - GRADE 6: Every year thousands of migratory birds make the long journey from North American forests, parks and backyards to the warm rainforests of Central and South America. Many of these birds will land in trees that shade coffee farms in Central America. Fifth and sixth graders will learn about the important work that SalvaNatura, the Rainforest Alliance's partner group in El Salvador, is carrying out to protect coffee forests and El Imposible, the first national park of El Salvador.	http://www.rainforest-alliance.org/curriculum/sixth
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PDF (print)	LESSONS - GRADE 7: Bananas, the world's most popular fruit, can only be grown commercially in the tropical regions of the world where rainforests also thrive. Many of these bananas are sustainably grown on banana farms certified by the Rainforest Alliance. Students will learn about the origin of the banana, how bananas are grown, and how their bananas travel from Honduras to their local grocery store.	http://www.rainforest-alliance.org/curriculum/seventh
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PDF (print)	LESSONS - GRADE 8: Spanning six million acres, the Maya rainforest represents the second largest contiguous tropical rainforest in the Americas, home to an astounding diversity of plant and animal life and a rich indigenous history. In this unit, students will learn how scientists classify forests, analyze maps to discover how the forests in Guatemala are changing and understand the role forest certification plays in conserving these unique ecosystems.	http://www.rainforest-alliance.org/curriculum/eighth
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	MP4 (video); PPT (slide); PDF (print)	THREATS TO THE TROPICAL RAINFOREST: HEP, mining, forestry, logging, farming, ranching. Includes rainforest song from TeacherTube	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PPT (slide); PDF and DOC (print)	TROPICAL RAINFOREST LEARNING MAT: This learning mat and the associated handouts within the power point includes uses/resources of the rainforest, the structure and layers of the rainforest, the causes and effects of deforestation and ideas for sustainability.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PDF (print)	USES OF RAINFOREST CARDS: Cards detailing 5 uses of Tropical Rainforests.	http://www.tes.co.uk/teaching-resources/
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	PDF (print)	WE PROTECT THE RAINFOREST TOGETHER: The Ito family's trip to the Amazon is an ITTO manga comic book that follows the adventures of the Ito family as they travel to the Amazon and learn about tropical forests and how ITTO is involved in the conservation, sustainable management as well as the rehabilitation and restoration of the world's tropical forests.	http://www.itto.int/cep_detail/id=2236
D. Upper Primary	Culture and Community	Making a Living	Managing Resources	Land and water management	MP4 (video)	WOK PLANIM NA LUKAUTIM PIKINNINI TEAK DIWAI: This introductory video looks at (1) seed germination, (2) nursery techniques, (3) uprooting and cutting, (4) site preparation, and (5) transplanting of teak stumps. The activities were filmed at OISCA in East New Britain Province, Papua New Guinea.	http://www.pip.com.pg/