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Australian Centre for International Agricultural Research

Final report

Small research and development activity

project	**Developing a DNA chain of custody method to verify legally sourced teak in Indonesia and Myanmar**
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1 Acknowledgments

The authors would like to thank the ACIAR for its generous support of this project; staff and students at the University of Adelaide, Double Helix Tracking Technologies, Ecosystem Conservation and Community Development Initiative in Myanmar and FOERDIA in Indonesia for their hard work, enthusiasm and support for the project; and participants of the workshop for their engagement with the project.

2 Executive summary

Teak is one of the most commercially important timbers in the world, and its duarable and and water resistance wood is used for boat building, exterior construction, veneer, carving, turnings, and for furniture manufacture.

Australia is committed to working in partnerships with supplier countries to reduce the trade in illegal timber into Australia for the economic benefit of supplier countries and to improve environmental outcomes globally.

This project aimed to develop the application of DNA markers to verify legal sourcing of teak for supply chains in Indonesia and Myanmar. Building on an earlier Proof of Concept project to develop the markers, this second stage is a larger body of research and development that undertook the reseach necessary for the adoption of this technology in Indonesia plantaion forests and Myanmar natural forests.

Using these markers, our objective was to work with regional producer governments, industry and communities to implement a framework for verifying the chain of custody of teak exports using DNA. Such a system can support both efficient value-chains for teak products, including value added products, and a robust chain of custody system. The implementation of these systems, that can verify the source of teak to local areas, will also support the ability of community forestry cooperatives to attract a price premium in the international market.

The project:

- Developed and applied DNA chain of custody verification tests to teak sourced from plantation forests in Indonesia and natural forests in Myanmar;
- A total of 100 samples of teak from Indonesia and 170 from Myanmar were collected and used in the genotyping process;
- Held a regional workshop in Mynmar and consulted with a broad range of stakeholders across the region (Indonesia, Myanmar, Laos, Thailand), including via the RAFT3 platform in collaboration with TNC, to scope a project to develop a broader regional DNA teak source verification tracking method for teak.

The need to obtain certification (Certisource, SVLK and/or FSC) is clearly recognised by teak growers (small-holder farmers, large scale plantation owners and natural forest concessions) to access high-value international markets, and is a situation supported by relevant government departments in Indonesian and Myanmar.

For Indoensia, teak supply chains have relatively high transparency and using the cheaper SVLK certification system as a framework, this project has demonstrated that it is possible to use DNA methods to verify the source origin of teak along the early stages of supply chains (e.g. between saw mill and plantation/farm).

The development of genetic reference data for Myanmar teak populations represents a huge opportunity to safeguard the Myanmar teak brand as well as meet the challenges presented by increasingly regulated consumer markets. By expanding the existing reference data regionally, a comprehensive set of markers can be developed and applied as a tool to scientifically verify the legality and supply chain integrity of teak sourced from plantations and atatural forests.

The close collaboration between the partners of this project has helped to strengthen relationships on a number of strategically important issues relating to forestry such as capacity building; legal requirements; systems that assure legality of timber and wood products but remove barriers to smallholders participating in international timber markets; enhanced forest law enforcement and governance; and the sourcing timber from legal and sustainable forest practices.

3 Introduction

Teak is one of the most commercially important timbers in the world, and its duarable and and water resistant wood is used for boat building, exterior construction, veneer, carving, turnings, and for furniture manufacture.

Australia is committed to working in partnerships with supplier countries to reduce the trade in illegal timber into Australia for the economic benefit of supplier countries and to improve environmental outcomes globally. Australia introduced illegal logging regulation on 30 November 2014, which requires importers of timber products to ensure they are sourced for legal timber harvesting. To support this new regulation, Australia wants to encourage and support increased legal trade between Indonesia and Australia.

DNA markers are being used successfully for other timber species to distinguish between species, between populations and between individuals of timber species (Dormontt et al 2015) . The cost of this technology is dropping dramatically and is already cost effective. In addition the technology is suitable for developing checks of existing chain-of-custody compliance claims, and has already been proven to be effective for other species in other countries (e.g. merbau in Indonesia).

In Indonesia, much of the planted teak is grown by smallholder farmers who have difficulty in meeting international requirements related to legality verification and/or forest certification so mechanisms to support such farmers to reach external markets and improve livelihoods needs to be explored.

In Myanmar, currently almost all teak comes from natural forests. Whilst the forest concession from which teak is log stamped, are often over harvested and where mixing of lots is common practice.

Removing doubt about origin creates certainty for industry and consumers, opens markets for timber and increases taxation revenue for governments in developing countries. It also provides a mechanism for community forestry suppliers to demonstrate sustainability to the global market.

An improved system of chain-of-custody verification is required to sustain forest resources and enable access to the increasing number of high-value markets sensitive to legality issues, including the EU, US, Australia and others. DNA has the potential to provide this verification technology for teak supply chains in Indoaneis and Myanmar.

The ACIAR Forestry Program aims to contribute to poverty alleviation and natural resource conservation and rehabilitation through scientific support for the establishment, management and sustainable utilisation of forests, providing optimum social, economic and environmental benefits to partner countries and Australia. This project contributes to the sustainable management of forests, and efficient and sustainable forest industries.

4 Objectives and Activities

The project aimed to develop the application of DNA markers to verify legal sourcing of teak for supply chains in Indonesia and Myanmar. Building on an earlier Proof of Concept project (FST/2014/028) to develop the markers, this second stage is a larger body of research and development that undertook the reseach necessary for the adoption of this technology in Indonesia plantaion forests and Myanmar natural forests.

Using these markers, our objective was to work with regional producer governments, industry and communities to implement a framework for verifying the chain of custody of teak exports using DNA. Such a system can support both efficient value-chains for teak products, including value added products, and a robust chain of custody system. The implementation of these systems, that can verify the source of teak to local areas, will also support the ability of community forestry cooperatives to attract a price premium in the international market.

This project also examined the viability of a larger program of work that would create a toolkit, processes and framework for verifying the chain-of-custody of high value teak timber that is sourced from Indonesia and other regional producer countries, including potentially Myanmar, India, Thailand and Lao PDR. This larger project was scoped in consultation with The Nature Conservancy (TNC) in order to explore potential opportunities for collaboration with the RAFT3 program.

The close collaboration of our Indonesian and Myanmar partners (Double Helix and FOERDIA) established during the proof of concept project helped strengthen regional relationships on issues relating to:

- Sourcing timber from legal and sustainable forest practices
- Capacity building
- Systems that assure legality of timber and wood products but remove barriers to
- smallholders participating in international timber markets
- Enhance forest law enforcement and governance
- Legal requirements

The activities supported by this project included:

- Developing and applying DNA chain of custody verification tests to teak sourced from community forests in Indonesia and natural forests in Myanmar;
- Consulting with a broad range of stakeholders across the region (Indonesia, Myanmar, Laos, Thailand, India), including via the RAFT3 platform in collaboration with TNC, to scope a project to develop a broader regional DNA teak source verification tracking method for teak, and to establish a legal framework for the integration of this technology into a chain-of-custody systems.
- Preparation of a report that describes the development of DNA markers for teak from Indonesia and Myanmar, the results from the research on application of DNA markers in chain of custody systems for teak, the future research needs and the prospects and benefits which could come from wider application of DNA based timber tracking systems in South East Asia.
- Communication of the research to key stakeholders in the relevant countries.

The implementation of systems that can verify the source of teak support the ability of forestry producers to attract a price premium in the international market.

5 Field sampling, training and DNA analysis

5.1 Field sampling and training

5.1.1 Indonesia

Building on the previous successful ACIAR project (FST/2014/028), where community forestry groups had been consulted on the potential to apply DNA methods to verify integretity of supply chains and support certification (including SVLK and FSC). The group had agreed to perform a trial of the methods within a forest plantation.

FOERDIA orgnaised a field trip betwee 5-6th January 2016 to a teak plantation area owned by Perhutani in Cepu. The aim of the trip is to collect cambium/wood of log and its associated stump for DNA log tracking. In doing so, the chain of custody of the log/wood products derived from the log can be traced back to its origin.

The Perhutani Forest Management Unit at Cepu obtained FSC certificate in 2012. FMU Cepu manages some 33,019 ha, dominated by teak, where annual timber production between 20,000 – 30,000 m3. The movement of logs from harvesting compartment to log yard and the delivery of log is well documented and provided a good test of the methods. All trees in a logging compartment are mapped based on GPS coordinate, and allows felled stumps to be relocated.

The sampling was done by selecting logs that had been recently harvested to ensure that stumps could still be found within the harvesting block. Fortunately, a harvesting trial had just been carried out so finding the related stumps was easy. Using documents available at the log yard, which describe the stump/log identification, length of log, and harvesting block, 25 log were selected for sampling.

Samples of cambium were taken using a puncher, the cambium was then stored in paper envelope and put in a plastic box with silica gel.

Table 1. List of teak samples (cambium and core from log and stump)

No.	Cambium samples from log	Cambium samples from stump
1.	035 J - #27*	035 J - #27*
2.	035 J - #33	035 J - #33
3.	035 J - #38	035 J - #38
4.	035 J - #39	035 J - #39
5.	035 J - #41	035 J - #41
6.	035 J - #44	035 J - #44
7.	035 J - #79	035 J - #79
8.	035 J - #219	035 J - #219
9.	035 J - #220	035 J - #220
10.	035 J - #221	035 J - #221
11.	035 J - #225	035 J - #225
12.	035 J - #250	035 J - #250
13.	035 J - #272	035 J - #272
14.	038 B - #3	038 B - #3
15.	038 B - #8	038 B - #8
16.	038 B - #13	038 B - #13
17.	038 B - #73	038 B - #73
18.	038 B - #36	038 B - #36
19.	038 B - #59	038 B - #59
20.	038 B - #77	038 B - #77
21.	035 J - #38*	035 J - #38*
22.	035 J - #41	035 J - #41
23.	035 J - #220	035 J - #220
24.	035 J - #221	035 J - #221
25.	038 B - #59	038 B - #59

General view of the log yard

Marking of the log consists of tree number, cutting number, length of the log, volume and forest district.

The stump

General view of trees ready for harvest – the trees had been girded one year earlier to allow the wood to air drying thus minimizing damage when felled

Border mark

Samples taken from stump

In adition to field plantation samples, leaf samples from a range of provenances grown at FOERDIA in Indonesia, as part of a provenance trial, were sampled including material from Java and Sulawesi (Indonesia), India and Thailand.

5.1.2 Myanmar

Double Helix Tracking Technologies, together with University of Adelaide worked to:

- Identify local partners for field work collaborate and oversee the collection of reference samples required for development of genetic markers.
- With local partner Ecosystem conservation and Community Development initiative (ECCDI) collect samples matching sawn wood and cambium samples from 30 individuals and cambium samples from 10 teak populations totalling a minimum 190 samples.

Collected samples were subject to two different genetic development outputs

- Individual assignment and chain of custody verification proof of concept
- The development of population based DNA markers

ECCDI was approached and contracted as a local on-the-ground partner. ECCDI have the experience and connections required to gain access to teak populations for sample collection. DoubleHelix trained ECCDI staff in sampling according to well established and proven DoubleHelix sampling procedures. These procedures are designed to ensure

- Samples are properly collected and remain in good condition
- Strong sample chain of custody and process documentation is maintained
- Relevant data is recorded in a clear, transparent and well documented way

A document package was generated and customised to facilitate and manage sampling including:

- Sample management system - An excel book which generates all sample identification names and is pre-formatted to show how many of each sample type from each region needs to be collected. Additionally all relevant data for each sample is entered after it is collected.
- Field data collection table - This document was used by the field teams to record all required data for each sample at the time of sampling in the field.
- Field standard operating procedure - A quick field reference standard operating procedure for sampling specifically designed to guide samplers through the sampling process in order to produce samples for the two outputs required.
- Full sampling SOP - A full detail procedural guide describing proper cambium sampling process in exacting detail and with example photographs.

All the necessary equipment for sampling was provided throughout the project. This involved ordering from local and foreign suppliers and arranging logistics for delivery to Yangon including

- Colour indicating silica gel
- 10mm steal hollow punches

ECCDI training participants at field trial

Two remote training sessions with the ECCDI sampling participants via video call were organized. The first session focused on:

- Project outcome overview
- Proper sampling techniques
- Data collections and recording
- Feld logistics
- Sample storage

After the first session the ECCDI team conducted a field trial where samples of each type were collected following the SOPs and using their knowledge from the previous days training. A follow up video call was then held to review the results of the field trail and answer any remaining questions and fill any apparent knowledge gaps. Details of the content of the training sessions are below.

Topic	Description	Outcomes
Training session 1 February 2nd		
Project overview	• Why are we sampling • What kinds of samples • For what purpose • How many samples • From what locations	Understanding of project goals and required outcomes from the sampling exercise
Equipment for sampling	• Review each required piece of equipment • What its purpose is • How to use it • Any required set up prior to use • Alternatives if failure in field occurs	Participants have a solid understanding of all required equipment and their use
Preparation for the field	• What needs to be prepared prior to sampling to ensure smooth operation in the field • Preparing samples bags, ID cards, silica etc.	Participants understand what to prepare prior to field operations to ensure smooth and efficient sampling. Understanding of how to use the sample management system
General Requirements	• Minimum data to collect • Basic sample management rules • Photographing the process	An understanding of general guidelines to follow concerning sample collection.
Cambium sampling	• Review what cambium is • Proper collection procedure using hollow punch and axe if punch fails • Sample size • Data recording • How to use provided sample data sheet	Thorough understanding of cambium sampling procedure, data collection, and data recording. Understanding of all provided documents and how to use them
Sawn wood sampling	• Identifying hardwood • Suitable tree selection • Sample size • Review same procedure for data as cambium	Thorough understanding of sawn wood sampling procedure, data collection, and data recording. Understanding of all provided documents and how to use them
Leaf sampling	• Suitable material • Sample size • Review same procedure for data as cambium	Thorough understanding of leaf sampling procedure, data collection, and data recording. Understanding of all provided documents and how to use them
Sample storage	• Field and long term sample storage requirements • Colour indicating silica use and requirement • Labelling requirements for shipping	Participants know how to store samples properly to maintain DNA integrity and ensure samples pass customs in Australia

Topic	Description	Outcomes
Field trial	• Overview of what to accomplish in the field trial	Ensure useful field trial
Field trial February 3rd		
Trial sample collection	• Collection of one cambium sample set and one sawn wood sample • Sample labelling and storage	Trial application of process learned in session 1 Trial of equipment
Trial data recording	• Record of all relevant data for both samples • Full photographic record of sampling process	Trial use of all recording tools and documentation
Session 2 February 4th		
Field Trial overview	• ECCDI participants prepared a presentation of the field trial experience • All documentation and photographs of the sampling process were presented • Questions from field trial were covered	Specific issues concerning handling of silica and sample size were addressed Participants felt fully prepared to undertake successful sampling independently DoubleHelix was satisfied with the performance in the field trial and was confident in the ECCDI's ability to carry out successful sampling

These samples are required to demonstrate the ability to extract DNA from sawn timber and match it to cambium samples from the same tree in the timber concession mimicking supply chain verification. Analysis will ensure sufficient DNA can be extracted from each type of material to perfrom a genetic matching analysis.

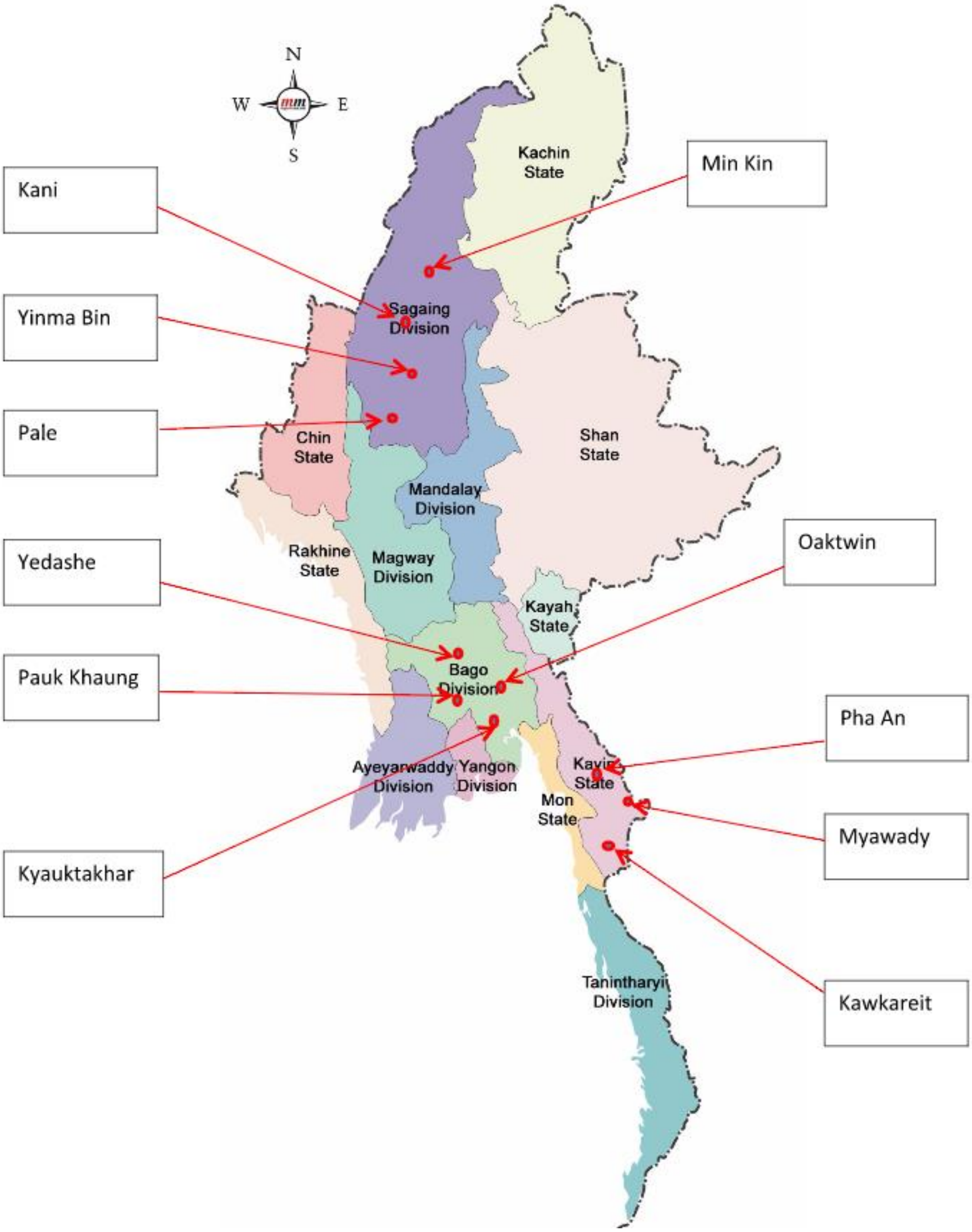
	Task	Planned scope of sampling	Sampling accomplished	Remarks
1.1	Select individual standing teak trees that have developed heartwood in each region	30 individual	33 individuals	Additional trees were selected because of sample quality concerns
1.2	Collect cambium samples and leaf samples from those selected trees	30 cambium and 30 leaf samples	33 cambium and 29 leaf samples	In 4 cases all the leaves had dried and fallen from the tree. No leaves were collected
1.3	These trees are felled and cambium samples are again collected from the felled trees	30 cambium samples	33 cambium samples	
1.4	Sawn wood samples collected from these felled trees	30 sawn wood samples	33 sawn wood samples	
1.5	A total of 90 samples will be	90 total	128 total	

	collected	samples	samples	

The following samples were used to develop population markers for origin claim verification.

	Task	Planned scope of sampling	Sampling accomplished	Remarks
2.1	Collect cambium samples from individual standing teak trees from different populations across Myanmar. Each population should be a minimum of 50 km apart and should cover as broad a geographic area as possible.	10 individuals from 10 different populations	10 individuals sampled from 11 different populations	An additional population was added due to concerns about adequate distance between the original 10 selected populations
2.2	A total of 100 samples will be collected	100 samples	110 cambium samples	

Three ECCDI teams collected a total of 238 samples across 11 different populations over the course of 3 weeks starting February 8th. All samples were inspected by Prof. Andrew Lowe and transported to the University of Adelaide for analysis.



Map of distribution of Myanmar teak populations sampled by ECCDI teams

5.2 DNA analysis

A set of molecular markers (single nucleotide polymorphisms, or SNPs) had been developed as part of a previous ACIAR project (FST/2014/028). These markers were further developed and optimised for broad scale and cost effective screening of teak chain of custody tracking samples using the MassArray system.

Previous work has highlighted that strong genetic structure exists across the range of teak, but that natural populations are highly variable genetically (Volkaert et al 2007; Fofana et al 2009; Verhaegen et al 2010; Lowe & Volkaert 2013; Widyatmoko et al 2013; Win et al 2015). Available marker development methods have progressed very quickly recently, and whilst still involving considerable laboratory work, we are now able to develop molecular markers for non-model organsiations relatively quickly and for non-prohibitive budgets (e.g. Jardine et al 2015).

5.2.1 Sample collation

From Indonesia, paired samples were avaialble from a plantation forest and tracked logs from a saw mill. For this project, 20 trees sampled both in the mill and from remaining stumps were selected to check for integretity of a typical teak supply chain (as outlined in the above section). The trees tracked as part of this work came from a Perum Perhutani plantation, which is an Indonesia State owned forest enterprise responsible for management of the State owned forests in Java. For five trees, a wood core was also taken in the mill and from the stump. Total number of samples = 50.

In addition material from a range of provenances, grown in Indonesia as part of a provenance trial at FOERDIA, were sampled. Leaf samples were taken. Selected samples were used in the current project to assess genetic variability in a range of teak provenances from Java and Sulawesi (Indonesia), India and Thailand. Total number of samples = 50.

Collections of teak from Myanmar forest connessions were made (as detailed in the above section). Samples included leaf, cambium and timber from selected individuals. Total number of samples = 170

Addition teak samples collected from around Myanmar and which formed part of a previous teak scientific publication (Win et al. 2015) were provided by collaborators in Myanmar. Total number of samples = 100

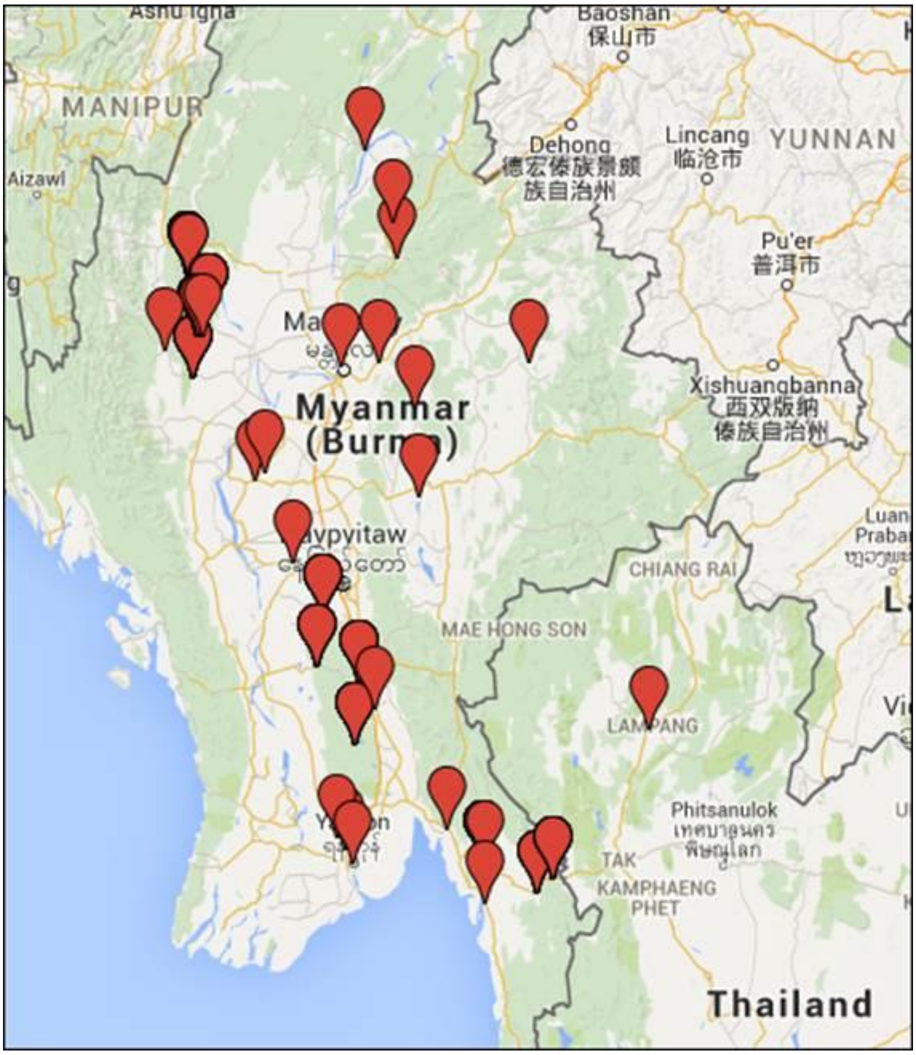
Grand total of samples available for genotyping in this study = 370.

Source	Provenance	Sample type	# Samples
Chain of custody	Indonesia	Cambium from the tree stump	20
		Cambium from the log yard	20
		Wood core from the tree stump	5
		Wood core from the log yard	5
Provenance trial	Java, Indonesia	Leaf	16
	India	Leaf	20
	Sulawesi	Leaf	10
	Thailand	Leaf	4
Myanmar collections	Hpa-an, Myanmar	Cambium	10

	Kani, Myanmar	Leaf	6
		Cambium	13
		Sawn timber	1
	Kawkareit, Myanmar	Cambium	11
	Kayin, Myanmar	Leaf	14
	Kyauk Ta Khar, Myanmar	Cambium	13
	Min Kin, Myanmar	Leaf	5
		Cambium	13
		Sawn timber	1
	Myawaddy, Myanmar	Cambium	11
	Oaktwin, Myanmar	Leaf	3
		Cambium	12
		Sawn timber	1
	Pale, Myanmar	Leaf	4
		Cambium	10
	Pauk Khaung, Myanmar	Cambium	14
	Yedashe, Myanmar	Leaf	2
		Cambium	11
	Yinma Bin, Myanmar	Leaf	4
		Cambium	11
Win samples	Hlawkha, Myanmar	Leaf	5
	Hmawbi, Myanmar	Leaf	5

	Yangon, Myanmar	Leaf	5
	Kyaukpadaung, Myanmar	Leaf	5
	Popa, Myanmar	Leaf	5
	Seitphyu, Myanmar	Leaf	5
	Taungdwingyi, Myanmar	Leaf	5
	Tharzi, Myanmar	Leaf	5
	Gangaw, Myanmar	Leaf	5
	Hteechaik, Myanmar	Leaf	5
	Indaw, Myanmar	Leaf	5
	Katha, Myanmar	Leaf	5
	Pyinoolwin, Myanmar	Leaf	5
	Naungkhio, Myanmar	Leaf	5
	Moemeik, Myanmar	Leaf	5
	Mabein, Myanmar	Leaf	5
	Hpa-an, Myanmar	Leaf	5
	Halinebwe, Myanmar	Leaf	5
	Bilin, Myanmar	Leaf	5
	Mawlamein, Myanmar	Leaf	5
Grand Total			370

Maps of distribution of analysed samples, rangewide (above) and Myanmar detail (below)



5.2.2 DNA analysis

DNA was extracted from samples and putative markers developed as per methods described in the project FST/2014/028. These markers had to be optimised for use on an Agena® MassARRAY® iPLEX™ platform so that they could be used routinely. Raw sequence data of 344 putative SNP loci were used to design multiplex groups, primers were designed for 309 loci, in seven multiplex groups using MassARRAY Assay Designer v4.0.0.2 (Agena®) software. iPLEX™ GOLD chemistry was used for the analysis.

DNA has been successfully extracted from all samples and genotyping via the MassArray platform is completed. Preliminary results from a subset of 95 samples using a single multiplex group showed very positive results with only 2% of samples failing to amplify at any loci. Of 49 loci trialled, successful amplification was found in 32, giving a success rate of 65%. Assuming a similar level of success across all seven multiplexes, we expect to obtain successful amplification in ~200 loci. In our experience this number of loci is ideal for geographic and individual assignments.

The full data analysis of DNA results is still underway and will be published as part of a scientific publication produced from the project.

6 Workshop and Communciations

6.1 Workshop

A workshop entitled, “Securing the supply chain for Teak in Myanmar using DNA” was held in Yangon on the 25th of February. The purpose of this workshop was to bring together a variety of regional stakeholders to discuss the potential for application of DNA markers to aid in controlling and verifying the supply chain of Myanmar teak. Attendees represented the interests of government, industry, and the scientific partners. Each key stakeholder group had a chance to present in order to establish key issues and current developments surrounding Myanmar timber trade, domestic certification schemes, as well how DNA can be applied to timber supply chain verification. An open question and answer format was held after each presentation. See appendix 1 for final participant list and workshop materials.

Presentations summary

1. Overview of teak trade/forest governance issues in Myanmar

Presented by: U Myint Thu, Myanmar Forest's Products Merchant's Federation (MPFMF)

- A general introduction to the history of the Myanmar timber industry
- Overview of recent trends in timber volume and value exports and to what countries
- Overview of the structure of the private sector industry as well as supply chain flows
- Current legal certification and CoC requirements
- Overview of Teak trade volumes, products, values, markets
- Issues facing forest governance

2. Overview of Myanmar Timber Certification Initiative

Presented by: U Barber Cho, Secretary of MFCC

- MTCI aims to ensure certification ensures, sustainable forest management, legality, and chain of custody transparency to link SFM to each sector of the market
- Chain of custody verification is critical to linking SFM and legal logs to market
- Overview of other certification systems EURT LACY FSC PEFC…
- MTCI based on the Malaysian timber certification model
- Structure and current state of the MTCI
- Barriers to Myanmar teak exports
- Limitation of MTCC and operating budget
- Overview of Myanmar's will for strengthened forest governance

3. Using DNA to protect and conserve tropical timber trees

Presented by: Prof. Andrew Lowe, University of Adelaide, Australia

- Overview of forest governance and international demand for sustainable forestry CITES Lacey EUTR
- Governance without enforcement produces no change
- Declining cost of genomic mapping and overview of species currently barcoded
- DNA's ability to verify species, origin, and the application to supply chain control
- Difference and background to DNA barcoding, fingerprinting, and population assignment
- Plan for DNA tracking applied to Myanmar teak
- Project progress/work to date

4. Practical applications of DNA to safeguard timber supply chains around the world

Presented by: Darren Thomas, Executive Director, Double Helix Tracking Technologies Pte Ltd

- State of global timber trade; increasingly complex, producer country regulatory legislation, certification systems, consumer country illegal logging regulations
- DNAs ability to provide traceability through entire supply chain
- DNA verification's application example *Prunus africana Congo Cameroon*
- DNA was used to exclude and identify illegal material from outside legal FMUs.
- This intern can create better supply chain control potential for expanded CITES quotas for export
- DNA application to Big Leaf maple theft in Washington state USA
- Individual assignment DNA markers were used as key evidence in case against theft of high value maple from nation parks
- DNA application to UK white oak product market investigation
- Samples were collected across many products and retailors
- Widespread false claims and species mixing among claimed white oak were found
- DNA verification systems can be used to support existing certification, supply chain control initiatives and expand market access

5. Current genetic structure of Myanmar teak detected by microsatellite markers
Presented by: Dr. Thwe Thwe Win, Assistant Director, Dry Zone Greening Department

- Background characteristics of teak, native range, growing area, Myanmar plantation area
- Genetic diversity and applications of DNA markers including barcoding, population genetics, mapping, breeding, and plantation tree improvement
- Myanmar teak genetic differentiation, overall unclear
- Sampling plan and sample collection for population marker development
- Marker types for development and methods
- Results; chloroplast markers low diversity, Nuclear microsatellite high diversity relatable to region

6.2 Communications

The ECCDI has been an integral partner in the successful completion of the field sampling tasks and organizing and hosting the first project workshop. Their extensive knowledge and network of forestry and government organizations and contacts is an invaluable resource. Their participation contributed greatly to the timely and efficient completion of this phase of the project. The communication and outputs received from ECCDI exceeded expectations. Their continued involvement will be critical to future activities as their governmental and forestry network compliments DoubleHelix's industry based network. ECCDI is well positioned and a capable organization that will be effective in contributing to the implementation of a DNA based verification program. The materials prepared for the workshop were distributed to partners in ajoining coutnries, incldugin Thialand and Laos and to RAFT and TNC.

As demonstrated in this report key factors are in place that would allow for an expansion of the practical and valuable work being conducted in across the reigon. Expansion of the existing project will further support efforts to establish better forestry and supply chain practices, reinforce the FLEGT process and support compliance with the Australian Illegal Logging Prohibition Bill regulatory requirements.

7 Conclusions and recommendations

7.1 Conclusions

The need to obtain certification (Certisource, SVLK and/or FSC) is clearly recognised by teak growers (small-holder farmers, large scale plantation owners and natural forest concessions) to access high-value international markets, and is a situation supported by relevant government departments in Indonesian and Myanmar. However the cost of gaining internationally certification standards (FSC), appers to be a significant financial barrier, particularly for small holder growers.

For Indoensia, teak supply chains have relatively high transparency and using the cheaper SVLK certification system as a framework, this project has demonstrated that it is possible to use DNA methods to verify the source origin of teak along the early stages of supply chains (e.g. between saw mill and plantation/farm). This system is already used in Indonesia to verify supply chains of merbau using DNA integrated into the certification standard Certisource (Lowe et al 2010).

The development of genetic reference data for Myanmar teak populations represents a huge opportunity to safeguard the Myanmar teak brand as well as meet the challenges presented by increasingly regulated consumer markets. By expanding the existing reference data regionally, a comprehensive set of markers can be developed and applied as a tool to scientifically verify the legality and supply chain integrity of teak.

The outcomes of the project also helped to inform the development a proposal for a large integrated project ‘Development and Applications of DNA Markers for Timber Legality Verification and Good Forest Governance in Cambodia, Indonesia, and Myanmar’ which was submitted to the Japan-ASEAN Integration Fund (request $3 Million; for cosupport from ASEAN – Korea, request $100,000; and ASEAN Australia, request $1 Million). During the progress of the project we have also been in close communication with The Nature Conservancy (TNC) and the Australian Government about the development and potential for integration with the new RAFT3 program.

The close collaboration between the partners of this project has helped to strengthen relationships on a number of strategically important issues relating to forestry such as capacity building; legal requirements; systems that assure legality of timber and wood products but remove barriers to smallholders participating in international timber markets; enhanced forest law enforcement and governance; and the sourcing timber from legal and sustainable forest practices.

7.2 Recommendations

Expansion of reference data material and marker development

Continuing to develop the resolution of the reference data to further differentiate and identify populations of Myanmar teak and other regional sources (e.g. Thailand and Laos) creates an extremely valuable tool. This tool can be applied to supporting domestic certification and supply chain control, expanding access to markets pressured by regulation, and protecting the brand of Myanmar teak.

Independent scientific verification has the potential to be the highest standard in chain of custody control. Creating a tool kit able to provide clear supply chain transparency would give Myanmar teak a huge market advantage. Consumer’s looking for material which meets their respective timber regulations (Australian ILPA, US Lacey, EUTR) will view

Myanmar teak as low risk and therefore favorable. Providing the buyer with assurance of legality expands Myanmar's market access.

An analogous example of this can be seen in the DNA verification system currently being applied to the *Prunus africana* market in central Africa. By introducing a tool capable of bringing security and control to the supply chain, producer countries may be able to expand CITES quotas and reduce the risk exposure to European buyers.

As Myanmar continues to develop its own timber certification system and continues FLEGT VPA negotiations, DNA chain of custody can be developed in parallel. At the appropriate time, a ready-made chain of custody supply chain verification system will support improvements in forest governance and enforcement, and position the Myanmar forestry sector as innovative and modernized.

The methods and applicaition case studies now exist to expand DNA verification to other teak natural population and plantation harvest regions (e.g. Thailand, Laos and Pacific regions)

Integration of DNA verification into teak certification and legality schemes

Developing a system to implement the use of DNA verification will support Myanmar's efforts toward legal and sustainable certification. Chain of custody is a critical component of an effective certification scheme identified during the workshop. With the continued development of genetic reference data, DNA could provide a CoC verification element required to support a robust and credible MCTI, and more broadly to other teak producing countries. Additionally the strength of a science backed verification system allows the authorities to monitor the efficacy of certification and empowers them with the ability to enforce legal measures as bad actors are identified.

As we identified in the Yangon workshop a certification or legality system is only as strong as its ability to enforce the standards it promotes. DNA provides a credible and independent method for monitoring and enforcement. Examples of this can be seen in the development of DNA markers to identify big leaf maple theft. Without the ability to demonstrate clear evidence which connected the product in question to the site of the crime there was little ability to enforce the Lacey Act. The following link provides further details surrounding this case http://www.doublehelixtracking.com/news/2016/3/7/plant-dna-evidence-supports-landmark-lacey-act-conviction-of-bigleaf-maple-theft

DNA verified supply chains also help to assure the quality associated with the teak brand. As part of a sustainable Myanmar timber trade, protecting the Myanmar teak "brand" as one of the last sources of natural quality teak will support the growth and reputation of Myanmar teak. Having a robust genetic reference base a system for DNA verification in place domestically protects Myanmar teak from imposter and lesser quality sources claiming the name and "brand" of teak in Myanmar from natural populaitons, and also demonstrate the sustainability of plantation produced teak from Indoneisa and other sources.

8 References

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8.2 List of publications produced by project

The project has produced data for a range of scientific publications on teak genetic markers. These results, combined with those of the previous ACIAR project (FST/2014/028) are now being prepared for publication.

9 Appendixes

9.1 Appendix 1: Supporting materials from Myanmar workshop, Yangon, 25^{th} Febrauray 2016

Ecosystem Conservation and Community Development Initiative (ECCDI),

Australian Centre for International Agricultural Research,

University of Adelaide &

Double Helix Tracking Technologies Pte Ltd

cordially invite you to participate in the

Inception Workshop of the project:

"Securing the Chain of Custody for Teak in Myanmar using DNA"

Venue :	International Business Centre (IBC), 88 Pyay Road, Yangon.
Date :	25^{th} February 2016
Time :	9:00 AM – 5:00 PM

RSVP **(by 23.2.2016): Goh Soo Lin (soo@doublehelixtracking.com or +65 6227 9706)**

"Securing the Chain of Custody for Teak in Myanmar using DNA"

Project Concept Note

This project aims to determine the feasibility of verifying the legality of teak supply chains in Myanmar* through the application of a genetic markers. Properly applied, DNA can safeguard supply chains from illegal timber substitution, enhance the credibility of the Myanmar timber industry and facilitate international trade with key export markets such as the USA, European Union and Australia.

The project will bring together key stakeholders from governments, industry and civil society to develop a framework for verifying chain of custody documentation and origin of harvest.

Teak – a valuable natural resource
Teak is one of the most commercially important timbers in the world, valued for its durability, water resistance and versatility. In Myanmar, almost all teak comes from natural forests where the world's largest remaining natural stands of teak are found here.

How do DNA markers work?
In natural forests, trees that are located closer to each other are more genetically similar compared to trees that are further apart. Sampling across teak's natural range makes it possible to develop a set of genetic markers specific to each population, concession, and even individual trees. This approach has been proven to work for other important timber species such as merbau (*Intsia* spp.), oak (*Quercus* spp.) and Bigleaf maple (*Acer macrophylum*).

Project partners
This project is led by Professor Andrew Lowe from the University of Adelaide. Prof. Lowe is Director of the Centre for Conservation Science and Technology, an international centre of research excellence in tree ecological and evolutionary genetics. All scientific and laboratory work will be conducted by Prof. Lowe's team at the University of Adelaide.

Ecosystem Conservation and Community Development Initiative (ECCDI) is the key Myanmar project partner bringing experience and knowledge of Myanmar forestry and on-the-ground expertise. ECCDI field teams will be collecting DNA samples from teak trees in several locations across Myanmar.

Double Helix Tracking Technologies (DoubleHelix) is focused on the practical application of scientific techniques such as DNA and chemical isotopes, to safeguard global timber supply chains from illegal timber laundering. DoubleHelix is responsible for ensuring that project outputs will integrate with any future Myanmar national timber legality system and support compliance with international timber trade regulations.

**This project is also being conducted in Indonesia, focusing on plantation teak in community forests.*

"Securing the Chain of Custody for Teak in Myanmar using DNA"

Inception Workshop Programme

08:30 – 09:00	Registration	
09:00 – 10:30	***Session I: Opening***	
09:00 – 09:15	Welcome and opening remarks	Dr. Kyaw Tint, Chairman, ECCDI
09:15 – 09:30	Welcome remarks	Director General, Forest Department, Ministry of Environmental Conservation and Forestry
09:30 – 09:45	Key-note Speech	Prof. Andrew Lowe, University of Adelaide, Australia
09:45 – 10:30	Group photo and refreshment	
10:30 – 16:10	***Session II: Paper Presentation***	
10:30 – 11:00	Overview of teak trade / forest governance issues in Myanmar	U Myint Thu, Myanmar Forest's Products Merchants Federation (MFPMF)
11:00 – 11:20	Question & Answer	
11:20 – 11:50	Overview of Myanmar Timber Certification Initiative	U Barber Cho, Secretary of MFCC
11:50 – 12:10	Question & Answer	
12:10 – 13:10	Lunch	
13:10 – 13:40	Using DNA to protect and conserve tropical timber trees	Prof. Andrew Lowe, University of Adelaide, Australia
13:40 – 14:00	Question & Answer	
14:00 – 14:30	Practical applications of DNA to safeguard timber supply chains around the world	Darren Thomas, Executive Director, Double Helix Tracking Technologies Pte Ltd
14:30 – 14:50	Question & Answer	
14:50 – 15:20	Refreshment	
15:20 – 15:50	Current genetic structure of Myanmar teak detected by microsatellite markers	Dr. Thwe Thwe Win, Assistant Director, Dry Zone Greening Department
15:50 - 16:10	Question & Answer	
16:10 - 16:30	***Session III: Closing***	
16:10 - 16:20	Wrap-up Remarks	Prof. Andrew Lowe, University of Adelaide, Australia
16:20 - 16:30	Closing Remarks	Dr. Kyaw Tint, Chairman, ECCDI

Workshop participation lists

THE UNIVERSITY of ADELAIDE

Inception Workshop of the Project ***"Securing the Chain of Custody for Teak in Myanmar Using DNA"***

25th February, 2016 (Thursday)
International Business Center, Pyay Road, Yangon

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