

Nutrition of tropical hardwood species in plantations in the south-western Pacific (FST/1996/085)

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Collaborating organisations	Ministry of Agriculture, Sugar and Land Resettlement (MASLR), Fiji; Ministry of Agriculture, Forests, Fisheries and Meteorology (MAFFM), Samoa; Kolombangara Forest Products Ltd (KFPL), Solomon Islands
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Related projects	FST/1994/025, FST/1995/103, FST/1995/106, FST/1996/05
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Duration of project	1 January 1998 to 31 December 2000, extension 1 January 2001 to 30 June 2002
Total ACIAR funding	\$848,586
Project objectives	<ul style="list-style-type: none">■ Species nutritional requirements and criteria for detection of deficiencies■ Fertiliser strategies■ Nutrient removal during harvesting■ Training■ Extension
Location of project activities	South Pacific and Papua New Guinea

Overview

Production of sawlogs and other timber products is a major contributor to the export earnings of many of the larger Pacific island nations. Most of this timber is still harvested from natural forests, and there are significant questions as to the environmental and social sustainability of these activities and to the value and fairness of benefits received by local communities.

Plantations of tropical timber trees offer an attractive alternative to natural forest harvesting because of the potential for much greater long-term benefits to the local economy and communities. At a time when a number of commercial plantation projects were being established by government and private enterprise in the region, this ACIAR project was developed to provide scientific support relating to the nutritional aspects of establishment and sustainability of plantation trees, and to build research capacity in local staff.

The primary collaborator in the project was Kolombangara Forest Products Ltd (KFPL), a joint venture between the Commonwealth Development Corporation (CDC), the Investment Corporation of Solomon Islands and the traditional landholders. KFPL was selected because it was a leader in the development of forest plantations in the region, and had a strong commitment of staff and resources to the research and extension activities that were underpinning its plantation establishment and harvesting operations.

Improved plantation establishment methods that were developed during the project are now incorporated into routine operations of the company. Initial work in the project identifying nutrient and water issues associated with sustainability of production from these plantations contributed to Forest Stewardship Council certification of the company's operations from 2002. The benefits of this 'green labelling' continue to flow to the company in terms of premium pricing and market access in Europe.

Benefits of the research to the local community arise through direct and indirect employment associated with the company's operations, royalties and lease payments to traditional landholders, and reduced environmental impacts. Spillover benefits of this technology to other plantation companies and smallholder growers are less clear due to structural problems in the forestry sector in many parts of the region; limited availability of resources to scientific and technical staff in other private and government forestry organisations; and a high level of political and social instability in many parts of the region, which limits the confidence of private sector investors in relatively long-term activities like plantation forestry.

Project achievements

The project had significant achievements in four areas:

- identifying the previously unrecognised extent and severity of nutrient limitations to productivity of timber plantations in much of the region
- providing novel and cost-effective solutions to improve establishment of plantation trees
- contributing to Forest Stewardship Council certification of the KFPL plantations by identifying and quantifying nutrient budgets associated with the continuing sustainability of these plantings
- enhancing the capacity and skills of researchers from a number of countries throughout the region.

The project identified that deficiencies of one or more nutrients were widespread. This affected the establishment and productivity of fast-growing tree species at a wide range of sites suitable for timber plantations in Solomon Islands, Fiji and Samoa. The extent and severity of these limitations on productivity in these areas had not been recognised previously. In response, a simple, robust framework for identifying the likelihood and severity of occurrence of specific nutrient deficiencies was developed for use in assessing likely problems that could occur on sites on similar soil types and parent materials throughout the region.

To address the major nutritional problems that had been identified, the project developed novel and cost-effective methods to improve the quality and health of nursery stock available for planting, and more effectively deliver nutrients within the root zone of planted stock during the critical early phases of their establishment in the field. Planting stock produced using the new practices had superior survival (>90%) and higher growth rates in the crucial first 9 months after planting out into the field. This superior performance reduced maintenance and weeding costs and eliminated the need for broadcast fertiliser to be applied during the first 12 months of plantation establishment. The technology reduced plantation establishment costs for KFPL by approximately US\$30 per ha. In addition, the use of coir as the basis of potting media resulted in the establishment of a new industry, creating income opportunities for women in local villages where coconut husks were previously a waste product of no commercial value.



Clonal *Gmelina arborea* at Kolombangara Forest Products Ltd nursery, Solomon Islands

The project generated estimates of site nutrient budgets for mature plantations at KFPL. This allowed assessments to be made of the net effects of harvesting and other plantation management operations on long-term site nutrient capital. This information contributed to the Forest Stewardship Council independently certifying the compliance of KFPL with best industry sustainability practice. This 'green labelling' of plantation produced timber allows KFPL greater market access and attracts a premium price on their products in Europe.

Capacity building was a fundamental achievement of this project. Research and technical staff from KFPL, the Solomon Islands Forestry Division, the Fiji Department of Forestry and the Samoan Ministry of Agriculture, Fisheries and Forestry were involved in locally appropriate and focused in-house training, together with regional workshops in scientific writing, data analysis and interpretation. One of the Solomon Islands project staff was a recipient of an ACIAR scholarship and completed his PhD studies in Australia in 2005.

The difference the project has made

The project has had a major impact on the day-to-day operations in KFPL's more than 15,000 ha of plantation. It has also increased the level of research skills of staff in other partner countries. The four areas in which the project has made the greatest difference are listed below.

Improved nursery production techniques

The project fundamentally changed the nursery production system used by KFPL. Coir produced from grated, composted coconut husks replaced soil collected in the field as the substrate for the nursery potting medium. This, combined with the careful incorporation of slow-release fertilisers throughout the mix, significantly increased the survival, growth rate and general health of cutting- and seed-grown material. Coir-based potting media are also lighter to transport into the field and adhere better to the root systems of young plants, causing less damage on planting out. Potting media based on coir and slow-release fertilisers were developed for four important plantation species used in the region, namely *Gmelina arborea*, *Tectona grandis* (teak), *Swietenia macrophylla* (mahogany) and *Eucalyptus deglupta*.

As a direct consequence of these improved nursery techniques, KFPL's two nurseries produce better quality planting stock in a shorter time and have increased flexibility in producing the 125,000 clonal *Gmelina arborea* cuttings, 7,000 *Eucalyptus deglupta* seedlings and 3,000 *Tectona grandis* seedlings that are required each month for the company's planting program.

Communities surrounding the KFPL estate have also benefited directly from this technology. It has provided an opportunity to generate additional income (especially for village women) by preparing and selling coir. Coir is made from husks that were previously considered waste from coconut and copra production. KFPL purchases coir from these villagers at SBD50 per 200L coir. In addition, KFPL has increased their capacity to supply planting stock to outgrowers—villagers planting trees on their own land, either as woodlots or using agroforestry concepts. At the time of this adoption study, there are 32 such outgrowers with a total plantation area in excess of 50 ha.

Improved field establishment techniques

Prior to this project, KFPL had been using standard industry practice for applying fertilisers during plantation establishment. These methods involved adding fertilisers to planting holes and broadcasting additional inorganic fertilisers during the first 6 months of planting out. This process is costly and environmentally unsound because of invariably high rates of leaching beyond the root zone. It is also inefficient because of the higher competitive ability of weeds in capturing applied nutrients compared to the establishing trees, and difficult to manage operationally.

This project developed a totally different approach to delivery of nutrients to plants during the critical first 9 months of establishment in the field. The approach involved incorporating long-term slow-release nutrients (9–12 month release time) in the coir potting medium used in the nursery, and completely eliminated the need for any fertiliser to be applied in the field during plantation establishment. The slow-release fertiliser used was in addition to shorter release-time fertiliser that was required for good growth and productivity in the nursery. The method worked because it provided a more targeted delivery, becoming available in the immediate proximity of the roots of the establishing plants. KFPL adopted this method as routine practice in all its plantings in 2002, and it continues to be part of their routine nursery operations. The benefits of this more targeted method of delivering nutrients to the establishing trees are increased survival and growth rates following planting out, earlier canopy closure (with consequent savings in weed management treatments) and elimination of the need for field-applied fertiliser early in the life of the plantation. The cost savings to the company from adopting this approach have been estimated at US\$30 per ha of new plantation established.

More sustainable timber production practices

The ability to maintain long-term timber production with minimal environmental impact is an important aspect of sustainability for both timber producers and timber buyers. Increasingly, access to key markets in Europe and elsewhere is dependent on demonstrating sustainability, and this has given rise to a number of schemes for independent certification or ‘green labelling’ of sustainably produced timber products. KFPL recognised this market opportunity and applied for Forest Stewardship Council certification for its products.

This project contributed technical information that was critical to an important component of the certification process associated with assessing impacts of plantation activities on site nutrient capital, and implementing management practices to minimise these impacts. The research produced estimates of site nutrient budgets and tracked the amount of nutrient lost from the site during harvesting operations through log removal, erosion and leaching. Because of its high content in wood and bark, calcium was found to be the nutrient most critically affected by harvesting. From this data recommendations were produced for management of harvest residues, on-site debarking of logs and long-term fertiliser inputs to overcome this problem.

The Forest Stewardship Council certified KFPL’s operations in 1997.

Better trained staff

Over the course of the project, participants from Solomon Islands, Fiji and Samoa received focused, in-house training relevant to their particular roles in the project. For example, KFPL staff gained knowledge and skills of methods and techniques to diagnose specific nutrient deficiencies and work out ways to improve nutrition of plantation species. They also learned approaches to estimate site nutrient budgets.

In addition, project participants were involved in a series of regional workshops that improved their skills in scientific writing, and in experimental design and data analysis and interpretation.

Project impacts

Impacts on KFPL and the community

Forestry projects focusing on generating export income differ significantly from those in much of the agricultural sector. The timeframes for return and the scale of operations required to be internationally competitive invariably require a company to invest in and manage the forestry process. Thus, impacts on the community will generally flow from the impacts on the company's operations and its level of adoption of new technologies. In these situations benefits to the community are derived from:

- improved direct and indirect employment opportunities associated with the company's operations
- payments to traditional landholders for long-term lease of land
- royalties and dividends on product sales paid to shareholders and government
- improved environmental quality associated with more sustainable management practices.

This project had a range of impacts on KFPL's operations, which in turn benefited the community.

The improved nursery production system developed in this project directly reduced operating costs for the company's two nurseries. At the same time it increased their annual production capacity, reduced environmental damage by eliminating the need to collect soil for potting media from surrounding forest areas, and created a new industry (producing coir) that was of special benefit to women in local villages.

The improved field establishment techniques markedly increased survival and growth rate of planted stock, resulting in earlier canopy closure and reduced need for weed control. These techniques also eliminated the need for field-applied fertiliser. Adoption of these establishment techniques had both financial (higher plantation productivity for reduced costs) and environmental (no leaching of broadcast applied fertilisers) benefits.

The identification and adoption of more sustainable plantation management practices in relation to nutrients contributed to KFPL being granted Forest Stewardship Council certification. Benefits of this 'green label' certification for KFPL include increased market accessibility and premium pricing for products in Europe. For the community the additional benefits in the adoption of more sustainable harvesting practices were reduced rates of erosion and of nutrient loss into streams and waterways.

Spillover benefits of this research to rural communities in other forest plantation areas are less clear. Many of the technical innovations made by KFPL in this project do not appear to have been adopted elsewhere despite the project involving researchers from government agencies within Solomon Islands and from other countries in the region. For example, a recent community forestry project in Solomon Islands supported by international donors has taken no account of the potential of the improved nursery production system developed at KFPL to benefit smallholder growers. This perhaps reflects a problem in lack of coordination in the aid area. New projects are often initiated in ignorance of previous activities, new consultants are brought in from outside, and ‘corporate memory’ is lacking in government and other local agencies due to the small critical mass and relatively high turnover of within-country technical experts.

Capacity building and scientific impacts

The project resulted in a discernable increase in knowledge, skill and confidence of staff that were involved from the participating partners. Many of the staff have moved to other organisations or into management positions in government agencies. One project participant from Solomon Islands was awarded an ACIAR Fellowship and completed a PhD at James Cook University in Cairns in 2005. Since completing his studies, this former student has established a private consultancy firm in Solomon Islands providing technical advice in agriculture, forestry, agroforestry and environmental issues for the South Pacific region. He is



Eucalyptus deglupta in root trainers filled with a mixture of coir and slow-release fertiliser at Kolombangara Forest Products Ltd, Solomon Islands

currently collaborating with the National Agriculture Research Institute (NARI) of Papua New Guinea on the domestication and commercialisation of *Canarium indicum*, and running in parallel a similar but smaller project in collaboration with the Solomon Islands College of Higher Education and the Department of Agriculture and Livestock in Solomon Islands.

This project generated a number of significant scientific impacts. Rapid diagnostic tests for nitrate and phosphate sufficiency using cheap and readily available test strips were found suitable for use in nursery stock and field plants. Visual symptoms of nutrient deficiency were described and photographed in a number of species and compiled in a book published by ACIAR. A number of invited book chapters and publications in scientific journals also resulted from this project. Regular articles highlighting key research findings were published in the regional Forests and Trees newsletter published by the South Pacific Commission. Oral and poster presentations by project participants were made at a number of national and international conferences.