FST 2016/025 SRA: Developing DNA-based Chain of Custody Systems for Legally-sourced Teak

Closing Workshop
25 & 26 September 2018

Provincial Agriculture & Forestry Office (PAFO)
Phabath Tai Village
Luang Prabang City, Lao PDR

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Executive Summary

About the Project

The ACIAR Teak Project FST 2016/025 SRA involved research and genetic map development of teak across six countries in Southeast Asia and the Pacific: Solomon Islands, Papua New Guinea (PNG), Myanmar, Thailand, Indonesia and Lao PDR.

This Project is led by Professor Andrew Lowe of the University of Adelaide. He is the Director of the Centre for Conservation Science and Technology, an international centre of research excellence in tree ecological and evolutionary genetics. The coordinating partner is Double Helix Tracking Technologies Pte Ltd (DoubleHelix) in Singapore.

The Opening Workshop was held in June 2017 in Honiara, Solomon Islands, where project partners and members of trade from the Solomon Islands and PNG were invited and shared insights on genetics research and issues facing teak management and trade in that region.

This report focuses on the Closing Workshop following sample collection, DNA extraction and marker development and the development of a higher resolution genetic map for this region.

About the Closing Workshop

During the workshop, research findings for this project was presented. There were discussions on the application of teak genetics research and a round table discussion on potential extensions to the teak genetic project.

In addition, each country partner also shared on teak management and trade in their respective countries.

In-country coordinator, Lao PDR

The in-country coordinator for this workshop was the National Agriculture and Forestry Research Institute (NAFRI), represented mainly by Mr Vongvilai Vongkamsao.

Vongvilai and his team (including Mr Bounchanh Lattanavongkot, Mr Banxa Thamavong and Mr Bounthavy Chaluensouknetwork) worked tirelessly to coordinate the teak sampling in Lao PDR across three locations and populations, and organised the logistics for the Closing Workshop.

In addition to the project team, the Deputy Director-General of NAFRI, Dr Chansamone Phongoudome was also in attendance at the workshop.

Participants

In total, invitations were sent to 45 guests (including organisers) that included project partners from Lao PDR, Myanmar, Thailand and Indonesia, Governmental Officials, members of the timber trade, NGOs and researchers.

We had 35 confirmed attendees. However, due to unforeseen circumstances, we had a total of 30 participants including the project team. This was within the expected number of attendees for this workshop.

The list of attendees is found in the table below:

No.	Guest	Organization	Country
1	Dr Chansamone Phonguodome	DDG of National Agriculture and Forestry Research Institute (NAFRI)	Lao PDR
2	Dr Xayaphanh Lasy	Provincial Agriculture and Forestry Office (PAFO)	Lao PDR
3	Somvang Sihalath	Director of Plantation Promotion Division, Department of Forestry	Lao PDR
4	Vongvilay Vongkamsao	NAFRI	Lao PDR
5	Bounchanh Lattanavongkot	NAFRI	Lao PDR
6	Banxa Thamavong	NAFRI	Lao PDR
7	Bounthavy Chaluensouk	NAFRI	Lao PDR
8	Nout Phengxay	NAFRI	Lao PDR
9	Somphanh Sakanphet	NAFRI	Lao PDR
10	Vansy Phengthajaim	National University of Laos	Lao PDR
11	Timnoy Salitxay	Souphanouvong University	Lao PDR
12	Saiyasith Phonphakdy	LPB Forestry Section	Lao PDR
13	Dr Suchitra Changtragoon	Department of National parks, Wildlife and Plant Conservation (DNP)	Thailand
14	Dr Hugo Volkaert	National Center for Genetic Engineering and Biotechnology (BIOTEC)	Thailand
15	Dr Nophea Sasaki	Asian Institute of Technology	Thailand
16	Kyi Soe	Ecosystem Conservation and Community Development Initiative (ECCDI)	Myanmar
17	Zaw Oo	ECCDI	Myanmar

18	Khine Thazin Aye	ECCDI	Myanmar
19	Dr Zar Chi Hlaing	Forest Department	Myanmar
20	Dr Thwe Thwe Win	University of Forestry	Myanmar
21	Barber Cho	Myanmar Forest Certification Committee	Myanmar
22	Dr Suma Arun Dev	Kerala Forest Research Institute (KFRI)	India
23	Dr. Anto Rimbawanto	Center for Forest Biotechnology and Tree Improvement (CFBTI)	Indonesia
24	Ida Luh Gede Nurtjahjaningsih	CFBTI	Indonesia
25	Fithry Ardhany Leman	CFBTI	Indonesia
26	Stephen Midgley	Salwood Asia Pacific	Australia/Laos
27	Professor Andrew Lowe	University of Adelaide	Australia
28	Darren Thomas	DoubleHelix	Singapore
29	Avalyn Lim	DoubleHelix	Singapore
30	Jomaine Tang	DoubleHelix	Singapore

Workshop Photos

Fig 1: Opening of the Workshop

Seated (L-R): Mr Darren Thomas, Dr Andrew Lowe, Dr Chansome Phonguodome, Dr Xayaphanh Lasy

Standing, middle row (L-R): Mr Vongvilai Vongkamsao, Mr Vansy Phengthajaim, Mr Somvang Sihalath, Dr Anto Rimbawanto, Dr Hugo Volkaert, Dr Nophea Sasaki, Mr Stephen Midgley, Mr Bounchanh Lattanavongkot, U Barber Cho, Mr Saiyasith Phonphakdy

Standing, back row (L-R): U Zaw Oo, Mr Banxa Thamavong, Mr Somphanh Sakanphet, Ms Avalyn Lim, Dr Suchitra Changtragoon, Dr Thwe Thwe Win, Dr Zar Chi Hlaing, Ms Timnoy Salitxay, Mr Nout Phengxay, Dr Suma Arun Dev, Ibu Fithry Ardhany Leman, Ibu Ida Luh Gede Nurtjahjaningsih, Daw Khine Thazin Aye, U Kyi Soe.

Photographer: Miss Jomaine Tang, DoubleHelix

Australian Government
Australian Centre for International Agricultural Research

THE UNIVERSITY of ADELAIDE

DoubleHelix

Fig 2: The Myanmar contingent. (L-R) U Barber Cho (MFCC), and U Kyi Soe, U Zaw Oo, Daw Khine Thazin Aye and Dr Zar Chi Hlaing from ECCDI.

Fig 3. Left: The Indonesian contingent from FOERDIA. (L-R) Ibu Ida Luh Gede Nurtjahjaningsih, Pak Dr Anto Rimbawanto, Ibu Fithry Ardhany Leman.

Fig 4. Below (L-R): Dr Hugo Volkaert, BIOTEC; and Mr Darren Thomas, DoubleHelix

Fig 5: Dr Andrew Lowe, University of Adelaide and Dr Nophea Sasaki, Asian Institute of Technology Thailand.

Fig 6: Traditional Laos Dinner for Workshop Participants

Project Objectives

From its inception, SRA project FST 2016/025 had three key objectives:

1. To develop and apply DNA chain of custody verification tests to teak sourced from community forests in Laos, Solomon Islands, PNG and Indonesia
2. To develop and apply DNA chain of custody verification tests to teak sourced from natural forests in Laos, Myanmar and Thailand
3. To enhance knowledge and capacity and develop a regional approach to DNA verification for teak.

Fig 7: Photo of the event tent cards and venue

The key objective of this Closing Workshop was to present the results of the DNA marker development from teak samples collected in the course of this project. Teak samples from Indonesia, Laos, Myanmar and Thailand were collected and processed successfully. Due to political and logistical challenges, and a change in project partner in the Solomon Islands, our partners from the Solomon Islands and PNG encountered severe delays in the sample collections of teak and were unable to submit them in time for results to be included in this workshop.

Note: At time of writing, samples for Solomon Islands have been collected at Kolombangara Forest Products Limited (KFPL) plantations and are en route to the University of Adelaide. Samples from PNG have just reached the University of Adelaide.

Day 1 Presentations

In fulfilment of the project objectives, the workshop opened with a welcome address by Dr Chansamone Phonguodome, DDG of NAFRI.

Day 1 presentations started with a brief introduction to tree genomic work and the results of this project (University of Adelaide), followed by the work of DoubleHelix in using genetics to track timber in supply chains.

This was followed by a special update on the national certification process being undertaken in Myanmar by MFCC. The country presentations were focused on general teak growing (natural forest and plantations) and teak trade updates from each of the project countries.

University of Adelaide

Professor Andrew Lowe gave a general overview of the use of genetic methods in timber verification and presented the findings of the genetic research conducted on the teak samples collected in the project.

Fig 8: Presentation of Project findings by Prof Andrew Lowe, University of Adelaide

The project has included analysis of samples from natural forest in Laos, Thailand, Myanmar, Indonesia and India, in fact across all of its natural range. Overall Indian populations showed high genetic diversity and were significantly differentiated from eastern range populations. Populations from Laos, Thailand and Myanmar could be distinguished genetically, and Indonesian populations at least from the region around Muna on Suluwesi were confirmed as natural. Within Myanmar, where intensive sampling was conducted, the northern, eastern, central, western and southern regions of the country could be distinguished genetically. These results indicate that a genetic test for teak will provide country level verification, and where intensive sampling is conducted (e.g. myanmar) regions within a country can be distinguished. Analysis of samples from plantations in Indonesia, Myanmar, Solomon Islands and PNG are being finalised.

DoubleHelix

DoubleHelix CEO, Darren Thomas presented on practical applications of the DNA research in trade, namely to track timber along supply chains and increase client confidence in provenance and quality of timber products.

The presentation covered:

- Value of DNA testing
  - To increase market confidence e.g. Indonesia SVLK and Myanmar MTLAS
  - Support national enforcement efforts e.g. detect illegal timber substitution.
  - Support exporters to regulated markets of Australia, Europe and United States
- Potential application of DNA technology
  - DNA population analysis could be done to verify the Forest Management Unit (FMU) origin
  - DNA fingerprinting can be used to verify harvest records and physically match log or sawn timber to stumps.

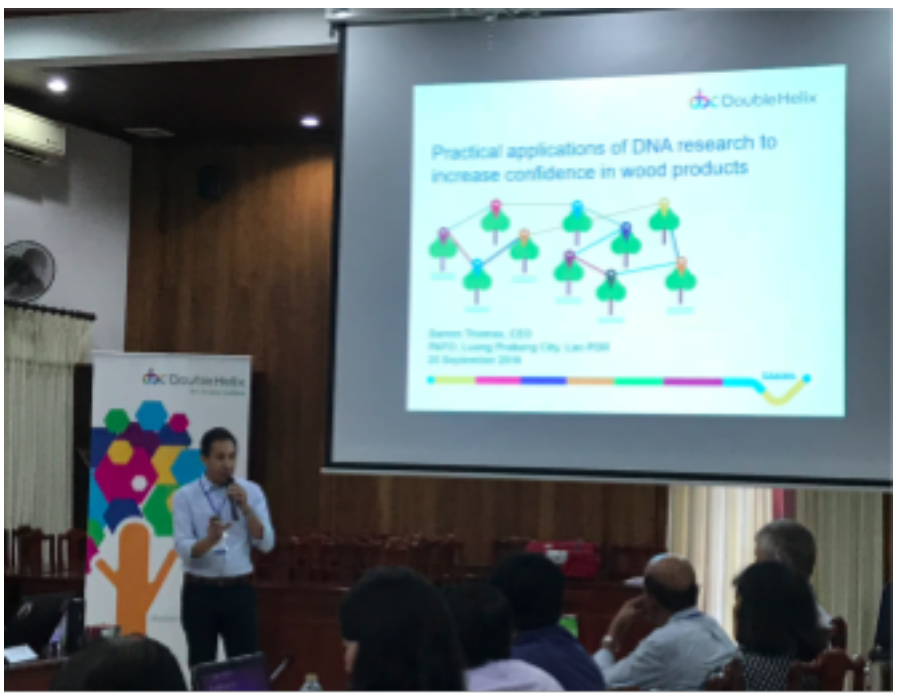


Fig. 9 Darren Thomas, DoubleHelix

Myanmar Forest Certification Committee (MFCC)

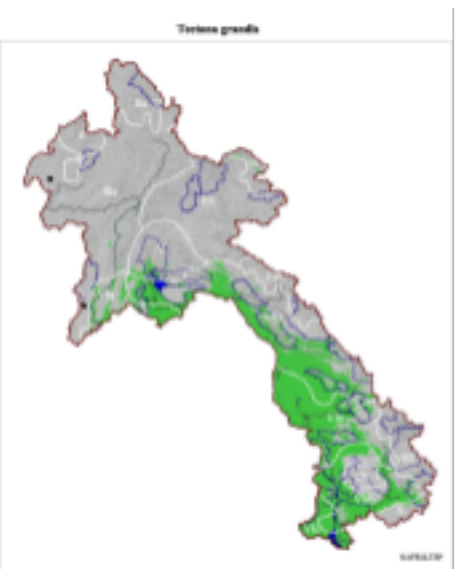
U Barber Cho, Secretary of the MFCC gave a presentation on the updates for MFCC, and the potential impact that DNA traceability would have in alignment with the objectives of the MFCC, as well as MTLAS. This presentation is summarised as follows:

- While Myanmar Timber Enterprise (MTE) has applied many document-based control systems, these systems were not intended to support traceability, but were designed instead for their own reference to support the Extraction Department, Domestic Marketing and Export Marketing Departments.
- Formation of MFCC: Timber Certification Committee-Myanmar (TCCM) was established in 1998 by the Ministry of Forestry to develop the principles, approach and methodology from which to establish a credible and pragmatic timber certification scheme. TCCM consists of representatives from the Forest Department, environmental non-governmental organisations (NGOs) and retired foresters.
- TCCM was reorganized in 2013 to become MFCC, comprising more representatives from NGOs and the Private Sector (2013-2018).

Fig. 10 U Barber Cho, MFCC

- Looking forward, MFCC will be reorganized by inviting one Certification Standards Office (CSO) representative for the first time (2018-2021). MFCC also intends to become a member of PEFC.
- The Myanmar Forest Certification Scheme (MFCS) has also been established for sustainable forest management. MFCS is being upgraded to meet PEFC requirements under Prince Albert II of MONACO with the cooperation of PEFC.
- MTLAS: developed to address timber legality, the MTLAS is also designed to support Disarmament, Demobilization and Reintegration (DDR) program while VPA is under negotiation. An MTLAS Gap Analysis Project was carried out in 2016-17 to find the gaps between MTLAS and international requirements. Gaps included:
    - No multi-stakeholder process
    - Incomplete coverage of legal requirements/sources
    - Not all supply chain controls documented
    - No third party certification
    - No independent system audit
    - Transparency
    - Accessibility
    - More coverage of source of timber needed
    - Illegal use of conversion / conflict timber
- In 2017, confiscated timber was banned for export. Timber from conflict area and conversion land was also banned.
- Other activities:
    - Revising documentation to link each other (Forest Department/MTE)
    - Initialization IT-supported Log Registration
    - Modifying Revenue Hammer
    - Hammering simple/necessary marks
    - Allowing MPs, CSO into forest
    - Allowing international verifiers/buyers into forest with the approval of MFCC.
    - DNA applications: use DNA to track harvesting agency, Forest Management Unit (FMU), conflict timber, conversion land.

NAFRI, Lao PDR



DoubleHelix was introduced to project partner, NAFRI through Aidan Flanagan from the Department of Forest Inspection in Laos.

After obtaining teak maps (see image on right) and seed stock maps from NAFRI, discussions were held with Drs Andrew Lowe and Eleanor Dormontt of the University of Adelaide to determine the best

locations for sampling in order to obtain a representative genetic map for Laos.

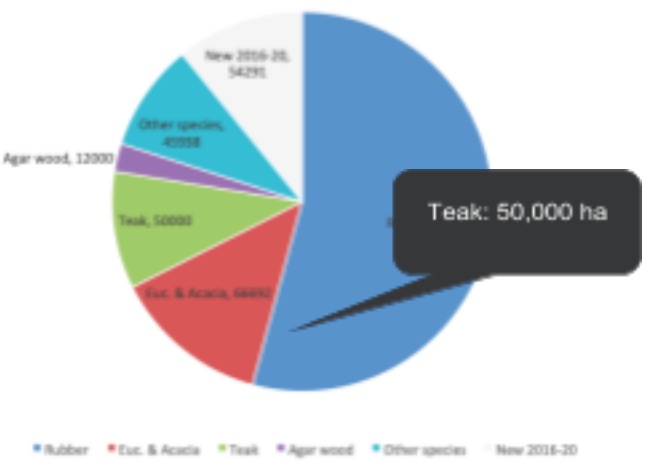
DoubleHelix conducted sample training in Vientiane for NAFRI staff in May 2017, and samples were obtained from three natural populations.

Fig. 12: Sampling training in Vientiane conducted by DoubleHelix

Mr Somphanh Sakanphet, Deputy Director, Upland Agriculture and Forestry Research Centre, NAFRI spoke on general forestry and teak management and trade in Laos:

- Current forest cover in Lao ranges between 59% (F-REDD Assessment 2015) and 69% (Global Forest Resources Assessment 2015, FAO, hereafter “FRA 2015”). This comprises:
  (a) 51 Production Forests (3.1 million ha) that are managed under the sustainable forest management system
  (b) 4.7 million ha of Conservation Forest and
  (c) 47 areas of Protection Forest (8.2 million ha)
- Lao has established 0.48 million ha of plantation land, of which teak makes up 50,000 ha. 98% of this is smallholder managed.
- Teak is mainly exported to China, Thailand, Vietnam & the European Union (EU). Teak is also used in domestic trade for local furniture.
- The key issues in Lao teak plantations are the limited technical knowledge in teak silviculture and the lack of marketing expertise. Seedlings come from unselected Mother trees and are planted with a stocking rate (spacing 2x2m to 3x3m= 1,111 to 2,500 trees/ha), but trees are not managed actively after planting. Farmers select and sell the best trees.

Fig 13. Mr Somphanh Sakanphet, NAFRI



- Marketing: farmers have limited market information (price, quantity, standard size, quality needs) and do not know how to estimate the volume of the tree. Hence they are disadvantaged when selling the trees.
- To assist the farmers, NAFRI is developing an app called MyGreenBank to help smallholders calculate the value of their trees.

Center for Forest Biotechnology and Tree Improvement (CFBTI), Indonesia

Dr Anto Rimbawanto of CFBTI covered an overview of the background of teak stand and plantation seed sources, past teak genetic work for seed stock improvement, as well as genetic diversity of teak in Indonesia:

Fig. 15 Dr Anto Rimbawanto, CFBTI

- Two sources of teak:
  - Commercial plantations ~ >1 million ha
  - Community/private plantations.
- Teak remains the preferred timber for the furniture industry
- Growing: teak is intercropped with agriculture plants, particularly in early years.
- Old stands in Isl. Java, Muna and Buton
- General history of teak provenance: two school of thoughts:
  - Native (De Veer 1957)
  - Introduced (Altona 1923, Purwowidodo 1991, Fofana et al. 2009, Verhagen 2010)
- First introduced to Java in the 7th century, and in Muna Sulawesi in 16th century. The Dutch found teak in Muna in 1727, but tree ring samples of the oldest teak in Indonesia, which happened to grow in Muna date back to 1565 (J.L. Gaynor 2016. Intertidal History in Islands Southeast Asia).
- Management of teak plantations in Java began in 1897, under Dutch colonial authority. Then transferred to Department of Forestry in 1927, and in 1930 to state-owned forestry company (Djatibedrijf).
- In 1940, management of teak forests returned to Department of Forestry until Indonesia's independence in 1945. State forestry company Perhutani was established in 1961 to manage teak plantation in Java.
- Community/private teak plantation established in more recent years.
  - Production from teak plantations in 2016 ~ 500,000 m3.
  - Demand for furniture industry ~ 2.5 million m3.
  - Rotation age is between 40 – 60 years.
  - Production from community teak unknown.

- Perhutani Teak Centre in Cepu Central Java, established in 1997, focuses on genetic improvement, seed production, tissue culture/clonal propagation.
- First provenance trial established in 1932, 12 geographical origin: India (Malabar, Central province, Godavari), Indo-China (Hinh, Kay, Kuoai,Kouoc), Indonesia (Muna, Cepu, Pati, Ponorogo, Gundih, Kesamben). Study in 1958 concluded that Malabar, Pati, Cepu and Ponorogo were best suited.
- Comprehensive genetic improvement program launched in 1981: selection of plus trees, establishing clone bank and clonal seed orchard. Over 680 plus trees selected. Cloned plus trees planted in clonal bank for safekeeping, and clonal seed orchard for seed production.
- Subsequently, progeny trials were established in 1987, 1988, 1995 and 1997. Around 125 elite trees selected.
- Clonal trials established in 1999 and 2000, 120 clones tested.
- Genetic Improvement of Teak
    - Seed production from clonal seed orchard ~ 40 ton/year, equivalent to 35,000 ha plantation
    - Planting materials from hedge orchard by cutting ~ 24 million plants = 36,000 ha plantation
    - Growth of improved clones at age 5 years: Height - 17.8m. Diameter: 18cm. Mean Annual Increment (MAI): 14m3/ha/year
- Community plantation of Teak
    - Teak is the preferred species due to its high economic value
    - Unknown sources, low genetic quality
    - Recently, local clone is available named Jun, that has been claimed as fast growing teak, harvestable at 8 years.

Fig. 16 CFBTI's teak breeding program

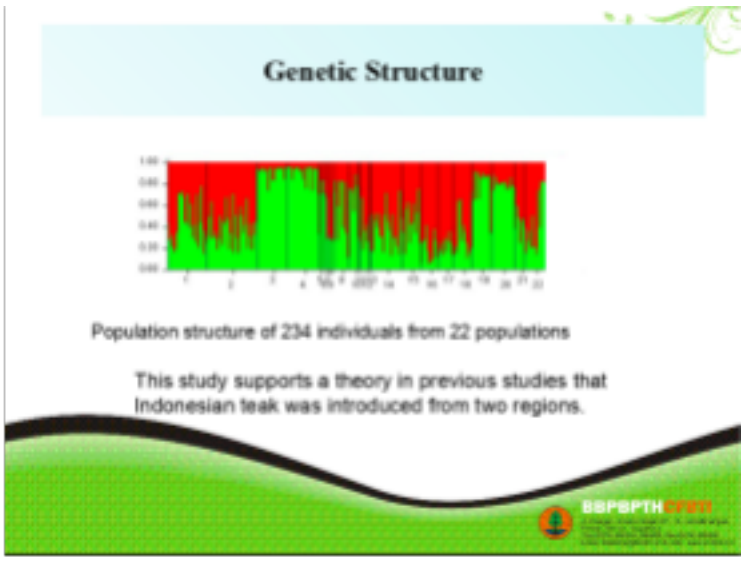


Fig. 17 Teak genetic diversity in Indonesia

ECCDI, Myanmar

U Zaw Oo, from ECCDI gave an overview of teak growing and plantation management in Myanmar:

Fig. 18 U Zaw Oo, ECCDI

- Growing stock of teak shows a downward trend and gradually decreased from 107 million m^3 in 1990, 104 million m^3 in 2000, and 100 million m^3 in 2005 to 87 million m^3 in 2010. (FRA, 2015)
- The Myanmar Selection System (MSS) was adopted in the moist and dry mixed deciduous forests. A felling series is divided into 30 felling coupes of approximately equal yield capacity. Selective logging is carried out in each of these coupes every year and the whole forest is therefore worked over in felling cycles of 30 years.
- According to MSS standard, the exploitable girth limit is 229cm (7.5ft) for good (moist) teak forest and 198cm (6.5ft) for poor (dry) teak forest respectively. Felling of exploitable trees is within the bounds of carefully calculated Annual Allowable Cut (AAC). AAC is thus a tool that ensures the harvest of timber yield on a sustained basis.
- Under the MSS, seed bearers are maintained so as to ensure natural regeneration of teak forests.
    - In addition to this, two cultural operations are carried out, namely: **O Felling and Y Felling** to enhance and improve teak natural regeneration as well as to maintain sustainable production of high quality teak.
    - A number of **cultural operations** are carried out in natural forests such as improvement felling, natural regeneration felling, thinning operation in natural regeneration of teak, climber cutting and fire protection.
    - In principle, the MSS had been applied for approximately 100 years but the growing stock and composition of teak have been declining due to various drivers of deforestation both directly and indirectly.
- The MSS itself has technical weakness, such as harvesting of all teak trees that have reached the exploitable girth limit. This will result in creaming of natural teak forests, frequently leaving behind an insufficient number of good seed bearers, thus the insufficient ingrowth has devastated the sustainability of natural teak-bearing forests and conservation of teak genetic diversity. (Tint, 2015)
- Plantations:
    - **Plantation establishment** was initiated in the late 1850s.
    - In the early 1970, **mass plantation schemes** were chosen to recover the natural forest degradation and deforestation.
    - Four main types of plantations are categorized namely: **commercial, local supply, industrial and watershed**.
    - The Forest Department is responsible for establishing all four major types but Dry Zone Greening Department (DZGD) has focused on the establishment of local supply and watershed plantations in the central dry zone of Myanmar.

- The state-owned plantations before 1981 were abandoned as natural forest.

Fig. 19 Areas under plantation in Myanmar 1981 – 2013, by usage and timber species

- Myanmar has practiced a very well organized and systematic forest management for more than 160 years. Consequently, policies, legislations, principles, guidelines, instructions and plans have all been put in place for sustainable forest management of the forest resources in the country.
- However, forest cover has significantly declined due to the drivers of the deforestation both directly and indirectly. Therefore:
  - Forest plantation with **fast growing species** should be encouraged throughout the country to recover Myanmar's degraded forest and to supply future demands on Myanmar's forest products.
  - **Plantation policy** is still needed to be formulated in order to achieve long term benefits from the forest plantation.
  - **Law enforcement** to combat illegal logging plays a pivotal role for the effective management and sustainability of natural teak forests and teak genetic diversity.
  - **People's participation** in forest management and **creation of incentives for private investors** in tree plantations could be fundamental in addressing the issues of forest degradation and depletion.
  - The Forest Department needs to strengthen **research base** for the sustainable production of both natural and planted forests.
  - Currently, international mechanisms such as **FLEGT and REDD+** are running to contribute to and strengthen sustainable forest management in Myanmar.

DNP, Thailand

Dr Suchitra Changragoon, Forest Technical Expert on Forest Conservation Research, Expert office of the Forest and Plant Conservation Research Office, Department of National parks, Wildlife and Plant Conservation (DNP) gave a presentation on teak management in Thailand.

Key takeaways included:

- There are no incentives for illegal teak exports/felling in Thailand because only the Forest Industry Organization can export log timber to other countries and has to pay 40% tax fee.
- The private sector can export only teak furniture and teak products to other countries and private companies use imported teak wood to produce furniture and export. At present, there is no possibility to export teak furniture based on teak origin from Thailand.
- Government is trying to reform and improve the law and regulation to expedite the process and provide incentive to private teak plantation and industry investment.

Day 2 Presentations

Day 2 presentations focused predominantly on the scientific work that has been undertaken in Thailand, Myanmar and India. Mr Stephen Midgely was also invited to make some additional remarks on the timber trade issues faced in Lao PDR on Day 2.

This was followed by two round table sessions.

Kerala Forest Research Institute (KFRI)

Dr Suma Arun Dev, Senior Scientist, Forest Genetics and Biotechnology Division at KFRI was invited to speak at the workshop, as the institute has been involved in teak genetics work, and was keen to contribute to this project and workshop, despite India not being a project country. Her presentation covered:

Fig. 21 Dr Suma Arun Dev, KFRI

- Overview of teak in India:
    - India is one of the major producers and consumers of teak wood. Of the 29.04 million ha of teak **natural** forests globally (FAO, 2014), India's share is 8.9 million ha (30.65%).
    - The estimated **planted** area of teak of approximatelt 5.98 million ha (ITTO 2016), 1.7 million ha is found in India (77,740 ha in Kerala) (KFD Forest Statistics, 2016).
    - Most plantations are in 2nd or 3rd rotation with a rotation age of 50 – 60 years (30-40 % decrease in productivity). 50,000 ha are replanted each year (5000 ha in Kerala).
    - The average productivity in India is only 2.423m^3/ha/year whereas potential teak yield is 10m^3/ha/year due to:
        - Deterioration of site quality
        - Non- availability of good quality planting material
        - Narrow gene pool
- Teak provenances in India: diverse physiogeographic zones below 24° N latitude
- Indian teak – Genetically distinct from Thai & Indonesian provenances and African landraces (Fofana et al., 2009, Hansen et al., 2015, 2017). Indicates the presence of broad range of alleles / heritable adaptations to local environmental factors
- Climate change prediction – global dynamic vegetation model indicates – 30% of teak growing areas is vulnerable to climate change in India. Vulnerable and Climate resilient populations have to be identified (Source: Gopalakrishnan et al., 2011)

- Genomic work:
  - Geographic patterns of genome wide variation needs to be analysed.
  - Genomic tools to monitor and manage adaptive variation
- Next generation sequencing-based whole genome sequencing (NGS-WGS) can enrich genomic resources of teak.

Thwe Thwe Win

Dr Thwe Thwe Win, Lecturer at the University of Forestry and Environmental Science in Myanmar was attached to the University of Adelaide as part of the project. She assisted in testing and analysing the teak samples during her attachment. During her presentation, she elaborated on the current genetic structure of Myanmar teak revealed by cpSNP & nSSR markers.

Her presentation covered:

- Natural teak in Myanmar
  - Myanmar: 16,517,700 ha of natural teak forest, or 59.13% of the world's natural teak growth
- Teak plantations in Myanmar
  - Started in 1700s
  - Between 1981-2016, there are about 384,114 ha for teak plantation established by the Forest Department. Between 2006-2016, 56,433 ha was established by the Private Sector.
- Teak sampling and markers
  - Teak samples were taken from 5 regions in Myanmar - Lower, Central, Upper, Eastern and Southern
  - The genetic structure and geographic variation pattern of Myanmar teak was based on three chloroplast DNA markers (cpSNP) and ten nuclear DNA markers (nSSR).

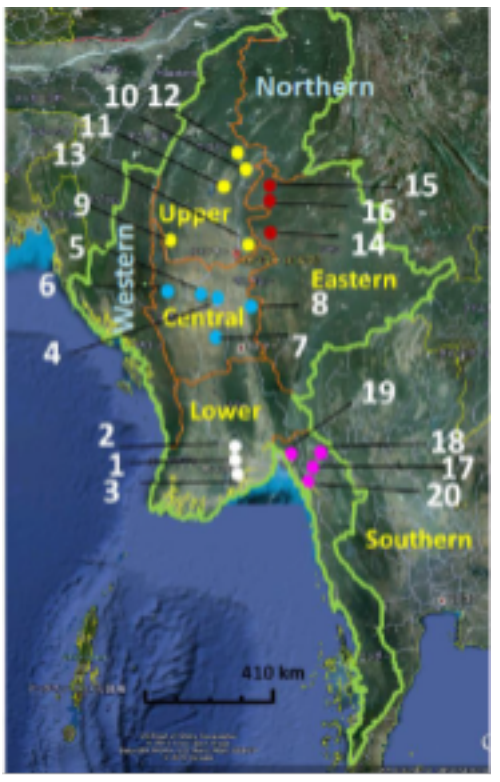


Fig. 22 Teak sampling areas in Myanmar for genetic marker development

- Results and Analysis
  - Based on the Haplotype at cpSNP, 4 distinct haplotypes were identified.
  - Based on the genetic cluster at nSSR markers, 4 clusters of markers were also identified. Therefore, we see four genetic clusters of Myanmar teak.

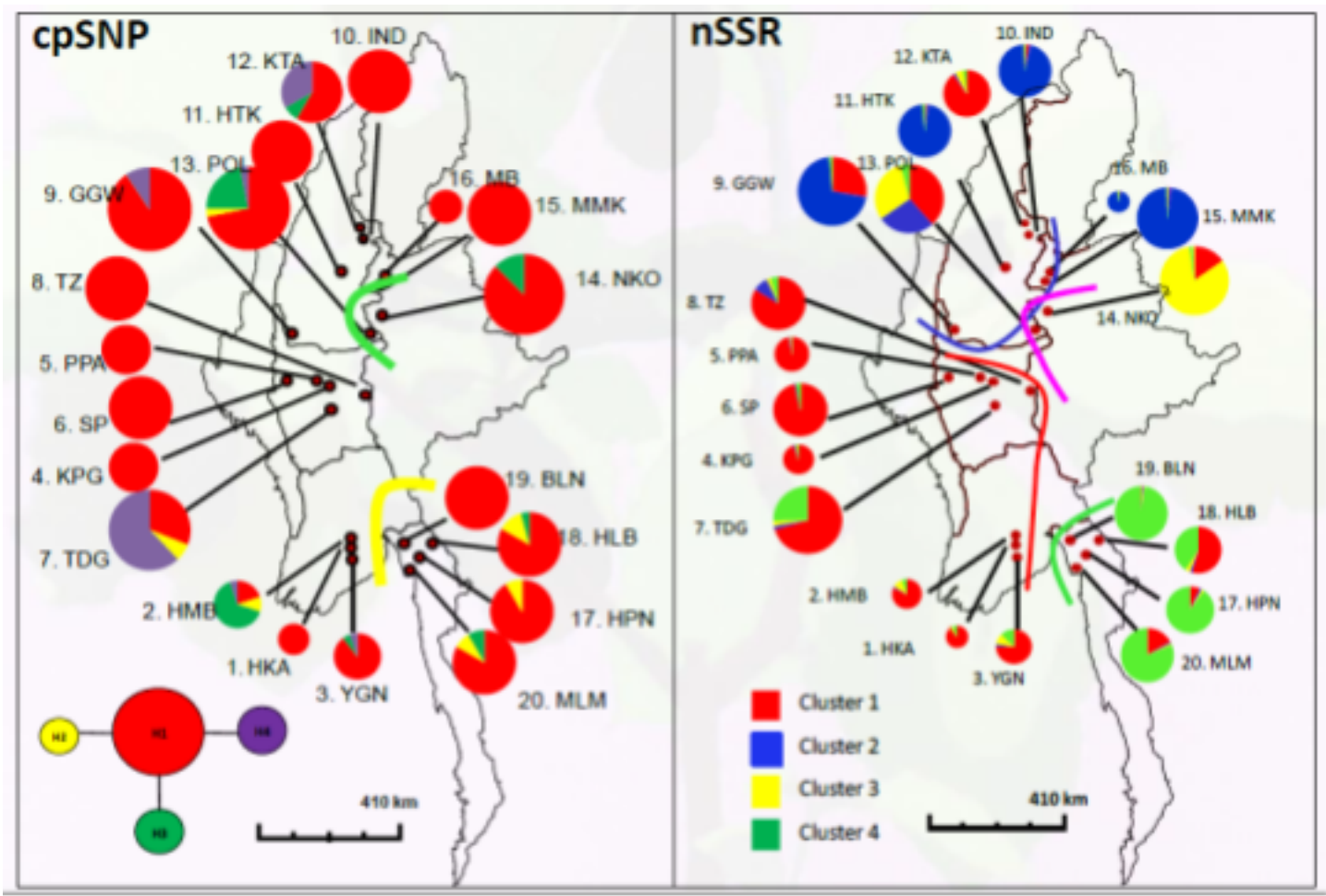


Fig. 23 Teak genetic variations across Myanmar

- Within the 5 regions, the Lower region had the highest level of genetic diversity amongst their samples while the Southern region had the lowest level of genetic diversity.
- The genetic centre of Myanmar teak appears to be in the lower region where the samples exhibited the highest level of genetic diversity.
- There was significant correlation of geographic and genetic distance in nuclear markers, but in the chloroplast analyses.

BIOTEC

Dr Hugo Volkaert represented the National Center for Genetic Engineering and Biotechnology (BIOTEC), Center for Agricultural Biotechnology and Kasetsart University Kamphaengsaen Campus to present on tree population genetics and genomics work in Thailand.

His presentation covered:

- The genetic variations and provenances of teak in Thailand
- Population structure of Thai teak
- Other tree species that have undergone genome sequencing:

- *Xylia xylocarpa*: 5 trees
- *Acacia auriculiformis*: 2 trees
- *Afzelia xylocarpa*: 1 tree
- *Dalbergia oliveri*: 2 trees
- *Dalbergia cochinchinensis*: 1 tree
- *Dalbergia cana*: 1 tree
- *Dalbergia cultrata*: 1 tree
- *Dalbergia lanceolaria*: 1 tree
- *Dalbergia dongnaiensis*: 1 tree
- *Pterocarpus macrocarpus*: 2 trees

- He concluded by saying that population genetic analysis could build genetic diversity:
  - To understand adaptation
  - For conservation
  - For tracing origin of seedlots / timber
  - To estimate impact of climate change

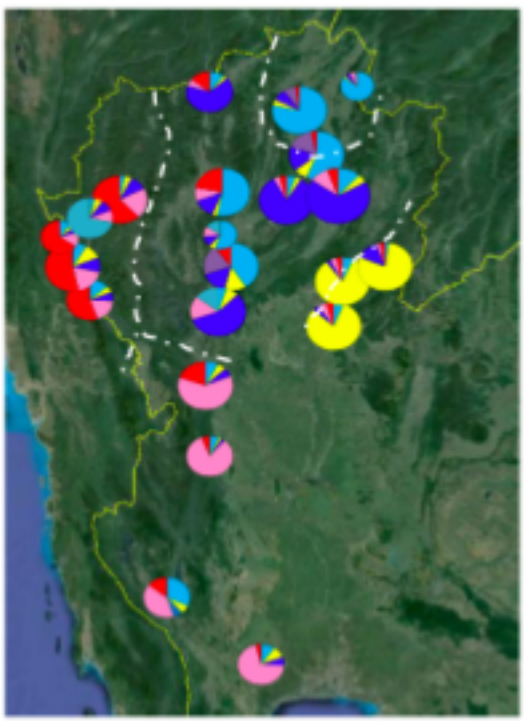


Fig. 25 Population structure of teak in Thailand

Day 2 Round Tables

Two round table sessions were held at the latter half of Day 2 of the workshop.

Round Table Session 1:

Andrew Lowe outlined the following discussion points:

- Application of technology to support legal teak export
- Market access and the role of source identity
- Cost and who pays
- Discussion by country and teak source:
    - Myanmar: Natural forest and plantation
    - Plantation – large scale government (Indonesia, Thailand, India)
    - Plantation – community forests/smallholder (Laos, Indonesia, Thailand)

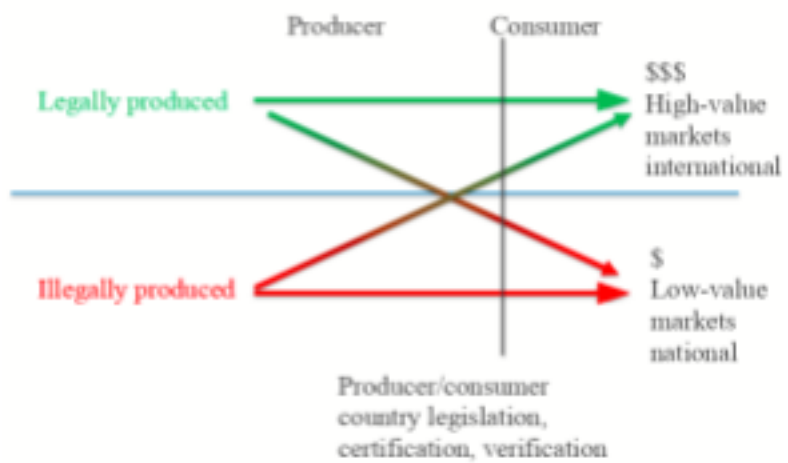


Fig. 26 Framework for round table discussion

Myanmar: Natural Forest and plantation stock

Andrew Lowe explained that the best way that DNA technology can help with native forest product is the generation of a country-level map that can verify the region of origin of timber products. For plantation stock, a profile could be developed to gain a better understanding of the stock used to establish the plantation. The aim is not to test the profile of every single log but to develop a framework and database for future testing as required.

Darren Thomas concurred that if DNA fingerprinting is done on a sampling basis in Myanmar, the claim that a log has been harvested from a particular stump in a certain region can be verified genetically and independently. This would allow an independent verification of the documentation system in Myanmar and help gain market access to the EU.

Suchitra Changtragoon pointed out that the EU should respect the credibility of the Myanmar Government documents, whereas the framework of genetic study can be utilised as a tool to absolve any lingering suspicion. Dr Thwe Thwe Win acknowledged that while the EU should respect the Myanmar government, this is not necessarily the case and any framework developed would be useful for the export of Burmese teak.

Hugo Volkaert pointed out the need to be sensitive to boundaries when drawing up the country-level mapping, as the genetic map will not necessarily align with the man-made/artibtrary borders that cut across both conflict and non-conflict zones. Andrew Lowe agreed and pointed out that nonetheless, the technology could still be used to independently corroborate claimed origin. For instance, if there is claim from a reputable producer that indicates the timber is from a non-conflict zone, we can at least tell if it is from a region which is a significant distance away from the conflict zone. Andrew Lowe added that he is aware that people in EU are interested in the development of a genetic map for Myanmar. While genetics do not lie, a number of them understand the inherent weakness of DNA testing. Nonetheless, it still demonstrates the intention to provide legality to the export of timber from Myanmar.

Laos: Small-holder producers with current natural stock and future cultivated stock

Bounchanh Lattanavongkot shared that Teak from India and Myanmar were planted in Laos for research and has not been distributed for plantation. For most of the small holder producers, the villagers take the teak seeds from existing teak trees in their vicinity. It is estimated that about 20-30 thousand hectors of teak are being planted by households. The seed source project in Laos was established to distribute quality seeds to farmers to improve the future quality of teak harvests. They would also like to propose the usage of tissue culture and clone bank technology to improve small-holder teak in Northern Laos.

Somphanh Sakanphet shared that for work done in collaboration with Mark Dieters, there are 3 main issues to look at – (1) The good management of existing teak seed stock, (2) ensuring that farmers follow the correct culture technique and (3) the provision of high-quality seeds.

Andrew Lowe clarified that in Laos, small holders have unimproved stock from local teak teaks and these are the type of stock that will be harvest in the next 10 years. There are teak seed culture projects of reduced genetic variable stock that will improve the next phase of teak harvested in the next 20 years and beyond. Between these two types of teak stock, it would difficult to verify those from the first stock but the second stock would be easier to verify as it should have a more unique genetic structure. Therefore, a database should be developed for the second stock for future testing and application into large-scale plantations.

Stephen Midgley pointed out that more focus should be placed on the breeding process and conservation of the natural teak sources in Laos, rather than legality and verification as these would help to secure more support from ACIAR. Andy commented that ACIAR was not the only funding source and that we need not unnecessarily limit ourselves. Notwithstanding, we could also look into partnering with Mark Dieters, who is well established in Laos and had a good programme of tree breeding and tissue culture, as a base for future expansion.

Banxa Thamavong shared that Laos had to set up a series of seed source orchards in 2000-2020 to; (1) conserve the tree source in Laos, (2) improve the community income by improving seed source and harvest. Teak seed sources established in Luang Prabang have been selected mother trees for plantation. The community received training on how to collect the seed of the mother tree.

To the query on whether the DNA results showed a distinction between Laos natural and plantation teak, Andrew Lowe explained that the lab is still analysing the results from the project testing. Based on the preliminary results, there was no large-scale difference between natural and plantation stock. This means that the plantation stock submitted came from Laos seeds. He would have to follow-up with more detailed analysis of the DNA results after the workshop.

Indonesia: Community forests and smallholder producers

Anto Rimbawanto shared that chain of custody experiments demonstrate the ability of DNA to indicate the origin of timber. If we want to verify the robustness of the documentation system in Indonesia, it would be important to do more sample testing. Due to the long history of work with the state forestry company, Perhutani, using plantation material in large quantity, the issue of DNA tracking could become less important because it's all within the framework of a rigid and highly-controlled system. DNA would only be applied in cases where there is a dispute in the legality of timber.

Anto Rimbawanto agreed with the other speakers that we tend to expect better income with the improved genetic material. However, this is not necessarily the case in reality. For small-holder farmers who needed to support a family, most of them would be pre-occupied with mainly planting cash crops, while teak trees would be planted along the border of their land. These teak trees would then be cut as and when they need more cash. In this sense, the management of plantations is not applicable to

small-holder industry. Therefore, future iterations of the project should look at the enhancement to community farmer groups.

Another issue highlight by Anto Rimbawanto was safe-guarding the credibility of the project among the farmers. Referring to a recent example in Indonesia, seeds of supposed superior quality were disbursed to farmers only to have 90% of them die within 2 years. In cases like this, it would be very difficult to regain the trust of the farmers again. If we were to build trust within the farming community, it would be prudent to first have a demonstration of the quality of the seed and harvest before asking the farmers to plant the seeds.

Regarding certification, most of the certification currently held in Indonesia was attained with the help of NGOs. Anto Rimbawanto expects that once the certification has expired, most of the entities/ community forests would not renew their certification because of the costs and application process required.

Summary: Session 1 Round Table

For Myanmar, the recommendation is to build a national/regional-level map that could inform the verification of legality and increase market access to the EU. In Indonesia, mapping the genetic sources of large scale plantation (e.g. Perhutani) and small holder teak farms. In Laos, it would be useful to merge the results with the current mapping already done by Mark Dieters. The application of DNA against source origin can be applied in some way to the dynamics of Laos' seed source project and future harvests.

We should be mindful of issues surrounding improved seed source, conservation and understanding the genetic resources in the natural populations and the breeding programmes.

Day 2 Round Table: Session 2

Andrew Lowe listed points to flesh with regard to future research priorities:

- Compile natural forest map – plantation concession mapping
- Development of genomic and genetic markers
- Refine tracking system for consistency, reliability and cost
- Genetic resource and forest management and REDD+, stock for breeding
- Market access and support for verification
- Capacity building for in-country testing
- Other species
- Partners
- Funding options – ACIAR, ASEAN, GCF

Thailand

Hugo Volkaert agreed that the areas identified by Andrew Lowe were all interconnected and had potential for further collaboration.

Nophea said that the development of genetic markers and zoning maps will help to track the movement of logs across different zones. There were two main objectives for moving forward, (1) to try to understand the knowledge currently available and synthesize it into a cohesive database/ framework, and (2) to develop the application of the technology onto real life cases.

In terms of funding, Nophea explained that the ASEAN secretariat has 2 types of funding options available. One catered for projects requiring less than $100,000 and the application was less than a few

months long. The other type of funding was for projects requiring more than $100,000 and the application process was significantly longer (could go up to a few years).

Suchitra Changtragoon mentioned that she would be interested in anything related to her area of expertise on genetic study for conservation, protection and education. A further suggestion was looking at species identification, which appears to be a problem for CITES regulation.

Laos

Vongvilay Vongkamsao said that future research priorities for Laos should support market access and capacity building.

NAFRI is open to being a partner for future projects, as dependent on the exact details of the next phase.

Stephen Midgley advised that the project should always focus on how the impact can help the people on the ground cautioned against linking the project too closely with REDD+.

Darren Thomas said that DoubleHelix would be happy to work on a simple verification system for Laos that could address the Australia Illegal Logging Prohibition Act (AILPA) and help Lao timber gain market access into the Australian market for the small Lao stakeholders.

Timnoy Salitxay from Suphanuvong University said that capacity building for in-country testing is important. Other neighbouring countries such as Thailand, Myanmar and Indonesia had such facilities and expertise but there was still much room for improvement in Laos.

REDD+

In response to Stephen Midgley's point about REDD+, Nophea explained that REDD+ has changed its project management and funding structure to avoid the past mistakes.

Andrew Lowe said that there would be good reasons to keep REDD+ included in terms of garnering the funding support. However, we would need to be aware of the perceptions and potential problems if we go in too heavily with REDD+ involvement.

Indonesia

Anto Rimbawanto shared that they would be keen to be involved in genetic development work, as well as anything that would support the market access of smallholder farmers. In addition, Indonesia would also be interested in the application of simple verification systems.

Myanmar

Dr Thwe Thwe Win said that Myanmar would be interested in 4 main areas – (1) market access and support for verification, (2) refined tracking system for consistency, (3) genetic resource and forest management, (4) capacity building for in-country testing (not just human capacity but also technological equipment).

India

Dr Suma Dev shared that genetic resources and forest management would be an area of interest. As a first step, the mapping of natural and plantation genetic stock would have to be developed. Regarding plantation concession mapping, in some cases, unknown plantation stock has been used and it would be useful to know the original breeding stock. This can inform verification further down the road, even if it is not clear at this point.

Other Species

Suggestions were made on including other species for further iterations of the project

1. *Tectona Grandis*
2. Rosewood, and specifically *Dalgerbia oliveri* (Suggested by Dr Thwe Thwe Win, Suchitra Changtragoon and Stephen Midgley)
3. *Millettia Pendula* (Suggested by Dr Thwe Thwe Win)
4. *Pterocarpus*
5. Sandalwood

Project Follow-up

Dissemination materials

A report is being compiled by Darren Thomas from DoubleHelix describing how best to incorporate genetic markers to verify claims of timber harvest origin from natural forest (Laos, Myanma, Thailand) and plantation forest (Indonesia, Solomon Islands, Laos, PNG). Workshop participants were keen to receive the report, and will be being used to help develop testing frameworks for European importation of teak with German competent authorities.

Joint publications between participants

Due to the level of interest amongst the workshop participants to work together a number of joint publications were planned to describe genetic variation across the natural and plantation range of teak, including partners from Laos, Thailand, Indonesia, Myanmar, India, Solomon Islands and PNG.

Future funding for joint projects

Due to the level of interest amongst the workshop participants it was agreed to explore a number f future funding options:

- Andrew Lowe to work with ACIAR for proposal for future iterations of the project
- Andrew Lowe and Nophea Sasaki to prep first draft of ASEAN proposal from previous application
- Andrew Lowe encouraged all the participants to also explore country-level funding within their own respective networks, and not be overly reliant on external funding to come through for this project. If one attains funding from somewhere, we may help to catalyse funding from other agencies as well. A call for bilateral funding between Australia and India is about to be announced focussing on plant genomics

END OF WORKSHOP

Annex A

Closing Workshop Programme

25 & 26 September 2018

Day 1

TIME	EVENT	SPEAKER
09:00 – 09:30	Registration	
Session I: Opening		
09:30 – 09:45	Introduction (Double Helix) Welcome by Dr. Chansamone Phongoudome, National Agriculture and Forestry Research Institute (NAFRI)	Double Helix NAFRI
09:45 – 10:30	**Group photo** and refreshment	
Session II: Project Presentations		
10:30 – 11:15	**Presentation:** ACIAR teak project research results and Q&A	Professor Andy Lowe University of Adelaide
11:15 – 11:35	**Case study:** Practical applications of DNA research in teak / Managing supply chain risk for teak in global markets	Darren Thomas DoubleHelix
11:35 – 12:00	**Presentation:** Practical application of Scientific Testing within the Myanmar Timber Legality Assurance System (MTLAS)	Barber Cho Myanmar Forest Certification Committee (MFCC)
12:00 – 12:15	**Q&A:** Practical applications of DNA research	
12:15 – 13:45	Networking lunch	
Session III: Country Presentations		
13:45 – 14:15	**Presentation:** Laos Teak Management and Trade	Somphanh Sakanphet National Agriculture and Forestry Research Institute (NAFRI)
14:15 – 14:30	Q&A: Laos	
14:30 – 15:00	**Presentation:** Myanmar Teak Management	Zaw Oo Ecosystem Conservation and Community Development Initiative (ECCDI)
15:00 – 15:15	**Q&A:** Myanmar	
15:15 – 15:30	Break	
Session III: Country Presentations		
15:30 – 16:00	**Presentation:** Indonesia's Teak Resources, Plantation and Community Forests, Teak Breeding and Plantation Productivity	Dr Anto Rimbawanto Centre for Forest Biotechnology and Tree Improvement (CFBTI)
16:00 – 16:15	**Q&A**: Indonesia	
16:15 – 16:45	**Presentation:** Thailand Teak Management and DNA Forensic case studies	Dr Suchitra Changtagoon Department of National Parks, Wildlife and Plant Conservation (DNP)

16:45 – 17:00	**Q&A**: Thailand	
17:00 – 17:15	Day 1 Closing Remarks	DoubleHelix
19:00 – 21:00	Delegate Dinner	

Day 2

TIME	EVENT	SPEAKER
09:00 – 09:30	Tea/Coffee	
09:30 – 10:15	Round table: Session 1 "Developing DNA-based Chain of Custody Systems for Legally-sourced Teak" Phase III ● Proposed research outcomes for Phase III ● Project extension roadmap	
10:15 – 10:30	Presentation: Global Markets for Plantation Teak	Stephen Midgely Salwood Asia Pacific
10:30 – 10:40	Break	
10:40 – 11:00	**Presentation:** Genetic structure of Myanmar Teak	Dr Thwe Thwe Win University of Forestry and Environmental Sciences
11:00 – 11:20	**Presentation:** Genome-wide SSRs: A potential source for verifying the declared geographic origin of Teak (TBC)	Dr Suma Arun Dev Kerala Forest Research Institute
11:20 – 11:50	**Presentation:** Timber genomic work in Thailand	Dr Hugo Volkaert National Center for Genetic Engineering and Biotechnology, Thailand
11:50 – 12:45	Lunch	
12:45 – 13:30	Round table: Session 2 ● Potential partners ● Funding proposals	
END OF WORKSHOP		