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Final report

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1 Acknowledgments

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However, our greatest thank you is reserved for the people of Western Province and in particular the individuals and communities that we have worked with to undertake this project. It has never been an easy road on which we travelled but the people with whom we have worked have been kind and understanding, patient and accommodating.

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2 Executive summary

Smallholder teak in Solomon Islands could form the basis for a sustainable forestry industry that earns significant foreign revenue for the country through exports. However, most of the smallholder plantations are remote from ports and infrastructure, small in size and scattered throughout the country, meaning that the normal, mechanised systems for dealing with timber as round logs are not applicable. The project was established to examine the possibility of using in-situ processing of the timber. This would entail using a portable mill within the plantation and having the processed timber carried out. The timber would then be taken to a centralised location for drying and containerisation prior to export.

The project tested two types of mill that it was felt were most suitable for Solomon Island conditions. The first mill was a chainsaw frame mill and the second was a bandsaw with a horizontal blade powered by a 10 hp petrol engine. Both provided accurately dimensioned timber but the bandsaw was much faster, both to load the logs and to cut.

The project has harvested timber from a number of sources across Vonavona and Roviana Lagoons, as well as the New Georgia mainland and Rendova Island.

ACIAR project staff and Munda Forestry Officers (the team) has been trained in all aspects of the operation from the safe and directional felling of the trees, manual handling and the safe operation of the tools and machinery including chainsaws, snigging winch, log arch, cant hooks, block and tackle and the bandsaw.

Technical manuals and training materials have been produced, aimed at assisting individuals and groups who wish to establish similar operations. These may also form modules for the vocational training sector.

Two solar driers were established to assist the drying of the timber prior to containerisation. Despite problems with the solar powered fans installed in one drier, the timber has dried and been stabilised ready for containerisation

The project has sold about 45 m^3 of Solomon Islands smallholder grown teak into New Zealand. The project has worked with 10 community groups or families in the Roviana and Vonvona lagoons, harvesting and milling timber across a variety of situations and testing the flexibility of the process.

The project concluded that in situ milling, also known as downstream processing, was viable provided that the operation strictly adhered to guidelines regarding the size and form of the trees harvested. Solomon Islands teak has a high value and, with an established value chain, could provide an alternative to native forest logging.

The project team has maintained the research sites that have been set up since ACIAR started running a forestry based programme in Solomon Islands in 2008. These sites include mixed species trials, spacing trials for both flueggea and teak, agroforestry trials demonstrating coffee growing under teak and provenance trials for flueggea, also now home to coffee under flueggea.

One of the most important of these is the natural regeneration trial sites, consisting of three paired sites on Vasavasara Island in the Vonavona lagoon. These sites are used for demonstration and education purposes and it is hoped will be supported into the future through the Ministry of Forestry Research.

3 Background

The Ministry of Forestry Research has estimated that there are 15,000 ha of plantations owned by 21,000 separate groups or individual growers in Solomon Islands. Many of these were planted in the period 1995–2000, and now these plantations are in need of either thinning or clear-felling. While the quality of the timber is good, the poor form of many trees is such that most cannot be sold commercially as round logs. The scattered nature of the resource also means that attracting harvesting operations such as those used in native forest logging is unlikely. This leaves thousands of growers with trees that are attractive to the export market but not suitable for domestic use and unlikely to sell.

The project was established to develop a practical model suited to small island states that would enable existing small-scale teak plantations to be utilised and to provide growers with good returns. This would encourage ongoing planting and the gradual development of a sustainable forestry industry centred on smallholder growers and localised downstream processing.

The methods to be used in this project were to develop sawmilling techniques that allowed growers to maximise the amount of commercial timber that could be recovered from smallholder plantations. This was to be combined with onsite drying and stabilisation of the processed timber to the point where transportation would be feasible.

Secondary drying facilities would be established at a wood yard situated in Munda. The project team would work with exporters and buyers to develop an understanding of market requirements for the processed timber, to gain maximum value from the export market. In the process the project would develop a socio-economic model of small-scale harvesting and processing taking into account a range of social, economic and environmental impacts on the community, and investigate the applicability of this model to other small island states.

Following harvesting, the project team would work with growers to develop silvicultural management strategies for the harvested areas. This would encourage restocking, with the eventual aim of small-scale timber growing as a sustainable form of income generation for more remote rural communities.

Scientific impacts from this project would include the development of processing and drying techniques that were appropriate to the technology available at village and provincial level. Guidelines for the establishment of second rotation plantations would also be produced. The ongoing mensuration of trials established in previous projects would enhance longer term understanding of the growth and performance of Solomon Islands teak.

Capacity impacts associated with this project were to include two Solomon Islanders receiving training in small diameter log processing and solar drying in Brisbane, who in turn would act as trainers on all project activities. The project would work toward developing small-scale business opportunities in processing (both harvesting and drying), guided by value chain work that would in turn assist processors to better target their efforts.

Community impacts were expected to arise from the sale of high value timber and the development of a realistic, low volume, export market. Opportunities to develop milling and drying into small-scale businesses were expected to benefit local entrepreneurs and increase supply capacity. Turning moribund plantations into economic opportunities would assist communities to realise there are opportunities for sustainable income from plantations. It was hoped that women in particular might benefit from developing secondary drying as a business opportunity.

The environmental benefits were to be realised through an increase in the area of degraded secondary forest brought back into productive forest management to provide timber for local processing and sale in the future.

3.1 Justification for the project

Inventories of plantations in Western province undertaken by ACIAR project FST/2012/043 and grower workshops through PARDI project PRA 2011.06 (PHAMA, 2016) revealed the state of the plantings. All the plantations are overstocked due to lack of thinning, leaving small diameter trees that are difficult to process yet still too heavy to transport in unprocessed form. Most of the Solomon Islands plantation resource is in poor condition, with the majority of the timber falling outside current grading rules. Yet, there are thousands of cubic metres of commercial timber locked up inside the plantations, suggesting the benefits of recovering this timber using cheap, reliable and locally appropriate methods. While the Lucas mill (www.lucasmill.com) is recognised as a very efficient method of milling timber, locally it has several drawbacks including expense, portability and complexity. Hundreds of abandoned mills have broken down and are beyond the capacity of the communities to repair. A recent ACIAR report stated that of the 7,000 mills known to be in the Pacific region, only 20% are operational (Holzknecht *et al* 2012).

There are also issues related to transportability. Round logs are simply too difficult for communities to handle. The round log market has been developed for commercial operations with mechanical handling and sophisticated transportation. In Solomon Islands village communities everything is manhandled, and transportation is by open boats 4–7 m in length and powered by an outboard motor.

The lack of markets for the timber and the growers' unrealistic expectations about the value of their trees further exacerbate the situation, leaving many growers disillusioned and frustrated. Many claim they would never plant trees again and just want their plantations clear-felled so they can put their land to more productive use. Solomon Islands has near perfect conditions for growing timber, and high value timbers such as teak and mahogany should be a valuable export commodity. This would benefit growers and would also benefit the country's foreign exchange. These opportunities may be lost unless a way is found to utilise the marketable timber in these plantations and encourage growers to restock.

Plantation forestry has the potential to become a viable rural industry in Solomon Islands. While the sale of the timber will be an obvious encouragement for growers, it may not be sufficient to overcome a stated reluctance to continue to grow trees.

4 Objectives

Objective 1: To maximise the timber that can be produced from small diameter and poor form trees

- Research and develop the best design of low cost, chainsaw mill that is appropriate to the skills and resources of Solomon Island communities.
- Have a Solomon Island team trained in the processing of small diameter logs to a level where they can also act as trainers on return to Solomon Islands.
- Develop strategies for maximising the volume of merchantable timber that can be extracted from small diameter, low grade logs.
- Develop and publish guidelines for the maximisation of timber processed from small diameter and low grade logs. Promote the uptake of on-site processing through training workshops for Solomon Islands Government (SIG) forestry officers from other provinces, rural training centre (RTC) field days and the production of educational material for use in workshops and field days and posters for display in regional offices.
- Facilitate workshops for the development of private enterprise involvement in contract harvesting.

Objective 2: To develop a system for value-adding to processed timber through air and solar drying

- Research the best design for solar drying of timber using air-drying, passive and fan-assisted solar kilns.
- Have a Solomon Islands team trained in the theory and practice of kiln drying at a level appropriate to Solomon Islands at the Queensland Department of Agriculture and Forestry training centre at Salisbury, to a level where they can establish drying facilities at a village and wood yard level.
- Develop the protocol ls and guidelines for drying and stabilising processed timber at village and wood yard levels.
- Undertake a series of training workshops for forestry officers from other provinces in the drying of processed timber.
- Produce educational material for use in workshops and field days and posters for display in regional offices and on the project website.
- Facilitate workshops for the development of private enterprise involvement in solar drying facilities to support export of timber.

Objective 3: To identify the social and environmental impacts of adopting a system of processing at a local level and the effect on the sustained long-term community economic and social well-being

- Analyse the economic viability of small-scale plantation activity.
- Identify the range of potential options for grower and other stakeholder support.
- Provide an economic and social assessment of which of the available options for grower and processing support will enhance the viability of small-scale teak plantations in Solomon Islands.
- Identify the factors that influence grower decisions (both social and economic) regarding participation in teak plantation programmes.
- Provide the economic and social analysis inputs into a model for the sustainable development of timber value-adding activities suitable for small island states.

Objective 4: To develop an appropriate model for improving economic returns through small-scale forestry in Solomon Islands and assess its suitability for other small island states

- Identify the markets and market requirements that are best suited to the supply capacity of a smallholder-based Solomon Islands timber industry.
- Identify the most appropriate business model and private sector partners that are able to link in to the markets and can meet customer requirements.
- Identify the most appropriate end product for each potential market.
- Develop a costed model of small-scale processing with a cost/benefit analysis at each stage of the process, from grower to processor to final buyer, that also takes into account the regulatory costs and government subsidies.
- Examine the role of government policy in supporting the development of market opportunities through the framework of the model and produce a technical manual on all aspects of secondary processing in a small island state, including the development of suitable business models.

Objective 5: To investigate post-thinning or harvesting silvicultural management of community teak plantations

- Establish paired trials looking at coppicing as a method for re-establishment of clear-felled teak plantations.
- Produce a silvicultural guide to coppicing teak in Solomon Islands.
- Develop measurement plots in plantations that have been thinned to final stocking rate to establish the level of response from suppressed teak plantations.
- Produce guidelines for community growers showing response to thinning.
- Continue the maintenance, mensuration and analysis of existing scientific trials.

Objective 6: To monitor and evaluate the progress and effectiveness of the project in achieving its aims

- Identify key stakeholders to participate in monitoring and evaluation.
- Establish a formal framework and programme for monitoring and evaluation.
- Circulate the annual collection of relevant data with summary report to stakeholders for comment and inclusion in Annual Report.
- Hold an annual meeting of stakeholders.
- Produce a report outlining the methodology and results of the monitoring and evaluation programme.

5 Methodology

Objective 1: To maximise the timber that can be produced from small diameter and poor form trees

The first stage of the project was to look at the different models of mill that were available and test those that were short listed as most suitable. The criteria for choice were:

- technological appropriateness (availability of parts, maintenance, fuel choice)
- transportability, as the project was founded on the premise that the mill would go to the plantation, not the logs to the mill
- reliability
- accuracy.

We tested chainsaw mills and a bandsaw, having rejected Lucas mill on the grounds of cost and maintenance issues.

Additionally, we looked at the ancillary equipment needed to keep the operation functioning. These included the use of Peavey or cant hooks, straps, block and tackle winches and log arches.

We also provided training to the teams that would be felling the trees. An Australian accredited trainer worked with the teams in the field for a week, resulting in dramatic improvement in the accuracy of the felling and the skills of the team.

Dr Graeme Palmer was brought in to work with the project on milling techniques and improving the outcomes from the milling.

Field trials took place in eight locations in the Roviana and Vonavona lagoons. These trials produced nearly 50 m^3 of sawn timber.

Objective 2: To develop a system for value-adding to processed timber through air and solar drying

The initial concept was that sawn timber would be stacked and allowed to air dry in the plantation for up to two months to reduce the weight. This happened in the first two communities of Saika and Madali. At Saika, the distance to the loading point at the water's edge was a problem. At Madali, the use of a flat-bottomed landing craft to move the timber across open water required as much weight be taken off the timber as possible.

In subsequent, lagoon-based field sites, the owners wanted the timber moving as soon as it was cut as that was when they were paid.

Two solar kilns were established near Munda at Lokuloku to evaluate solar drying prior to containerisation. One kiln used passive air flow and the other was fitted with fans powered by solar panels. The two different systems would test the need for the additional expense of solar powered ventilation against passive air flow.

Concurrent trials were conducted in Australia to develop improved rates of drying and dried quality in large wood sections. This was considered desirable to improve the economics, treatability and finished goods' value.

Objective 3: To identify the social and environmental costs and benefits of village economy change associated with access to markets for smallholder teak, and the effect on the sustained long term community economic and social wellbeing.

Research into the social and economic impacts of the processing and sale of smallholder teak on communities was undertaken by Dr Peter Daniels of Griffith University. Ms Miri

Taqu of Munda held the roles of community liaison, interpreter and field worker. This work consisted of community surveys, which were conducted in three stages.

The stage 1 survey covered: community and household demographics and roles; economic activities, income and expenditure types; decision-making systems; knowledge and expectations and ideas about the teak project; and anticipated and preferred income and spending related to teak (for both families and the community at large).

The stage 2 survey was designed to monitor the effects of the project in villages where the teak plantation milling and drying had been completed and payments made for its sale.

Visits to the communities for conducting the stage 2 survey included a feedback report to the communities about some of the key results from the stage 1 survey. This was to ensure the communities felt that the sample results were generally accurate and representative and to enhance awareness and participation in the study.

The stage 3 survey assesses post-operational impacts, including community impacts and perceptions several months after the test teak milling, sale and income distribution (in most communities).

Objective 4: To develop an appropriate model for improving economic returns through small-scale forestry in Solomon Islands and assess its suitability for other small island states

Meeting this objective involved looking at factors that would constrain or enhance the economic activities associated with small-scale processing in Solomon Islands and relate this to other small island developing states. Factors to be considered included:

- the supply of timber to the market, in particular constraints on grower participation
- the processes involved in the milling operation and associated bottlenecks
- transport logistics
- markets for smallholder teak
- protocols to ensure compliance with timber import/export legislation.

These factors were examined in light of dealings with growers, transport options, market access and export and import systems. Details are reported in separate reports on milling and processing (Appendix 1) and the business case (Appendix 3).

Objective 5: To investigate post-thinning or harvesting silvicultural management of community teak plantations

- The establishment of plots to measure the effect of thinning was not undertaken due to the nature of the harvest operations, which effectively thinned from the top down and did so randomly throughout the plantations. In most cases at least 60–70% of the standing trees remained after harvesting with a high proportion of undersize trees and trees with poor form.
- Re-establishment through coppicing did not eventuate because the stands were not clear-felled. In discussion with the Research Project Manager, the project team agreed that the cost of establishing trials outweighed the benefits and therefore, re-establishment was also dropped as an objective.
- Mixed species plantings required either clear-felling or establishment of new areas with a desire by the landowner to re-plant. None of the landowners we have dealt with have cleared the remaining trees from their land.
- The trial plots from previous projects continue to be maintained and measured.

- A report synthesising the work carried out by ACIAR on smallholder forestry in Solomon Islands will be made available when completed.

Objective 6: To monitor and evaluate the project

A monitoring and evaluation programme was identified at a two day workshop in Honiara that was attended by the project team.

While well-meaning, the exercise did not deliver concrete results and project monitoring and evaluation remained informal. All coordinators were required to submit monthly activity reports to the project leader, and, as far as was practical, team meetings were held at the beginning of each project leader's visit to discuss the reports and decide on future action.

This informal monitoring and evaluation was able to respond to the ever changing realities of life on the ground, including staff changes.

6 Achievements against activities and outputs/ milestones

Objective 1: To **maximise the timber that can be produced from small diameter and poor form trees**

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Test different models of chainsaw mills	Report on the ease of use, reliability, transportability and accuracy of the different mills tested	July 2020	See FST/2014/066 – Report on Milling and Processing 0f Smallholder Timber in Western Province of Solomon Islands (Appendix 1)
1.2	Train two team members at QDAF	Staff members competent in milling techniques	September 2015 June 2018 July 2019	At QDAF request it was decided to train the two staff members in-country as a suitable mill was not available at Salisbury. Training carried out in-country by Dr Graeme Palmer. The advantage of this approach was that the entire team received the training. Further training in the correct use of chainsaws for directional felling was provided by Steve Smith of Chainsaw Training. This has significantly improved safety and accuracy during harvesting operations. On the job training in all aspects of the operation are a regular feature of the work, with regular field sessions held by the project leader. Regular maintenance has become a key feature of both mills. A full clean down is performed at the end of each working day, with chainsaws stripped down and cleaned. The bandsaw also has a checklist of tasks to ensure accuracy of cut and safety of operation that is performed prior to the start each day. Sharpening of the chainsaw blades is crucial as teak has a high silica content. Two sharpening jigs have been purchased for the rip and crosscut saws. The project has also acquired a sharpener and setter for the bandsaw blades. All members of the project team have been trained in the operation of all three jigs and regular refresher training is undertaken on days when the weather prevents other activities.

No.	Activity	Outputs/ milestones	Completion date	Comments
1.3	Establish a portable sawmill unit at Munda	Equipment set up and operational Munda forestry officers trained in the safe operation and maintenance	December 2015	There are currently two styles of mill based at the Ministry of Forestry Research Office at Munda the Logosol M8 chainsaw mill and the Woodmizer LT 10. A portable capstan winch rated to 1 tonne is used to assist in moving logs and in lifting logs on to the bed of the Logosol mill. This improves workplace safety. Staff have been trained in the safe operation of both mills.
	Undertake trials at local plantations	Establish up to 6 harvesting trials pa in Western Province in years 1 and 2	June 2016	The project has milled timber from the following communities in Western Province: Saika (Logosol mill) Madali Taboca (two periods) Namba 7 (two periods) Nusa Hopei Kopo (two periods) Bopopa. See FST/2014/066 – Report on Milling and Processing 0f Smallholder Timber in Western Province of Solomon Islands (Appendix 1)
	Workshop held in Munda	Provincial Forestry and stakeholders informed on the operation of portable mill	December 2016 November 2018	The operation of the mill was one of the focal points for the field days held in November 2017. Workshops will not be held until we have realised the best options for utilising both mills and are able to demonstrate the process with confidence. A further field day was held for provincial forestry officers with 16 officers from Isabel, Malaita, Makira, Guadalcanal and Western Province.
1.6	Undertake Provincial trials*	Deleted from objectives		
1.7	Technical manuals	Guidelines for growers on yield Technical manual on maximising timber recovery	December 2019	See FST/2014/066 On-site Bandsaw Operational Guide for In-situ Processing of Smallholder Teak in Western Province of Solomon Islands (Appendix 2)

No.	Activity	Outputs/ milestones	Completion date	Comments
1.8	Workshops for private enterprise	Workshop held in Munda to explore the business opportunities from contract harvesting		Informal discussions have been held with local businessmen but without hard data on costs and cost recovery it was not considered appropriate to hold workshops. The project has supported the establishment of a standalone milling and harvesting operation. In conjunction with the Ministry of Forestry and Research, the project is supporting Mr Gideon Bouro to develop downstream processing as a cost-effective private enterprise through the donation of the equipment.

PC = partner country, A = Australia

Objective 2: To develop a system for value-adding to processed timber through air and solar drying

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Concurrent training with objective 1.2	Two team members trained to a satisfactory level	September 2015	As with 1.2 above, training was held in-country and involved the entire project team.
2.2	Field evaluation of air-drying (using timber from 1.4)	Up to six site-based drying trials each year in WP for Year 1 and 2	June 2016	Timber has been air-dried successfully at both Saika and Madali communities. In reality, communities want the timber to be moved from the village as quickly as possible after processing as they only get their money once the timber has been shipped over to Lokuloku. The timber from all the other communities has been shipped within a week of milling finishing as the growers are desperate for the money.
2.3	Establish solar Kilns at Munda	Research on the gains in timber quality and stability to be gained from secondary drying	June 2016 November 2018	Two kilns have been constructed at Lokuloku. Temperature and humidity loggers have been installed and test pieces are weighed to assess rate of drying. A Delmhorst J-2000 Timber Moisture Meter with hammer electrode is used to test moisture content within the stacks. Solar powered fans were installed in one kiln. The performance of the system has been disappointing with very little charge getting to the batteries on cloudy days, which are the norm in Western Province.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.4	Workshops held in Munda (concurrent activity with 1.5)	Provincial Forestry officers and local entrepreneurs shown the operation of solar kilns Report on options for scaling out solar drying	December 2016 November 2018	Forestry officers from Honiara attended one of the field days, which included both the milling at Taboca village and the kilns at Lokuloku. The project team had invited the Ministry to send officers from the provinces, but only HQ staff attended. Provincial forestry officers attended a demonstration of the kilns in November, before the solar panels were installed. Discussion of the performance of and and recommendations for the solar kilns are included in FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1).
2.6	Technical manuals	Technical manual on drying rates, optimum timber moisture content	March 2017 June 2019	Theft of the computer with the data and the dismissal of the coordinator responsible for undertaking the trials mean this report will not be produced.
2.7	Workshops for private enterprise	Workshop held in Munda to explore the business opportunities from solar drying	March 2016 Elsewhere by request	Will be run in conjunction with 1.8 above.
2.8	Australian trials	Improved systems to accelerate drying rate and enhance dried quality for large sections	February 2019 July 2019	Interim Reports previously supplied to ACIAR are: • Drying and preservative treatment of softwood poles - literature review • Install Small Scale Drying and Preservation Trials • Install Large Scale Drying and Preservation Trials Installation Milestone 4 report. Final Reports from this sub objective have been forwarded to AC IAR in the Annual Report

PC = partner country, A = Australia

Objective 3: To identify the social and environmental costs and benefits of village economy change associated with access to markets for smallholder teak, and the effect on the sustained long-term community economic and social well-being.

No.	Activity	Outputs/ milestones	Due date	Comments
3.1	Identify the aspects of the project that affect social and environmental outcomes	Field interviews and structured surveys, up to 10 per region	June 2016 Western Province June 2018	The post-July 2016 period involved the completion of five main tasks related to objective 3.1: (1) completion of all of the required stage 1 surveys in the six study communities. (2) data entry, coding, cleansing and primary analysis of the detailed survey results for the stage 1 survey. (3) summaries and an initial analysis of the community leader interviews and village demographic tables (age by gender). (4) design of the stage 2 operational impacts survey questionnaire. (5) pilot testing, revision and completion of the first few stage 2 survey interviews in the three communities where teak milling and payment has occurred.
3.2	Field interviews to elucidate the structure of the community socio-economy	Report on the existing levels, patterns and distribution of economic flows Report on costs and benefits from sawing and drying operations	June 2016	Following the mid-2016 pilot testing and revision process, 45 stage 1 survey interviews of community individuals were completed in the field primarily by Miri (and some by Alick). These were completed by early 2017. The age and gender makeup of the stage 1 surveys is presented in Appendix 2 of social research report. The stage 1 survey focused on the six communities in which the project is operating, mapping the socio-economic structure and identifying the anticipated social and environmental impacts of the project. Peter Daniels designed the initial survey questionnaires in consultation with Miri, with revisions taking into account the pilot testing. Miri's local knowledge and contacts, social skills and experience in social research were invaluable in completing the surveys. The stage 1 surveys covered: (1) community and household demographics and roles (2) economic activities, income and expenditure types (3) decision-making systems (4) knowledge and expectations and ideas about the teak project (5) anticipated and preferred income and spending related to the teak (for both families and the community at large).

No.	Activity	Outputs/ milestones	Due date	Comments
				The data from the stage 1 survey has been prepared, input and subjected to overall summary analysis (mainly frequency analysis and some cross-tabulations). This has been important to obtaining the required background information on the community social and economic characteristics and perceptions, in order to gauge, manage and optimise the ongoing impacts of the teak milling project. It also provides the data necessary for further analysis in the subsequent two community surveys. Some of the results of the stage 1 survey are presented in the mid-term report presentation but the more detailed analysis linked to the ongoing effects of the teak project covered in the stage 2 and stage 3 surveys is covered in the Social Research team final report. The stage 2 survey was designed to monitor effects of the project in villages where the teak plantation milling and drying has been completed and payments made for its sale. Pilot testing of the stage 2 survey, and some interviews using the final questionnaire, were completed in the three villages in January 2018. The visits to the communities for the stage 2 survey also included a feedback report to the communities about some of the key results for the stage 1survey. This was to ensure the communities felt that the sample results were generally accurate and representative and to enhance awareness of and participation in the study.
3.3	Assess the local effects of economic change	Preparation of business models for sawing and drying enterprises An analysis of the range of direct economic and non-monetary consequences	Interim May 2017	The stage 1 survey provided the basis for assessing the ongoing local effects of the teak project economic activity (stage 2 and stage 3 surveys). As of February 2017, only three of the communities had received economic benefits from the milling (Saika, Taboka and Mandali). These communities have been the focus of the next round of visits from the social research team (focused upon operational social and economic impacts, and monitoring of expectations regarding the project). The stage 2 survey was slower than originally planned, largely due to some delays in getting the project through to sale stage in the other villages. The initial teak milling and sale impacts are the focus of the stage 2 survey of individual community members. In January 2018, the pilot survey testing was completed in the three villages and the interviews for the revised stage 2 questionnaire (operational phase) commenced for the individual community members.

No.	Activity	Outputs/ milestones	Due date	Comments
3.4	Identify the impacts of direct economic change on the community through time	Longitudinal study using 3.2 as a base deigned to gauge social, re-distributional and other economic changes and identify net economic and social welfare impacts	May 2019	The assessment of the medium- and longer-term economic (and social and environmental) impacts of the teak milling and sale requires the communities to have had adequate time to experience and evaluate such effects. The project has been extended for six months and the community impact assessment has been further delayed due to delayed progress in milling and drying operation across the different villages. The assessment depends upon key project activities being completed and allowing time for the communities involved to perceive and assess the impacts of the activity and its economic, biophysical and social flow-on effects. This has only been possible for four communities – Madali, Saika, Taboka and Namba 7. The stage 2 survey is nearing completion across these four communities. However, two more communities have received payment (as of July 2019) and the survey may be extended to cover these communities as soon as possible. The stage 3 survey was the operational impacts assessment, which monitored the impacts in villages where the teak planation milling and drying had been completed within a month of the trial milling and receipt of monies.
3.5	Examine environmental externalities resulting from project activities	An examination of changes within the biophysical environment arising from project activities	March 2019	The stage 1 survey (background information) results provided substantive information on existing and anticipated environmental conditions and impacts of any existing experiences with milling for the communities. The stage 2 survey collected data on community perceptions of any biophysical environmental impacts related to the project and the results will be analysed on completion of the survey (in late September). Many environmental effects are, of course, longer term and are likely to more evident with larger scale implementation of teak milling in the communities. Hence, these results are likely to be precursory. The stage 3 survey of post-operational impacts will survey of impacts and perceptions at least several months after the test teak milling, sale and income distribution (in most communities). Again, the amount of time elapsed from milling and payment and the small-scale nature of the project trails may affect the results.
3.6	Identify social impacts arising from 3.1 – 3.5	An examination of the inter-community impacts (as opposed to intra-community impacts discussed above)	March 2019	The broader scale impacts of the project will be described where possible from the three surveys. However, during the completion of the first two surveys it became apparent that the inter-community impacts were unlikely to be of major relevance to the net community welfare associated with the project. Hence, the survey data collection shifted to community and gender-based outcomes and the analysis reflects this realignment in the research objectives.

No.	Activity	Outputs/ milestones	Due date	Comments
3.7	Identify the effects of project activities on the role of women	An examination of the impact of gender specific activities on the role and function of women	March 2019	All three surveys included substantive sections on the attitudes, views and knowledge of women in the communities about anticipated benefits, problems, and roles associated with the teak milling project and related income.
3.8	Overarching assessment	A summary of the social and environmental costs and benefits	March 2019	See Appendix 6: - Community Impact Section Report

Objective 4: To develop an appropriate model for improving economic returns through small-scale forestry in Solomon Islands and assess its suitability for other small island states

No.	Activity	Outputs/ milestones	Due date	Comments
4.1	Evaluation of factors that affect the supply of timber to market	Report on factors that influence and constrain grower participation	June 2016 (Western Province) June 2018 Other provinces	The activities undertaken thus far have not identified any reluctance of the growers to take part in marketing activities. Everyone who has been approached has shown a willingness to participate, because even the modest returns the project guarantees are significant sums for subsistence farmers. The small scale of the project has not led to a resurgence in planting activities. There is significant evidence that this is occurring on Kolombangara, where the local growers have greater access to markets through Kolombangara Forest Products Ltd (KFPL). Evidence of this mainly comes through the increase in sales of seedlings from the community nursery that was established at Vanga Rural Training Centre and personal communication with the General Manager of KFPL.
4.2	Evaluation of harvesting milling and drying activities in respect to how they affect the flow of material	Recommendations for improving the processes involved in producing the raw material	June 2016 June 2017	The flow of material had challenges at every stage of the process, including:. • distance from plantation to water, quality of the tracks to be negotiated, lack of transport or any means of moving heavy timber, which all impact the flow of material to the sawmill • movement of logs around the site in preparation for milling, noting that the use of the log arch is probably the single most important factor in moving the timber on site • the grade of logs processed, which has considerable impact on the speed of processing (the project did not process logs with a diameter less than 25cm over bark because this size yields two 150mm x 50 mm (6 inch x 2 inch) planks, the minimum size accepted for export) • the availability of local landing craft to transport the time from the village to Lokuloku.

No.	Activity	Outputs/ milestones	Due date	Comments
		Report on options for financing new timber enterprises		See report: FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)
4.3	Evaluation of transport logistics	Report on the transport options, costs and benefits at different stages in the movement of products and distances from ports	June 2016 (Western Province)	The project used a 3 m^3 landing craft, depending on the weight. In Solomons Islands dollars (SBD), the cost is $1,500 per day plus petrol. The craft is underpowered and can only make trips outside the lagoons in calm weather. The slowness and lack of deep-water stability has an impact on the quantity of timber that can be transported, overall cost and reliability. To date we have moved timber using this method from two sites within Vonavona lagoon and from Rendova Island. The barge was also used for picking up timber at Kopo, Bobopa and Nusa Hopei within Rovianan Lagoon though this can be a tricky run at periods of low tide. Boats usually go outside the fringing reef into the Blanche Channel. KFPL is testing collecting timber from other islands using their tugboats. While this method is only marginally, if at all, cost-effective, it does show that with the correct help from outside, growers can access markets for their teak. The use of unpowered barges that can be left on location for loading while the powered craft is free to undertake other activities would be an ideal solution, especially if combined with machinery to assist in snigging and loading, which even a small tractor could do. Interestingly, this system would suit round logs rather than processed timber. This in turn would allow for a stationery mill to be established in a central location that would undertake the value-adding. See: FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands (Appendix 4)
4.4	Analysis of the markets for smallholder grown teak	Breakdown of available markets suitable for smallholder grown teak	Reports in June 2016 June 2018	The unexplored market for smallholder timber is the local market, which is the only outlet for the majority of the logs that fall outside the grading rules and are too small for milling. In general, teak is ignored as a timber for local use. In some situations, the project team has thinned the mixed species trials of teak and flueggea and offered the timber to the local communities. All of the flueggea was taken and all of the teak was left behind. The project has undertaken an education campaign to demonstrate the use of teak. It has built a shade house in the grounds of the Munda Forestry Office

No.	Activity	Outputs/ milestones	Due date	Comments
				completely of teak and is encouraging the use of teak as an alternative timber for carving. The local tree that is normally used (kerosene wood or *Cordia subcordata*) is in short supply and teak makes an excellent substitute. Carving is a significant revenue earning activity in Solomon Islands. Meetings have been held in Australia and New Zealand with potential importers to assess market interest in importing Solomon Island teak. The presence of Solomon Island teak in New Zealand has been an opportunity to further explore market opportunities and in conjunction with the importer, South Pacific Timbers, we have visited a number of potential customers. South Pacific Timbers is now proactively developing interest in the teak.
4.5	Development of protocols for ensuring compliance	Report on protocols to facilitate compliance with timber import legislation Report on timber exports from project activities	May 2018 May 2019	The project has shipped three containers to New Zealand. The containers were shipped without a phytosanitary certificate as this was not available at Port Noro. A report on the paperwork, with examples, is attached. See: FST/2014/066 Report on protocols to facilitate compliance with timber import legislation (Appendix 5)
4.6	Toolbox for smallholder forestry industry	Technical reports from Objectives 1 and 2 Video Tables of costings for raw materials, transport and establishment costs including sawmill development Legality guidelines	Ongoing development with annual progress reports and evaluations Final toolbox March 2019	FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1) FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3) FST/2014/066 On-site Bandsaw Operational Guide for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 2) FST/2014/066 Report on protocols to facilitate compliance with timber import legislation (Appendix 5) Video: available on the Griffith University website

PC = partner country, A = Australia

Objective 5: To investigate post-thinning or harvesting silvicultural management of community teak plantations

No.	Activity	Outputs/ milestones	Due date of output/ milestone	Risks / assumptions
5.1*	Establish measurement plots in thinned areas	6-monthly measurements Six plots	Interim Report June 2017 Final Report June 2019	The project thinned from the top down, as it is only processed Grade A logs with a diameter at breast height (DBH) of approximately 40 cm. The 4 m^3 of timber that the project team has negotiated with the communities only requires around 16–30 trees, therefore the thinning effect was not consistent and likely to have any real impact. One of the real impacts of the field days has been a greater realisation by local growers of the size and quality of the timber needed for milling. There has also been greater discussion around local use of teak.
5.2*	Re-establishment trials -Coppice - - Plantation Using mixed species model	Up to six plots established and measured on a six-monthly basis	Interim Report June 2017 Final Report June 2019	The plantations were not clear-felled, therefore re-establishment trials have not taken place In order to establish a trial, the project would have to pay for the timber that is cut down and then for the ongoing maintenance of the trial plot. The best possibility for that would have been at Taboca community but the estimated cost was around AUD $10,000 and much of the timber would not have been suitable for export. The project has established coffee trials within the experimental areas at Poitete and Ringii on Kolombangara Islands, as the final phase of the mixed species trials that were established there. It will be some time before the coffee starts producing a large quantity of berries, but the project has shown that the plants grow successfully between the teak trees and under flueggea and would seem to be a good intercrop to provide a continuous livelihood for the smallholder growers.
5.3	Annual maintenance and mensuration of existing trials	Scientific data on key economic plantation species Peer-reviewed journal articles	Final Report June 2019	The majority of the last 2 years of data were lost through theft of the project computer. Further mensuration of plots is still planned and relevant for future publications
5.4	Production of a consolidated Technical Report	Technical report outlining the scientific and economic basis for small scale teak forestry in Solomon Islands	End of Project June 2019	FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1) FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)

* Objectives 5.1 and 5.2 were based on the assumption that plantations would be clear-felled and that plantation owners would have some interest in adopting a post-harvest management strategy. Both of these were false assumptions. Even when all of the useful trees have been removed from the plantations, there seems to be no further interest in active management of the plantation, and an assumption that the remaining trees may be harvested at some future date.

Objective 6: To monitor and evaluate the project

No.	Activity	Outputs/ milestones	Due date of output/ milestone	Comments
6.1	Establish evaluation parameters during inception workshop	Monitoring and Evaluation Plan with a series of indicators to assess project progress	July 2015	Completed
6.2	Annual reports to stakeholders	Annual report against the monitoring indicators established during inception workshop	Annually in May	Annual reports have been sent to Ministry of Forestry Research headquarters at Honiara the main stakeholder nvolved in the project.
6.3	Feedback to stakeholders	Meeting to review and guide project outcomes. Mid Term Review Meeting	Annually in July July 2017	No annual meetings have been held, though there is regular communication between project staff and the stakeholders such as the Ministry of Forestry Research the Solomon Island Association of Rural Training Centres, KFPL and the communities.
6.4	End of Project	Final report synthesising progress against deliverables and intermediate outcomes		FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1) FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)

7 Key results and discussion

A more detailed overview of the project can be found in:

- FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1)
- FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)
- FST/2014/066 On-site Bandsaw Operational Guide for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 2).

The project was tasked with determining if onsite processing of smallholder timber would be an economically viable method of allowing smallholder growers to access a market for their plantation grown teak. One of the greatest barriers to market access for smallholder growers is the scattered nature of the plantation resource, with an estimated 15,000 ha of smallholder teak owned by 21,000 separate groups or individuals across a country comprising over 900 islands. While commercial logging operators in Solomon Islands use heavy machinery to harvest and transport round logs, with barges to move the logs to larger ships for export, these facilities are not available to smallholder growers. There is also an environmental cost to commercial operations that it is desirable to avoid.

Onsite processing was seen as a way of overcoming some of the problems related to transportation. Converting round logs to sawn timber makes it possible to move the timber from the plantation without machinery. Sawn timber also makes possible the use of small landing craft type barges to transport the timber to a central point. With this method, no waste timber is transported, and the value of the timber carried can justify the expense.

7.1 Maximising timber production (objective 1)

The reality is that small diameter and poor form trees cannot be processed on a commercial basis.

See: FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)

7.1.1 Identify suitable mill

The first stage of the process was to identify the most suitable mill that fulfilled the requirements by being technologically appropriate (maintainable), transportable, accurate and cost effective. The Lucas mill is the most commonly used mill for local processing in Solomon Islands and other Pacific Island Countries. However, the difficulties associated with maintenance, access to a saw doctor for the blades and the initial expense led to this being discarded as an option. The project originally looked at an Australian designed frame mill, the Wombat sawmill, which comprised a frame with a chainsaw attached to a sliding carriage which was winched along the frame producing accurate straight cuts along the log (see Image 4 in the milling report at Appendix 1). A prototype made in Australia demonstrated that the concept worked well, but getting the frame made up in Solomon Islands proved too difficult, and having it made in Australia was too expensive.

A suitable alternative was the Swedish Logosol mill. This worked on the same principles as a frame with a sliding carriage, but the logs were lifted onto a frame that had adjustable supports at either end to facilitate levelling. The Logosol was used at Saika village in

Vonavona lagoon, which was the first community to take part in the trial. This site was chosen because the project team had worked extensively with the Saika community since ACIAR started the forestry programme in Solomon Islands in 2008. The Saika community hosted the only community-based mixed species trial and took part in the social research programme. Assisting the community was a way to repay their generosity towards the project. The community teak plantation had suffered cyclone damage and the project was asked to salvage the teak. The project milled 4 m^3 of teak from the plantation, for which the community received SBD $6,000. The following points emerged from the Saika trial:

- The Logosol mill was highly transportable and was light enough for the frame to be carried by two people. The cuts were accurate and the adjustable bed for the logs was easy to use. The mill could be moved to piles of logs, reducing distance for the logs to be hauled.
- Ripping logs using the chainsaw was very slow, especially on the wider sections of logs. The logs were milled into squares, meaning that only four cuts were made per log, but this was still very time consuming. Allowing for lifting the logs onto the bed, milling and stacking, the process could take 40 minutes per log.
- The high silica content of the wood rapidly blunted the chain. This was eventually overcome by having two chainsaws on carriages and purchasing a very effective manual sharpening jig. The chainsaws were alternated, allowing for one on the mill and one being sharpened and maintained.
- Because the project was salvage logging, there was little control over the size or quality of the logs.
- The tension within the logs caused by lying haphazardly for long periods after the cyclone meant that the logs split easily, reducing the amount of timber that could be recovered from the logs.
- The Saika trial took months to achieve 4 m^3 of sawn timber. The plantation was situated a 30-minute walk from the jetty, itself a 30-minute boat rise from the project base at Munda. The walk to the plantation was uphill along a muddy track. The project team purchased two wheelbarrows to help carry food, water and fuel, which meant two people with ropes pulling each barrow and one person keeping it balanced. The difficulty of access and time lost each day getting to and from site was one factor in making this operation very slow. The difficulty of working in a cyclone damaged plantation was another slowing factor. The Saika trial showed clearly that a chainsaw mill, while simple and accurate to use, was too slow to achieve a commercial level of productivity.

After some research, it was decided to use a bandsaw mill. The Woodmizer LT10 was chosen for the next trial. The LT10 was the smallest and lightest in the Woodmizer range and was competitively priced. There are other similar bandsaws available, and the choice of the Woodmizer is not an endorsement of one model over another. With a weight in excess of 400 kg, moving the bandsaw to less accessible plantations restricted operations to plantations that were close to, or at, the water's edge.

Madali community, having also suffered cyclone damage to their plantations, was chosen as the next venue. The bandsaw was established away from the chaos of the plantation, and the project commissioned a log arch to be made at Griffith University that could be dismantled for transport. This aided movement of the logs considerably. The milling proved much faster with the bandsaw, but operations at Madali were still too slow to be commercially viable. Ten cubic meters of sawn timber took four months to process. The main points that emerged from this trial were:

- Lack of control over which trees were milled (due to salvage) meant that too many trees were of poor quality and form.

- The trip to Rendova island took 30–45 minutes each way, depending on weather and tide. Rendova was across open water from Munda and the seas become quite rough in the afternoons, so the tide dictated which crossing could be taken through the reef.
- There were disputes over the royalties due to the landowner. The Madali community is predominantly of Malaitan origin and rent their land from the landowners. The Landowners demanded a percentage of the value of the timber from the community. Work at the community was stopped for a month until the dispute was resolved.

One of the problems identified during the first use of the bandsaw was getting the sizing accurate. The mill is American and the scale used for sizing the logs in imperial measure. It proved impossible to train operators to accurately deduct the size required from the scale. For example, the first cut may have left the log height at 11¾ inches and the size of the cut 2 ¼ inches. The log then had to be cut at a height of 9 ½ inches. Changing the scale to metric did not really improve the process. Eventually a system was devised using magnetised plastic (similar to a fridge magnet) cut to the correct size and put in place after the cut. The head was lowered so the pointer went from the bottom of the plastic guide to the top. The head was then locked in place and the correct size cut was made.

Based on the reliability of the mill, its running costs and accuracy and the relative ease of transport, the project conclusion was that a bandsaw mill was an appropriate choice for Solomon Islands. As the accessible sites become fewer, future operations will have to take into account some mechanisation for getting equipment in and timber out of the sites. This lies beyond the scope of this project but has been covered in the recommendations. See:

- FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands (Appendix 5)

7.1.2 Communities/ Sites

Subsequent communities in the project were not cyclone-impacted, therefore the trees were selected and felled by the project team. It became clear that the forestry officers who operated the chainsaws had been self-taught, as felled trees were becoming entangled with standing trees or were falling in the wrong direction. A trainer was brought over from Australia, and the trainer spent a week working with the teams as groups and individually. The people who would be allowed to operate the chainsaw to fell the trees were chosen at the end of the week, and from then they worked in pairs. The use of wedges was introduced, and the felling improved dramatically.

One lesson was that each site provided unique challenges, and some situations would be best avoided. Some of the problems the project encountered were:

- Sometimes there was a lack of social cohesion between community members, In Nusa Hopei, for example, everyone wanted to be part of the trial, however no one was prepared to assist when it came to taking trees from different areas, and the project stopped felling.
- Disputes over payments for labouring featured in three instances. Due to the small size of the project team, resource owners agreed to provide three labourers each day to assist in the operation. The agreement was later amended to state that if they could not provide labour, the project would hire labour and charge the owner by deducting the cost from the amount paid for the timber. Both approaches caused problems, either disputes over how much should be deducted or distrust that the resource owner would pay for the labour. In the business case at

Appendix 3, we have attempted to overcome these problems by removing the requirement for resource owners to provide labour and costing the provision of labour into the budget overheads.

- Some of the sites chosen were unsuitable. Site choices should take into account the following issues:
    - Sites distant from an embarkation point require too much effort to get mill and tools in and timber out. This is especially true where equipment such as cant hooks, ropes and winch and food and fuel have to be taken on site daily.
    - Unless the work team is prepared to camp out during the week, sites too distant from the project base, ie that require more than a total travel time of 90 minutes per day, are uneconomical.
    - Some sites have insufficient suitable trees. The team needs to mill 2 m^3 per day of timber to move beyond simple cost recovery (see the business case at Appendix 3). This is only feasible when the majority of trees are 40 cm DBH and greater. There should be sufficient trees to mill 10 m^3 of timber, and preferably more.
    - Waterlogged sites present significant challenges, both for moving equipment and timber for timber quality. Waterlogging can cause serious problems that are not apparent from the outside and that can reduce timber recovery by over 50%. It is a recommendation that such sites be avoided.

As a general recommendation, each prospective site should be subjected to a rigorous assessment before any agreement is reached with the resource owner. That assessment should include the following considerations:

- resource ownership, including whether there are any potential disputes regarding the trees and whether these can be resolved before any agreement is signed
- accessibility, including the distance from base and distance from loading point, and whether camping out will be needed during the week
- security of tools and equipment and whether they can be safely left on or near the site, or whether they would need to be moved back to base each day
- quality and quantity of merchantable trees, through then assessment of standing timber and the marking of trees to assist the felling teams
- site conditions, noting that susceptibility to flooding and the waterlogging of soils are important factors.

Objective 1 was not achieved. The results from the trials undertaken by the project clearly showed that small diameter and poor form trees were not commercially viable, the recovery was low and the time taken to process the trees ensured that the mill could not be run at a profit. However, if the objective of obtaining a mill was to assist communities to take maximum benefit from their resource, not to run as a commercial enterprise or to make a profit, then the smaller trees could indeed be utilised and both mills could achieve that goal.

7.2 Value-adding to processed timber through air and solar drying (objective 2)

The initial proposal envisaged a two stage drying process:

- Initial drying would occur onsite with the timber stacked with stickers between each layer and a roof of tarpaulin or timber offcuts to provide shade. This would allow some of the weight of the green timber to be reduced, to ease carrying the boards from the plantation to the water's edge. It would also allow a greater quantity of timber to be loaded onto the small barge on each run.
- The second stage would be at the solar driers that were constructed on the New Georgia mainland at Lokuloku. Two driers were established with an internal capacity of 62.5 m^3 each. One was operated on solely passive airflow, whereas the other had a bank of fans operated through a solar panel and batteries. The idea was to make a comparison between the two to understand if the extra cost was needed.

7.2.1 Initial drying

Initial drying onsite was carried out at the first two sites, mainly due to the extended milling period of several months at each site. The logistical difficulties of moving the timber from the plantation at Saika was also an issue, which was resolved when a truck was acquired that was able to take the timber down an old logging road to a loading point on the opposite side of Kohinggo Island. The effectiveness was difficult to ascertain, because whilst the timber certainly lost some weight, the stresses within the timber induced by cyclone damage caused many of the squares to split and rendered most of the timber unsaleable.

On-site drying did not eventuate for the other communities involved. As part of the agreement reached between resource owner and the project, the timber would be paid for as soon as the timber left the site. It was felt that prepayment may result in an unacceptable level of losses. The pressure for the money was so great that all the other resource owners insisted that the timber be removed as soon as milling ceased, even when that meant they had to carry the green timber on their shoulders to the loading point.

7.2.2 Solar kilns

The solar kilns were designed to be constructed locally from widely available materials. The final design was a simple 5 m by 5 m square with an effective height of 2.5 metres. The roof was made of trusses constructed on the ground and then offered up and braced. The front had bifold doors to allow ease of loading. The entire frame was covered with a commercial greenhouse film sourced from Australia. The frames were constructed by local carpenters and the project team. This was a novel construction approach for Solomon Islanders, with the walls constructed while laid flat and each offered up in one piece. The first kiln took a week to construct, whereas the second took two days.

The design of the kiln evolved over time. Both kilns were initially passive flow with flaps cut into the plastic film at the apex of the gable end walls to allow air to circulate. There were concerns that the temperature was too high, so closing flaps were introduced to the bottom of the side walls to increase air flow. Eventually these were re-sealed and only the upper flap remained.

It was two years before the project was able to install the battery powered fans into the second kiln. The project team tried to source all the materials locally but eventually had to bring the fans and solar panel in from Australia. The batteries were sourced locally. The fans worked perfectly on installation but stopped within days after Dr Palmer, the installer,

returned home. This became a pattern, with the fans never running for more than a few days. The high level of cloud cover in Solomon Islands did not improve the situation.

Dr Palmer worked with the project coordinator to establish a drying trial where test pieces of timber were weighed and then re-weighed on a regular basis to establish the drying curves. Unfortunately, the coordinator was dismissed for theft, which included the theft of the computer that contained the data from the drying trials and the temperature and moisture meters that were installed in the kilns.

While there is no data on drying, both kilns were effective in stabilising the timber and considerably reducing its weight. The purpose of the exercise had never been to dry the timber to a commercial level, indeed that would have been pointless as commercially dried timber has to be sealed within packets in order to retain the required moisture level. The kilns were very successful in both drying and stabilising the timber. The timber was protected from fungal attack and it was widely felt that they kept the timber in the best possible condition for export. The weight of the green timber was such that trying to load 18+ m^3 of green timber into a container would probably have exceeded the capacity of the somewhat ancient side lift transporter to move the container.

While it would clearly be preferable to have the data on drying, there is no doubt that the solar kilns were very effective in achieving the goals for which they were designed. Timber stacking in Solomon Islands can be haphazard at best. The timber is often thrown on the ground outside the yards and when it is stacked, it rarely has stickers between the layers. The driers introduced discipline into the stacking regime by allowing the timber to straighten, kept the timber from damage (and theft) and reduced the weight considerably. A drying kiln introduced into Honiara as part of another development package required gas and electricity to run and held a similar amount to one of the driers at Lokuloku. The driers at Lokuloku cost under AUD $5,000 for the pair, including labour and imported greenhouse film, whereas the drier in Honiara cost in excess of AUD $75,000 and did no better at the job.

7.3 Identifying the social and environmental costs and benefits (objective 3)

Please see the Appendix 6: - Community Impact Section Report

7.4 Improving economic returns (objective 4)

There were no specific factors that constrained grower participation in the project (objective 4.1). Indeed, there was a waiting list of people who wanted to have their trees harvested. However, this conceals a much deeper problem that would eventually act as a barrier to grower participation. Most of the growers who were involved in the project had planted their trees over 20 years before and most had been disillusioned by the lack of market access. It has been reported back to the project from interviews undertaken by the social research teams that many would not re-plant and simply want the land cleared. There is also the problem of remnant trees. In most cases at least 70% of the trees within the plantations visited were left standing because they were of insufficient girth or the form was too poor for the project team to process. The team had discovered previously that the trees do not respond to late age thinning, which means that the growers are stuck with a plantation of unsellable trees and without the capacity to clear the land or find a use for the standing timber. This eventually acts as a barrier to a sustainable forest industry.

There are many impediments to the flow of material when operations are carried out away from the limited infrastructure associated with the two ports at Honiara and Noro (objective 4.2). The flow of material has challenges at every stage of the operation:

- Distance from the plantation to water, the quality of the tracks to be negotiated and lack of transport or any means of moving heavy timber all impact the flow of material to the sawmill, regardless of whether the mill is placed within the community or located at Lokuloku.
- The movement of material around the site is labour-intensive and time-consuming. Round logs are stacked off the ground close to the mill, therefore each has to be moved from the place where it was felled to the log pond. Originally this was done with straps but the use of the log arch has greatly improved the situation. The capstan winch is also used in stacking and in hauling logs out of situations where the log arch cannot be used.
- The grade of logs processed has considerable impact on the speed of processing. The project placed a limit on the processing of logs with a mid-point diameter less than 25 cm over bark because this size would yield two planks at 150mm x 50 mm, the minimum size acceptable for export. Even this guideline is under review, as to attain sufficient speed of operation the project has concluded that a 40 cm mid-point diameter is the minimum that should be milled. The problem is that this would exclude 90% of the plantation trees.
- Movement of timber from the villages to Lokuloku is currently dependent on the availability of the only landing craft type of boat that operates locally. In areas where the loading point is shallow, such as along some of the rivers, the timber has to be transhipped from smaller boats, increasing time and expense.

Transport logistics (objective 4.3) play a major role in the viability/profitability of any exercise involving smallholder timber. All equipment has to be moved to the plantation and all of the timber moved to the port. In areas that are within the road infrastructure of either of the main ports this is relatively straightforward. For everybody else, in the vast majority of instances, transport is by water and distance to the port becomes critical. The project has based the milling activities in Roviana and Vonavona lagoons and on the island of Rendova within a 20 km radius of the driers at Lokuloku and within a 30 km radius of Port Noro.

Day-to-day transport involved a 23 foot fibreglass open boat with a 60 hp outboard motor. This is the most common configuration seen around the islands and can be regarded as the workhorse of the rural areas. This boat is used to transport tools, equipment and workforce to and from the plantations, which limits the size and type of equipment that can be used.

A small landing craft style barge with approximately 3 m^3 capacity, depending on weight, is used to transport the bulk sawn timber. The cost is SBD $1,500 per day plus petrol. The craft is underpowered and can only make trips outside the lagoons in calm weather. The slowness and lack of deep-water stability has an impact on the quantity of timber that can be transported, and on overall cost and reliability.

KFPL tried collecting timber from other islands using its tugboat. While this was only marginally cost effective, if at all, it does show that with the correct help from outside, growers can access markets for their teak.

See:

FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands (Appendix 4)

7.4.1 Markets and market requirements

There is a world-wide appetite for teak that has not diminished through the global financial crisis to the present day. The market is predominantly in round logs, with the price highly dependent on size. There is a limited supply of timber cut into squares. These markets depend upon volume and a sophisticated supply chain. This was never going to be a suitable market for smallholder teak in Solomon Islands, although KFPL did manage to include smallholder teak thinnings into their shipments. These thinnings were all sourced from Kolombangara out-growers and utilised the machinery to harvest, snig and transport the timber to the loading area. The inclusion of this timber into a shipment was negotiated by the KFPL management team.

For all other growers in Solomon Islands there needs to be a different approach. Growers in areas of Guadalcanal have road access to Honiara, the major port. Most timber exporters are based in Honiara and have an active programme for buying timber at the yard gate from growers or middlemen. These timbers are often ripped by chainsaw. The ripping is freehand with highly variable sizes but these are normally squares or billets that the yard rips down to standard sizing. This timber is also used for the domestic market in and around Honiara with a limited amount of value-adding such as moulding taking place.

Western Province has access to Port Noro, but with a very limited road network, this access only directly benefits those growers fortunate enough to have land adjacent to a road. Even then, the movement of round logs is difficult and there are no timber merchants involved with shipping round logs out of Port Noro. There was a sawn timber export operation, but this has closed.

The project was faced with having to find a market for small and mainly intermittent quantities of sawn teak, delivered by the container load. The Asian and Indian markets were considered too risky with a high chance of non-payment or greatly reduced rates once the payment had been received. The project team therefore decided to concentrate on potential buyers in Australia and New Zealand. Craig Johns and Tim Blumfield spent a week in Brisbane visiting potential buyers in Brisbane who had been identified and contacted by Craig Johns. It became obvious that the once thriving outdoor furniture industry had succumbed to cheaper foreign imports and the manufacturing base in Brisbane was nearly non-existent. The one remaining company expressed interest but would only take 3 m^3, which is a non-viable amount.

A second trip to Auckland was more promising, with some interest shown by manufacturers and wood yards. The stand-out was South Pacific Timber in Auckland, which was owned by Chris Vincent. Chris Vincent followed up by visiting Solomon Islands

and spending a week looking at the various aspects of the operation. It was later agreed to send a trial shipment of one container to Auckland so that South Pacific Timber could gauge interest from its buyers.

The project has shipped approximately 45 m^3 of sawn timber to Auckland. There has been a reasonable level of interest reported by Chris Vincent, considering that the second shipment arrived in the middle of the first COVID-19 shutdown.

7.4.2 Business model and private sector partners

Taking into account the slow operation of the mill and therefore supply of timber, it was decided to stay with the one purchaser, South Pacific Timber, and rely on the owner, Chris Vincent's, knowledge of local markets and understanding of the practical problems in selling timber out of Solomon Islands. During a subsequent visit to Auckland, Craig Johns and Tim Blumfield accompanied Chris Vincent to meet potential suppliers and leave them samples of the teak. It was later agreed to trial different configurations of timber. The project had mainly supplied 55mmm thick boards previously, and would include 150 mm square posts in the next shipment.

7.4.3 End products

The majority of timber required is 50 mm boards of varying widths. These can be broken down into the most commonly used sizes. As South Pacific Timbers continues to develop the market for teak, it will be possible to tailor the timber sizing to suit. The top end of the market is for quarter sawn timber, but the size of the logs is such that very little of this can be produced. Current discussions range around shipping flitches from debarked logs or squares. This would require reprocessing in New Zealand and would therefore affect the price.

7.4.4 Costed model

A breakdown of costs associated with this model of small scale processing has been prepared.

- FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)

7.4.5 Role of government policy

The role of the Solomon Islands Government in encouraging and developing markets for small-holder teak is discussed in Appendix 4:

- FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands (Appendix 4)

7.4.6 Technical manual and business models

See:

- FST/2014/066 Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands (Appendix 1)
- FST/2014/066 Business Case for In-situ Processing of Smallholder Timber in Western Province, Solomon Islands (Appendix 3)

7.5 Post-thinning or harvesting silvicultural management of community teak plantations (objective 5)

Previous work carried out under FST/2007/020 demonstrated that there was no late age thinning response in the teak plantations. In general, teak plantations in a high growth environment such as Solomon Islands are in suppression within 5 years of planting, most of the Solomon Islands teak plantations are now 20+ years since establishment and there is little chance of any significant release or response to suppression.

In all of the plantations in which we worked, with the exception of cyclone damaged Madali and Saika,, at least 70% of the trees remained standing once the merchantable stems had been harvested. In each case the team sat down with the owner and discussed the best option for dealing with the remnant trees. The choices facing growers are stark: harvest to waste and re-plant, or do nothing. The project has made the recommendation in the report on milling (Appendix 1) that the Ministry of Forestry Research consider ways to assist growers to deal with remnant trees. These ways may include:

- use of the remnant trees as a biofuel source
- the production of biochar
- the development of a domestic market.

7.5.1 The establishment of plots to measure the effect of thinning

This exercise was not undertaken due to the nature of the harvest operations, which effectively thinned from the top down and did so randomly throughout the plantations. In most cases at least 60–70% of the standing trees remained after harvesting, with a high proportion of undersize trees and trees with poor form.

7.5.2 Re-establishment through coppicing

This part of the project did not eventuate for the same reason as above, that the stands were not clear-felled. In discussion with the Research Project Manager, the project team agreed that the cost of establishing trials outweighed the benefits and this was dropped as an objective.

7.5.3 Mixed species plantings

This exercise required either clear-felling or the establishment of new areas where there was a desire by the landowner to re-plant. None of the landowners who were dealt with by the project team have cleared the remaining trees from their land. Remnant trees will discourage further planting by growers.

The trial plots from previous projects continue to be maintained and measured.

8 Impacts

8.1 Scientific impacts – now and in 5 years

This project was less about scientific impacts and more about the overcoming the obstacles that growers face in accessing markets and improving their standard of living through smallholder forestry.. However, the loss of the drying data further reduced the scientific impacts.

8.2 Capacity impacts – now and in 5 years

The team at Munda Forestry has been the main beneficiary of the capacity impacts of this project.

The project provided training in the:

- setup, maintenance and operation of a chainsaw frame mill, including use of different options for sharpening chains
- operation of a capstan winch, including the theory and usage of block and tackle equipment to provide a mechanical advantage in forestry operations
- use of a chainsaw in felling operations, with an emphasis on safe directional felling of trees
- setup, maintenance and operation of a portable horizontal bandsaw
- use of a diamond wheel bandsaw blade sharpener
- instruction in the correct stacking of solar kilns.

This group could form the kernel of a training unit to help communities establish their own milling operations and for training other provincial forestry officers in the skills required to harvest trees and operate mills.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

In the rural areas in which this project has operated, 80% of the population are rural subsistence farmers who, even if they can access work, are often paid the minimum wage of SBD $8 per hour. This is less than AUD $10 per day. The low income of rural subsistence farmers exposes growers to unscrupulous dealers who take advantage of their financial desperation. Rural communities have to find school fees and hospital fees from incomes usually derived from selling excess produce on the local markets.

Each grower involved in the project was paid SBD $1,500 per cubic metre of sawn timber that the project took from their property. At an average of 6 m^3 per smallholder or SBD $9,000, this represents a significant influx of money to some of the poorest people in the country. While this impact was very limited, and it was only possible to work with a small number of communities, it is still significant.

The project has exported approximately 45 m^3 of timber to New Zealand and has paid communities and individuals around SBD $80,000 for the timber. The project has also employed casual staff as labourers on the project

8.3.2 Social impacts

Please see Appendix 6, - Community Impact Section Report

8.3.3 Environmental impacts

The use of timber is integral to many aspects of rural Solomon Islands life: housing, transport, furniture, fencing and traditional pursuits such as carving. Allied with the still enormous logging activity within the country, the pressure on the timber resource is unrelenting. The project works to demonstrate the values of good silvicultural management for plantations, but also demonstrates how to regenerate logged forest through simple cost-effective techniques that are available to all. The demonstration sites that this project has established have attracted a lot of attention from local communities. The project team is now having a conversation with the FAO Integrated Forest Management team based in Honiara with regard to their taking over and expanding the trials as a training resource for developing similar ideas in other provinces.

This project is based on plantation forestry and has always operated in established plantations where the environmental impact has already taken place. Unlike the native forest logging operations throughout Solomon Islands, this project's operations are undertaken with minimum disturbance to the local environment with due care being taken near watercourses and rivers. The project activities do not generate sediment load into the lagoon or significantly disrupt local fauna.

8.4 Communication and dissemination activities

The project leader attends the Western Province Network for Sustainable Environment when possible. Activities have included presenting on the principles underlying the project and the longer term potential for developing a sustainable teak growing industry within Solomon Islands.

In September 2018, the two Japanese International Cooperation Association (JICA) coordinators were given a tour of the field sites at Kolombangara and Vasvasara and a demonstration of the bandsaw milling at Taboca. This led to a permanent invitation to attend the Forestry Sector Technical Working Group that JICA has established in Honiara.

In November 2018, the project hosted a field day for 16 provincial forestry officers from Isabel, Malaita, Makira, Guadalcanal and Western Province. The visit took in the mixed species plantings, the nelder wheel, the agroforestry plot that now includes one of the coffee trials, the natural regeneration trial at Vasvasara, a demonstration of the milling at a village in Vonavona lagoon and a visit to the solar driers at Lokuloku.

The project leader attended the Forestry Sector Technical Working Group in Honiara and gave a presentation on project activities.

The project has been featured in one of the Solomon Island leading newspapers following a visit from the Minister of Forestry Research to the project activities. The Minister visited the site of the milling operation and watched a demonstration of the machinery. He also visited the teak and coffee trial plots on Kolombangara and the natural regeneration trial at Vasvasara.

https://www.solomonstarnews.com/index.php/news/national/item/21679-forest-minister-graces-local-farmers

July also saw a visit from three officers from the FAO Integrated Forest Management project. These officers spent two days looking at the various research sites and expressed a desire to see many of the project initiatives established on a country-wide basis.

The project activities have generated significant interest in the local area with the so-called Coconut Telegraph spreading word of the project activities widely. This is a very important development, as there have been a lot of negative activities around local teak plantations. In particular, a company has started logging teak along the Noro Road and loading the round logs into containers. While this sounds positive, the growers have not been paid and have not been told what price their timber will fetch. The company involved did not properly research the market before commencing activities, and the likelihood is that the growers will receive nothing for their timber. This joins a long, sad history of shattered hopes for growers. The story of our project, with growers being paid well for their timber, is an antidote to this history and gives growers and the community hope that it is possible to have a sustainable plantation industry based on smallholder grown teak.

A video of project activities has been produced and will be on both ACIAR and Griffith University websites.

The project has its own website: https://sites.google.com/site/solomonislandsagroforestry/

9 Conclusions and recommendations

It can be seen from the six project objectives, including the 40 sub-objectives, that this project was far too ambitious in scope, especially given the fact that Solomon Islands does not have a viable forestry research organisation and no effective partners or co-workers were involved in the implementation.

ACIAR forestry projects in Solomon Islands have always relied upon the goodwill and active participation of the Munda forestry officers, but through death, chronic illness and retirement the effective staff have been reduced from 10 to five. Meantime, the workload has remained the same or increased.

Two of the in-country coordinators left, one for higher study and one to take up a permanent position in a government ministry, and one coordinator was dismissed for misappropriation and theft. These staff movements have disturbed the continuity of the project.

9.1 Conclusions

Downstream or onsite processing still remains the only viable outlet for smallholder timber away from the infrastructure associated with the ports at Honiara and Noro. To achieve a significant level of onsite processing will require the direct and committed intervention of the Solomon Island Government, though the Ministry of Forestry Research. This intervention would have to address all of the issues that face growers, from the cost of providing the equipment, training in the correct use and maintenance of the equipment and the provision of transport to move timber to the port.

The bandsaw mill has proven effective and appropriate to the Solomon Islands situation, though there are hard decisions to be made if the processing is to be run on a commercial basis. This in turn will have an impact on growers who mostly have over-stocked plantations, with up to 70% of the trees not suitable for milling for profit.

Solomon Islands is ideally suited to growing high value trees such as teak, yet it depends on the exploitative logging of the natural forest. Eighty per cent of the population live in rural poverty as subsistence farmers, yet they have the land and natural advantage of climate and soils to lift themselves out of subsistence and make a real contribution to the development of the country through sustainable forestry.

9.2 Recommendations

The project has produced some recommendations for the Solomon Islands Government regarding the stated government objective of encouraging downstream processing of timber in Solomon Islands. These can be found in the report:

- FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands (Appendix 4).

In summary, the project recommends:

- That the Solomon Islands Ministry of Forestry Research invests in the equipment to provide suitable groups and communities with the capacity to undertake the milling of their own timber. This need not necessarily be just high value, export timbers such as teak or mahogany, as there exists a domestic market for locally grown and milled timber. However, only high value timbers can be considered for export due to the costs associated with export.

- Training will need to be given along the spectrum of operations involved in processing, in particular chainsaw operation, mill operation, manual handling and timber stacking and drying. This can be managed through either the Solomon Islands National University or the Solomon Islands Vocational and Rural Training Centres.
- Issues surrounding transportation need to be resolved, with particular emphasis on accessing more remote plantations, establishing provincial timber holding areas and establishing port containerisation facilities at Honiara and Port Noro.
- The issue of remnant trees needs to be dealt with, as they will be a continuing hurdle to the development of a sustainable timber industry. Growers need help to clear-fell their trees and to do something useful with the timber. One possibility is for the government to assemble milling teams with the sole aim of converting remnant trees into posts and boards for community use or for domestic markets. The requirements for export are high, but many of the boards rejected for export have proven to be useful in a domestic setting.

10 References

10.1 References cited in report

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10.2 List of publications produced by project

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11 Appendixes

11.1 Appendix 1

FST/2014/066 - Report on Milling and Processing of Smallholder Timber in Western Province of Solomon Islands

11.2 Appendix 2

FST/2014/066 - On-Site Band Saw Operational Guide for In-situ Processing of Smallholder Teak in Western Province, Solomon Islands

11.3 Appendix 3

FST/2014/066 - Business Case for In-situ Processing of Smallholder Teak in Western Province, Solomon Islands

11.4 Appendix 4

FST/2014/066 - Recommendations on the role of government policy in supporting the development of market opportunities for smallholder grown timber in Solomon Islands

11.5 Appendix 5

FST/2014/066 - Report on protocols to facilitate compliance with timber import legislation

11.6 Appendix 6

FST/2014/066 – - Community Impact Section Report