



Enhancing Conservation and Sustainable Management
of Teak Forests and Legal and Sustainable Wood
Supply Chains in the Greater Mekong Sub-region PP-A/54/331

Training Workshop Report Teak Propagation Technique and Silvicultural Practices

5-9 August 2019

at Elephant Conservation Center,
Lampang Province, Thailand

Contact more details at :

Kasetsart University
Prof. Yongyut Trisurat
Faculty of Forestry, Kasetsart University
50 Ngamwongwan Road, Chatuchak, Bangkok 10900
Tel : +66 2579-0176 ext. 516
E-mail : fforyyt@ku.ac.th

Secretary Office of ITTO Teak in Mekong Project
Ms. Saichol Matarapat
International Forestry Cooperation Division
Office of Planning and Information
Royal Forest Department
Tel: +66-2-561-4292 ext. 1416; Fax : +66-2-561-4292 ext. 5673
Email : chon-ag44@hotmail.com



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**5-9 August 2019 at Elephant Conservation Center,
Lampang Province, Thailand**

Prepared for International Tropical Timber Organization

By

ITTO Teak Project in Mekong – Thailand Component



Training Workshop on Teak Propagation Technique and Silvicultural Practices

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Editors Prof. Dr. Yongyut Trisurat, Ms. Chumnun Piananurak, Mr. Tosporn Vachrangkura, Ms. Saichon Mutarapat and Ms. Suchanart Suyarat

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FORWARD

Teak (*Tectona grandis*) is one of the most important and valuable hardwood species in the world. The Greater Mekong region contributes with over 70% of the global natural teak forests (about 29 million hectares). In particular, Myanmar accounts for 50% of the total area, followed by Thailand. Unfortunately, the natural teak forest area has been reduced substantially due to overexploitation, agriculture expansion, and unsustainable management. Although teak plantations are found in about 70 tropical countries in Africa, Asia and Latin America, seed sources are generally unknown and most likely originate from roadside plantings. Thus there is a high risk of losing the species' high diversity of genetic traits and wood characteristics.

With the financial support from the Federal Republic of Germany through the Federal Ministry of Food and Agriculture (BMEL), "The International Tropical Timber Organization (ITTO) Teak Project Phase I, Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region (PP-A/54-331)" is being executed by ITTO in collaboration with five agencies, namely Cambodia's Forestry Administration (FA), Lao PDR's National Agriculture and Forestry Research Institute (NAFRI), Myanmar's Forestry Department (FD), Thailand's Royal Forest Department (RFD) and Vietnamese Academy of Forest Sciences (VAFS). Besides, Kasetsart University of Thailand serves as the Regional Activity Manager for coordinating all activities implemented in the five participating countries.

The organization of the Training Workshop on Teak Propagation Technique and Silvicultural Practices, held at the Elephant Conservation Center, Lampang Province, Thailand on 5-9 August 2019 aimed at introducing a basic genetic improvement of teak and selection of materials for propagation techniques, the principle of teak plantation establishment and the principle of intermediate silvicultural practice. Besides, the participants from the five participating countries also had opportunities for practices after the lectures and to visit a few public and private teak plantations.

This Training Workshop Report summarizes key lecture notes and important activities conducted during the workshop period. The local organizing committee does hope that the participants and interested agencies and individuals, especially smallholders, can make use of this report and recall the lecture contents.

This Training Workshop and the report would not have been possible without the valuable inputs and supports of many organizations and individual experts. Key institutions providing facilities and support include Royal Forest Department (RFD), Forest Industry Organization (FIO), and Kasetsart University (KU). Our special thanks go to three lecturers, namely Mrs. Chumnum Piananurak (Production of good-quality planting material Consultant), Mr. Tosporn Vacharangkura (Field training in silvicultural practices Consultant) and Mr. Boonlert Srisuksai (invited lecturer).

We express our deep appreciation to Mr. Suchat Kalyawongsa, Director of Forestry Research and Development Office, Royal Forest Department for contributing enthusiastic Opening Remarks and National Coordinators from the five participating countries for support. Mr. Palle Havmoller was helpful to carefully check and edit English of all lecture notes. Finally, we gratefully acknowledge the BMEL and ITTO for financial and technical support, respectively.

Prof. Dr. Yongyut Trisurat

*Regional Activity Manager (RAM)
ITTO Teak Project in Mekong*



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Acronyms and Abbreviations

ASEAN	Association of South East Asian Nations
BMEL	Federal Ministry of Food Agriculture, Germany
CF	Community forestry
DBH	Diameter at breast height
FA	Forestry Administration
FAO	Food and Agriculture Organization
FIO	Forest Industry Organization
FRI	Forestry Department/Forest Research Institute
GMS	Greater Mekong Sub-region
ITTC	International Tropical Timber Council
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
KU	Kasetsart University
MoU	Memorandum of Understanding
NAFRI	National Agriculture and Forestry Research Institute
RFD	Royal Forest Department
VAFS	Vietnamese Academy of Forest Sciences



The Event

Teak (*Tectona grandis*) with its outstanding physical and aesthetic qualities is recognized as one of the most important and valuable hardwoods in the world. It has been used for many centuries for a range of products in furniture manufacturing and housing construction, as well as in cultural services. Natural teak forests covering an area of about 29 million hectares occur in central and southern India, Lao PDR, Myanmar and Thailand. However, the natural teak forest area has been reduced substantially in all native teak growing countries mainly due to over exploitation, agriculture expansion, and shifting cultivation. In particular, old-growth high-quality teak stands have declined significantly for many years and there is a high risk of losing their high diversity of genetic traits and wood characteristics.

The International Tropical Timber Council (ITTC) and International Union of Forest Research Organizations (IUFRO) approved at its 53rd Session in Peru and the Global Landscapes Forum in Bonn, Germany in 2017 an activity entitled “Enhancing Teak Management” to improve the management and marketing of both natural and planted teak in all three tropical regions. The Federal Republic of Germany through the Federal Ministry of Food and Agriculture financed the first stage of this activity in the Greater Mekong Sub-region (GMS). ITTO signed the Memorandum of Understanding (MoU) with Kasetsart University and assigned the Faculty of Forestry to serve as the Regional Project Manager to coordinate the implementation of the teak project with National Project Coordinators from 5 participating countries.

The ITTO Teak Project within the Mekong Project aims to enhance the efficiency of natural teak forest management and forest plantations production and marketing by improving legal measures and regulations that facilitate sustainable teak production in the supply chain and enhance the quality of life for people and owners of small forest parks in the Greater Mekong Sub-region area. To enhance the efficiency of the smallholder community-based plantations and agroforestry system, the ITTO Teak Project in Mekong is planning to organize a training workshop covering basic genetic improvement of teak and selection of materials for propagation, basic principles of plant propagation, techniques for propagating teak by using seeds and vegetative propagation and principles of establishment of teak plantations. This activity is relevant to the Inception Report: Output 1, activity 1.3 and Output 2, activity 2.1)

Date of workshop 5-9 August 2019
Venue Elephant Conservation Center, Lampang Province, Thailand
Executing Agency International Tropical Timber Organization

Collaborators Forestry Administration, Cambodia
Forestry Department/Forest Research Institute, Lao PDR
National Agriculture and Forestry Research Institute, Myanmar
Royal Forest Department and Kasetsart University, Thailand
Vietnamese Academy of Forest Sciences, Vietnam

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Produced by Prof. Dr. Yongyut Trisurat
Ms. Chumnun Piananurak
Mr. Tosporn Vachrangkura
Ms. Saichon Mutarapat
Ms. Suchanart Suyarat

English Editor Mr. Palle Havmoller



Welcoming remarks



Mr. Suchat Kalyawongsa,
Director of Forestry Research and Development
Office, Royal Forest Department

Mr. Tosporn Vacharangkura, Ms. Chumnun Piananurak, Consultants and Instructors Dr. Saroj Wattanasuksakul, Senior Expert of the RFD, Prof. Yongyut Trisurat, Regional Activity Manager, ITTO Teak Project in Mekong, Participants from Cambodia, Lao PDR, Myanmar, Thailand and Vietnam

Ladies and Gentlemen.

Good morning. It is my great pleasure to represent the Royal Forest Department of Thailand and ITTO to deliver opening remarks at the Joint Training Workshop on Teak Propagation and Silvicultural Practices of the Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region at the "ITTO Teak project in Mekong" this morning.

Ladies and Gentlemen,

Teak is recognized as one of the most important and valuable hardwoods in the world. It generated foreign exchange and capital for national development of Thailand and Myanmar during the nineteenth century. However, natural teak forests have been reduced substantially in all countries which have natural forests of teak mainly due to unsustainable logging, agriculture expansion and unsustainable development. In addition,

old-growth high-quality teak stands have declined significantly for many years resulting in a high risk of genetic loss and poor wood characteristics. Thailand and Myanmar have a history of more than 100 years of teak plantations, however the existing planted teak forests are of poor quality and unknown genetic origin.

The ITTO Teak Project in Mekong sub-region aims to enhance natural and planted teak forest management, production and marketing through the establishment of legal and sustainable wood supply chains as well as improve local economy and local communities' livelihood development in the Mekong subregion.

In Thailand, the project starts at the right time to support the New Amended Forest Plantation Act which stimulates the National Policy on Green Growth Economy in Thailand, as well as promoting local people participation in co-management of forest resources to meet their needs and improve their well-being. Ladies and gentlemen The objective of this training workshop is to enhance the efficiency of the smallholder community-based plantations and relevant agencies on the selection of planting materials for basic principles of plant propagation. It is the first training session conducted by the project at a regional level. On behalf of the Royal Thai Forest Department as one of the implementing agencies, I would like to thank all



instructors/trainers, the project secretariat and the participants from all participating member countries, namely; Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. Furthermore, I would like to extend my appreciation to the Federal Republic of Germany and ITTO for financially and technically supports to the ITTO Teak Project in Mekong.

I wish the Joint Training Workshop on Teak Propagation Techniques and Silvicultural Practices will succeed and achieve all desired outputs.

Thank you



Prof. Dr. Yongyut Trisurat
presented the objectives of training workshop to participants.

Thematic areas

Plus Tree Selection of Teak and Its propagation techniques. Ms. Chumnun Piananurak, Consultant#2 Production of good-quality planting material

Plus tree selection

Genetic resource

Genetic resource is the first step of a teak improvement program. Genetic resources for selection of plus trees could be natural stand, old plantation, experimental plots and provenance trials. The natural distribution of teak in the world cover four countries including India, Myanmar, Thailand and Laos. When selecting in old plantation, it easier to compare growth of candidate trees because they are of the same age and environment, except for the border trees which grow bigger because of less competition. Selection from natural forest is less reliable due to the different environment each candidate trees has encountered from germination until selection.



Natural stand of teak for plus tree selection in Mae Hong Son province



Ms. Chumnun Piananurak giving a lecture.

Criteria for teak plus tree selection

Criteria for selection is based on fundamental theory of heredity inheritance that passing of discrete units of inheritance, or genes, from parents to offspring. Good offspring, therefore, must come from selected parent trees. In order to obtain desired characteristic of trees in plantation, seedlings to be planted must be propagated from plus trees. Characteristics for selection of plus trees depend on the utilization of the tree species. Teak is utilized as timber which will be processed to be veneer, marine decking, furniture, etc. Stem form and wood texture, therefore, are important traits for selection. Criteria for selecting stem form are straightness, clear bole and axis. Trees that are straight with long clear bole, cylinder axis with less taper are desired. Branch characteristics that affect stem form are size and angle. Smaller branches and perpendicular angle appear to prune better naturally resulting in a higher clear bole. Wood texture can be identified by the pattern of bark. Straight stripe pattern determines the desired straight grains of wood inside while a spiral pattern indicates undesired twisted grain of wood. A high buttress is more difficult to log when harvesting, so no or low buttress is more desired



for selection. The buttress, however, often occurs where a tree grows on loose soil. Health of the tree is also taken into consideration when selecting plus trees, so a tree with sign of bee hole borer attack or fungi attack is avoided. When selecting plus trees, the selector must look closely on the tree trunk from all directions as to look from afar or just from one side may not be appropriate. When selecting plus trees for plantation one important character is growth of the tree. The biggest and highest tree is, therefore, chosen. Commercial height is considered more important than total height. At least 15 meter commercial height is prescribed for a plus tree. The phenotype of the plus tree that is selected is the sum of a genetic and an environmental effect. Therefore, after selection, the plus tree must be tested to verify its higher genetic values in clonal tests. 636 plus trees were selected in Thailand from both plantation and natural forests. Photographs and information of the plus trees were recorded in plus tree record forms and kept in office. Branches of plus trees were taken back to the nursery and propagated by budding technique. The budded seedlings or the later rooted cutting seedlings are then planted in clone banks for further improvement programs such as clonal tests, established clonal seed orchards, and tests of their progeny performance in the form of full-sib and half-sib progeny tests.

Season for plus tree selection.

As mention above after selection of plus trees the trees would be propagated by budding technique to safely keep their genetic materials in clone banks. Selection of plus tree must be done when the season is appropriate for budding. The most suitable time for budding is when the bud starts to sprout which occurs in late February to early April when it is dry season in Thailand. During that period the forest floor is also clear, it is more convenient to walk in the forest and clearer to see the form of the tree with no leaf.

Propagation Techniques of teak.

Propagation by Seed

Propagation by seed is the easiest technique to propagate teak because it is a natural method. The majority of plantations in Thailand were propagated by seed. Containerized seedlings and bare rooted seedlings are commonly used. Bare root seedling is called “stump” and is prepared from a 1-year-old seedling raised in a seed bed. The stem part and lateral roots are cut off the seedling, only 1-2 buds and tap root are maintained. To prepare seed beds, soil must be ploughed thoroughly and the bed as high as 30 cm and 1 m wide, the length of the bed is as convenient. Broad casting of seeds of 1 liter/m² is recommended. The seeds are then slightly covered with rice husk or dirt to prevent the seeds floating away. If too deeply covered in soil, the seeds would not germinate. Seed sowing should be done during early rainy season in April to June. Watering is not necessary if intervals of dry eriods are not longer than 2-3 weeks. Weeding is required at least twice or more. Leaf pruning is necessary in order to control seedling size so it will be suitable for out planting. Pruning leaves of over growing seedlings is done to reduce their growth rate and to open gaps for under grown ones so they can compete and grow up. The seedlings must be raised through the dry season before lifting because then the tap roots will store food supply and be dormant. The best time for stump harvesting is, therefore, just before rainy season when the food in the root is ready to be used for flushing for the new season.



Fruits of teak as called “seeds” flushing for the new season.

When the climate is more stable and the plantation site is far from accessible roads, bare root seedlings are more popular and practical. Nowadays, potted seedlings are used more due to irregularity of the weather. Potted seedlings can be produced directly from seeds or from stumps. Potted seedlings are usually produced from stumps sized less than 0.7 cm in diameter as they are not suitable for direct planting. The small stumps are prepared as explained above and soaked in water 1hr or overnight before planting in containers. A 2x6 inches black plastic bag is the container used for teak seedlings. The media used is a mixture of top soil and rice husk and rice husk ash. The mixture ratio depends on the property of top soil. If the soil is sandy less rice husk and rice husk ash are added, but clayish soil needs more rice husk and rice husk ash. The seedling beds should be located in full sunlight. Watering, weeding, fertilizing, and insect controlling are done in the same way as raising other seedling species.



Germinating seeds suitable for transplanting

Directly sowing of seeds to produce potted seedlings needs more care and is riskier and is not a popular method among small farmers. The seeds can be sown in the same way as preparing stumps but more seeds per square meter should be applied. Watering is applied on days when it does not rain. As soon as the seeds germinate about 2 weeks after sowing, they will be transplanted to the containers. Media and containers can be prepared in the same way as for seedlings from small stumps.

These seedlings, however, must be raised in a nursery which provides about 50 % shade. The newly transplanted seedlings are very vulnerable to waterlogging or drought. Regular watering every day is necessary to prevent drought. Covering the seedling beds with plastic chambers will help prevent loss from waterlog when there are too much rain. Once the seedlings are established, gradually removal of plastic chambers and later shading for the seedlings to be exposed to full sunlight must be done in order to hardening the seedlings. When 3-4 months-old seedlings will be ready for out planting. These seedlings are, however, less strong than the seedlings from small stumps.

Application in a teak improvement program

Seeds are the product from the mother tree, after fertilization by pollen from father tree. Genetic values in seeds are, therefore, inherited from both father and mother trees. The offspring performances are varied and depend on what parts are controlled by father gene or mother gene. The performance can be worse or better than its parents. This fact is useful for an improvement program when the better offspring are selected for next generation. In a teak improvement program, improved seeds for better plantations are the end products of the program. Its roles in the program are to produce seedlings for establishment of seedlings seed orchard, half-sib progeny test and full-sib progeny test. Once the seed orchards are established seeds are the main genetic materials for plantations.



1-month-old teak seedlings



Vegetative propagation

Seedlings propagated using other parts of the plant besides seed or cloning will maintain the same genetic characteristic as the mother plant. The techniques do, therefore, not improve the genetic of plants but can be used to multiply the genetically improved plants. There are many techniques to vegetative propagate teak such as budding, rooted cutting and tissue culture. Each technique has advantages and disadvantages therefore the most suitable application should be considered in order to gain the highest benefit. Because of short period of the training course only budding and rooted cutting are included in the training program. Tissue culture can be available when there is a special request from interested counterpart countries.

Budding technique is the method where scion buds are grafted on to the stock plant. The new plant is developed from the scion bud using the root system of the stock plant. Budding has more advantages than twig grafting because many buds can be obtained from 1 branch for producing many seedlings while grafting can only produce 1 seedling. T-budding was the first technique used



Slit scion bud the same shape and size of slit stock then patch the bud on the stock.

in Thailand thereafter forked technique was applied. The open-two-flap technique was then introduced when the forked technique was not very successful with the bigger and more succulent buds taken from clone banks. Opentwo-flap was very successful and used for a long time until the chip-patch technique was applied. This technique was very successful and can be done 3 times faster than

other techniques. The Chip-patch then became the technique used until present.

Planting stock for teak budding.

At the beginning of the Teak improvement program stock plants were planted in clone bank and clonal seed orchard 1 year prior to the budding procedure. The success was very low and uneven. Later stumps of 1 year old seedlings were successfully used as planting stock. The stump should be of the same size as the scion. To prepare stumps for budding, 1-3 years-old seedlings were lifted from the seedling beds, lateral roots pruned and stem parts topped about 20-25 cm long. Chip-patch about 3-5 cm long were slit just above root collar to be grafted by scion bud patching. Stump can be stored up to 3 days covered with moist sand before budding.



Sprouting bud suitable for budding

The suitable bud for grafting is the bud that just has started to sprout. Selection of plus trees must therefore be done during March to April, when the buds of teak starts to sprout. Buds taken from newly flushed shoots (1-2 years) are easier to graft than those taken from older shoots. Buds taken from the outer crown produce shoots that show more twig characteristic than the ones taken from the inner crown. When plus trees are selected, branches that contain suitable buds are harvested and brought back to the nursery for budding. The branches should be kept in a sack and stored in a cool place. They can be kept under moist rice husk for 1 month. While stored under moist rice husk,

the dormant buds will sprout, where after the buds can be taken for budding. For grafting on root stocks, buds are cut to the same shape and size as the chip-patch of the root stock and then placed on to the slit part of the stock. The two parts were then tied together with a plastic sheet and the bud was left exposed.



Stock plant from 1year old seedling in stump preparation bed

Raising of budded stumps.

After planting the budded stumps into containers, the buds were then covered with a small plastic bag to prevent moisture loss from the bud and water to get into the joining part. The budded stumps were then raised in a nursery that provides 50 percent shade. Watering must be done regularly until the buds sprout in about 1-3 weeks. Make sure to remove all shoots sprout from the root stock. When the scion buds sprouting is observed, remove the cover plastic bag to let the new shoot grow freely and prevent sunburn. Look after the budded seedlings the same way as ordinary seedlings for 2-3 months. The seedlings will then be ready for out planting or for trimming leaves and top shoots to produce juvenile shoots for rooting cuttings.



Cover with plastic bag before planting in container



About 1 -2 weeks the bud will sprout, the plastic bag should be removed to prevent shoot burn.

Incompatibility due to the different growth rate of stock plant and scion or fungal infection at the joining part of the budded teak causes the trees to be slow growing or die. After budding, removal of sprouts from the stock plant must be done regularly to make sure that there are no sprouts from the stock overgrowing the scion shoots, otherwise the clone bank or clonal test plot will be contaminated with undesired genes from the root stocks.

Application of budding technique in teak improvement program.

After other techniques had shown up not to be successful for teak, Thailand used the budding technique to establish clone banks, seed orchards, and clonal tests. When applying rooted cutting and tissue culture for teak are possible, budding technique is less used but still important. In spite of the above disadvantages, the technique is still

useful because it is the most successful technique for propagating mature material of teak. Therefore, it is suggested that the technique should be used to propagate plus trees. Furthermore, it was found that serial buddings can rejuvenate mature material. When the material is rejuvenated, it is easier to propagate by rooted cuttings and tissue culture. Budding technique is not recommended for propagation in a clonal test because the root system does not belong to the tested plant.

Rooted cuttings. A plant cutting is a piece of a plant that is used in horticulture for vegetative (asexual) propagation. A piece of the stem or root of the source plant is placed in a suitable medium such as moist soil. If the conditions are suitable, the plant piece will begin to grow as a new plant independent of the parent, a process known as striking. A stem cutting produces new roots, and a root cutting produces new stems. For teak it was found that it is more difficult to induce roots in cuttings of a mature branch than in cuttings of juvenile material. To propagate by cutting of plus trees which are old, the branch must be rejuvenated. Rejuvenation of plants can be done through serial budding, tissue culture, serial cutting and pruning. To keep juvenility of the stock plant, hedge orchard of teak must be planted in small plastic bags instead of planted in the field. Maintenance activities of the hedge orchard are watering, draining, weeding and controlling of pest and disease. The stock plants need to get full sun light in order to be healthy. About 3 weeks prior to the cutting process, the stock plants must be pruned to get juvenile shoots. When the stock plant is getting too mature, pruning is the technique to rejuvenate the new shoots. Rejuvenation of teak cutting materials can be done when the shoot age is not more than 4 weeks after pruning, the size of the stem is less than 0.5 cm in diameter, leaves are soft and thin with hairy covering. To prepare the cutting, leaves were trimmed to about 1/3 to reduce transpiration. The cutting is then applied with rooting hormone for 10 second before striking to rooting media. The shoot handling processes affect freshness and health of shoots. Selection of juvenile shoots as described above is very important. Collecting the shoots in the morning or when the weather is cool is recommended. Duration between cutting and striking into the media

should be as short as possible. Treatment with fungicide is necessary. Slitting of the shoot base should be done with a sharp cutter rather than shears or scissors. Using a stick to make a leading hole in the media prior to striking of the shoot will reduce rotting due to bruises of the base.



Trimming of old shoots and leaves to get new young shoots for rooted cutting

Environment control

A non-mist propagator consisting of a bamboo frame covered with plastic sheets was used to control relative air humidity around the cuttings. Moisture content in the rooting media was controlled by watering until very wet before striking the cutting. Applying water to media after this is not necessary if the media still is wet. Temperature was controlled by plastic shade around the rooting chamber and spraying water around the rooting chamber during the day when the weather is hot. It is more desirable to do cutting in rainy season since the weather then is suitable for plant growth. Normally the root will develop after one month.



If there is root at shoot base, the possible causes could be: too wet rooting medium and poor drainage, fungus infection, bruising of tissue due to dull scissors or cutter, damages by alcohol which is used as solvent for the rooting hormone. Possible causes of callus development are: wrong hormone, try new hormone or new concentration, too much leaf area which can be reduced by trimming more leaves, collecting of shoots from a too high portion of the mother tree, too old shoot, too much sunlight in the hedge orchard. If the shoots are not dead but not rooted the causes can be the same case of callus development. Try then to improve the rooting chamber or try trimming leaves at various sizes or try using younger shoots. This may help solving the problems. Possible causes of yellowish leaves of cuttings could be: too much shade, there are pest and deceases, nutrient deficiency of the stock plants. Seedling wilting while the soil is wet indicates that the new seedlings have lost water through excess transpiration of the water uptake by roots. The seedlings therefore need shade or to be put back into the rooting chamber. The maintenance of the cuttings once they are establish could be done as for conventional seedlings, such as pest and disease control, grading, hardening of seedlings before transportation to be planted in the field.

Signs of problems and their possible causes

Critical time and activities that the cutting will be damaged and needs special care are: the first week of cutting, repotting, poor drainage of cutting media, abruptly changing of cutting environment, unsuitable and irregularly watering, roots grow through pot and get into soil.

Things that should be observed during the rooting procedure are: wilting, leaves shedding, rotting, production of callus but not roots, no production of callus and no roots, leaves turn yellowish. If the cuttings wilt, the causes might be: too wet media, too dry media, relative humidity too low, poor root system, the seedlings are shocked after new exposure to sunlight, the weather is too hot or too cold. The possible causes of leaves shedding are: too long soaking and too much water, when collecting shoots, the shoots are burned due to heat or frozen due to ice during transportation, too long time between shoots collection and striking, exposure to heat from sunlight and wilting during transportation or rooting process, too dark in rooting chamber, shoots are too old and ready to shed their leaves.



Application of rooted cutting techniques in the teak improvement program



After the success of rooting cuttings of teak, the technique was applied to prepare seedlings for 4 sets of clonal tests. Each set contains 100 clones and is tested in 4 sites. Clone bank of plus trees from number 401 and later were propagated by cutting technique. For the copies of clone banks in the other 3 locations, the seedlings were propagated by rooted cuttings. The technique was used in combination with tissue culture to produce special teak that was harvested to build the Giant Swing in 2006. 200,000 seedlings were tissue cultured as parent materials then propagated by cutting to produce up to 1,000,000 seedlings of the special trees to give out to people. At present when new improved materials are selected, tissue culture is used to produce stock plants then cutting is the main activity to mass propagate teak for distributing seedlings to farmers.



Participants were listening the lecture.



2 months after budding



Teak hedge orchard from budding technique

Poster Session and Exhibition

There were 8 posters demonstrated at the meeting hall for interested participants to study. They were about teak plus tree selection and propagation. Titles of the posters are as follows:

1. Teak Plus Tree Selection
2. Management of Teak Seed
3. Producing Stumps or Bare Root Seedlings
4. Producing containerized seedlings from Seeds.
5. Producing containerized seedlings from Small Stumps.
6. Teak Budding
7. Teak Rooted Cutting
8. Hedge Orchard Management of Teak for Rooted Cutting.



Exhibition of teak seeds, stumps, seedlings from small stumps, seedlings from seeds, budding equipment, budded seedlings, stock plants for rooted cutting and equipment were demonstrated along with the posters.



Practices

Teak propagation by seeds.

Participants were trained to prepare stumps from given teak seedlings. The participants were requested to classify the stumps into 3 categories: small stumps for containerized seedlings, stumps for out planting and large stumps for budding.

Teak budding.

Budding technique was demonstrated by training staff before each participant had a chance to practice by oneself. Chip-patch budding was the technique for practicing. While budding practice, all participants worked closely with training staffs to make sure that the right techniques were followed.



Ms. Chumnum Piananurak was explaining rooted cutting.

Rooted cutting

Stock plants management

Participants were trained to manage the stock plants by selecting the suitable shoots and classify the too young shoots and too old shoots. Participants were trained to rejuvenate the old shoots by pruning technique.



Participant from Myanmar was practicing on stump preparation.



Participants were classifying seedlings for stump preparation as small to be potted, medium to be out planting, and large for budded stock plants.

Participants were trained to build up a rooting chamber from provided bamboo sticks, mix rooting media and put the media into plastic containers, arrange containers in the bamboo chamber. It was emphasized that the size of the chamber must fit with the number of cuttings. A too big chamber will be unable to control humidity.



Building rooting chamber

Preparation of cutting materials and striking.

Participants were trained to harvest the cutting shoots, prepare the shoots by trimming off the leaves and apply rooting hormone. Preparation of rooting hormone was also practiced by group representatives. The cutting materials were then struck into rooting media. In all processes, the participants worked closely with the training team to make sure that right techniques were followed.

Rooting Procedure

The participants were requested to review the rooting procedure learnt from the presentation to make sure that every participants know what to do after striking, and problem solving.



Participants were divided into groups to build rooting chamber.



Ms. Chumnun Piananurak was explaining applied rooting hormone.



Ms. Chumnun Piananurak was showing the suitable bud for budding.



Myanmar and Vietnam participants were working together in the workshop.



Establishment of Teak Plantation By Mr. Boonlert Srisuksai

Ecological Characteristics of Teak

(*Tectona grandis*)

- 1) Teak is a light demanding species.
- 2) It is a periodic growth species and grows well during the transition period between wet and dry seasons.
- 3) It prefers well-drained soil or endurable flooding.
- 4) Teak has a coppicing ability. After cutting the tree, new shoots will generate through coppicing but stem form may not be straight, with clear bole and axis. Thus, pruning is highly recommended.



Mr. Boonlert Srisuksai, Advisor to Forest Industry Organization (FIO)

Facts about Teak

1. Site Quality

- 1) Grow well in loamy, deep and well-drained soil
- 2) pH ranging from 6-7 or alkaline soil originated from limestone
- 3) Rainfall 1,200-2,500 mm./yr.
- 4) Natural teak forests are dominant in tropical zones (e.g., India, Myanmar, Thailand and Lao PDR) but they can be grown in temperate zones, where average temperature ranges from 13 °c - 40 °c
- 5) Teak is normally found in altitudes under 700 meter above sea level. Occasionally, it also occurs in higher altitudes such as 900 m. in Mae Hong Son province.
- 6) Flooding is a limiting factor.



Teak Plantations in Phrae Province, Thailand

2. Management practices include site preparation, seedling preparation, planting & replacing, and maintenance.

Site preparation

1. Land clearing. Debris should be removed either by farm tractor or human labor.
2. Staking. This is to clearly locate the planting plot according to the designated spacing. Common spacing is 2 m. x 2 m., 3 m. x 4 m. or 4 m. x 4 m.
3. Hole digging. Appropriate hole size is at least 50 cm. x 50 cm. A larger size is better.
4. Fill in mixed soil. The original soil texture at the planting site may not be appropriate. It is recommended to fill mixed soil inside the hole after digging and before planting a teak seedling.



Spacing 2 m. x 2 m.



Spacing 3 m. x 4 m.



Spacing 4 m. x 4 m.

Seedling preparation

1. The seedlings should be from good quality seed and/or stumps with reliable sources such as seed orchard, seed production area, and natural stand. Seed from teak plantations of not certified quality and from roadside trees should be avoided as teak plantations require long-term investment (30-40 years rotation).



Seed collection from good quality



2. Tissue culture has become popular in the last decade, but the cost for preparation of tissue culture seedlings is high and smallholders have limited capacity for this technique.



Preparation of tissue culture seedling

Planting & Replacing

1) Selection of good seedlings to plant is very important. A suitable seedling size is 30-50 cm and age 6-12 months.

2) Any damage to seedlings during transportation from nursery to plantation area should be avoided.

3) Soil from the bag or container should be kept around the seedling when it is taken out otherwise there will be a lot of problems to the root system.

4) Planting in early rainy season (May-June) is recommended.

5) Two weeks after planting, the survival of the seedlings must be checked. If any have died, replacing them is recommended. Re-planting later than after 2 weeks may result in uneven aged stand.

Maintenance

1) Weeding practice should be done twice a year. After three years or after near crown closure one weeding per year is fine.

-Apply fertilizing NPK 15-15-15 1kg./tree, or manure 15kg./tree

2) Pruning in order to obtain stem form straightness, and good wood quality, the following pruning practices are recommended:



Eight months old saplings from tissue culture



One year old from stump seedling

1. Cut new coppices at the buttress and small branches, and use only straight and strong stems during 1st-3rd yr.

2. Prune approximately 1/3 of the live crown to minimize the effects on the growth and development of the tree after the 4th yr.

3. Pruning should be conducted in dry season to avoid broken trunks.

4. Pruning practice should be conducted every year.



Applying fertilizer: NPK 15-15-15 1kg. /tree



Weeding practice should be done twice a year.

How to obtain high quality wood?

Characteristic	Silvicultural practice
Big size	Weeding, Spacing, Fertilizing
Straight-long	Spacing, Pruning, Thinning
Thin sapwood	Old teak, Highland
Heartwood color	Site quality
No knot	Pruning
Less taper	Spacing, Thinning
No buttress	Soil depth, Soil texture
No bee-hole borer	Protection

Key success factors for teak plantations

1. Knowledge about teak and teak plantations
2. Intensive management
3. Need for continuing maintenance annually



Teak plantations from good management





Vietnamese participant asking a question to Mr. Boonlert Srisuksai



Cambodian participants and others were listening the lecture.

Intermediate Silvicultural Practices By Mr.Tosporn Vacharangkura



Consultant#5 Field training in silvicultural practices and Former Technical Forestry
Official of the Royal Forest Department (RFD)

Background

Mr. Tosporn Vacharangkura is the Consultant#5, Field training in silvicultural practices, of the ITTO Teak project in Mekong, “Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region”. His main responsibility is to support local communities and small holders through establishment of demonstration plots and field training on silvicultural practices and improved stand management.

He was one of two main instructors of the training session on “Teak Propagation Technique and Silvicultural Practices”. He delivered the lecture on Overview and principal of intermediate silvicultural practices after plantation establishment and thinning and pruning practices (field practice). His lecture aimed to introduce participants to the basic principle of intermediate silvicultural practices and to train participants in the techniques of pruning, thinning, and coppice regeneration of teak plantation.



Lecture contents

The contents of the training on Teak plantation establishment and silvicultural practices after plantation establishment are summarized below:

1. Planting System

Before planting, farmers or individuals should consider the following conditions and factors:

1) There are several planting systems, which are appropriate for teak including monoculture, mixed species and agroforestry. Choice of selection depends on the purpose and plantation objective.

2) Consider land conditions and land use before choosing the best planting system for teak.

3) Apply mixed species or agroforestry to increase diversity of products for short, medium and long-term revenue.

2. Land Preparation

Land preparation includes the following activities: site selection, clearing land of bushes and weed roots, stump destruction, ploughing, harrowing, and stone removal. Land preparation is necessary to provide the best growing conditions possible for teak. Land clearing and tillage are done to reduce weeds and improve soil quality. Land clearing also reduces shade, since teak is a light demanding species.



Land preparation for teak plantation

Teak grows naturally in lowland areas from 0 to 1000 m. a.s.l. with rainfall of 1250-3000 mm. annually. However, to produce high-quality timber, the suitable sites should also:

1) have soils with high lime and good water drainage.

2) have distinct dry and rainy seasons

3) be located less than 700 m. a.s.l.

4) sloping land is vulnerable to erosion and land slides so teak need terraces.

5) on rocky land monocultures or mixed plantation are more appropriate than agroforestry system, because tillage for annual crop production is difficult.

3. Plantation Establishment

3.1 Spacing

In a monoculture system, the most commonly used spacing in Thailand are 2x4 m., 3x3 m., 4x4 m., 2x8 m., 3x4 m. and 2x2 m. Dense spacing will produce straighter stems and faster height growth, whereas wide spacing will produce larger stem diameters. Tree spacing depends on genetic superiority of the seed, site quality and the market for small diameter logs (from thinning). The space made available to each tree strongly influences its growth patterns and therefore the overall yield of the plantation. Spacing has a strong effect on quality of timber as well.



Spacing of 3 m. x 6 m.

3.2 Preparing planting holes

Pitting must be carried out just before and during the early rains. Well prepared holes of 30cm. x 30cm. x 30cm. allow newly planted seedlings to quickly establish and grow a rooting system that ensures survival during the first dry season.



Sample hole

3.3 Planting material

Teak plantation can be established from seed or vegetative propagation such as shoot cutting, tissue culture.

A planting stock from improved seed should be used. Planting should be carried out at the beginning of the rainy season to allow the maximum growth of the young trees. The most common planting material for establishing teak in Thailand in former time is stumps (prepared from seedling) but, nowadays seedling or grown seedlings from stumps is preferable used because keeping and maintenance of stump costs much and timing of rainfall in the rainy season varies because of climate change, therefore it is difficult to plant teak trees with stumps in proper time.

3.4 Planting

A homogenous planting material from improved genetic sources should be used. Before planting, apply a proper amount of basic fertilizer to planting holes. Planting should be carried out at the beginning of the rainy season to allow for maximum growth

of the young trees before the first dry season.

3.5 Replanting

Replanting must be carried out within 2-4 weeks of planting. An allowable final reduction in stand density is 10% (90% survival rate).



Root ball should not be cracked after taking off plastic bag.



Place a seedling in the hole with stem straight.



The soil should be firmly packed around the seedling.



3.6 Maintenance after planting

1) Weeding

The purpose of weeding is to reduce competition on the tree crops. Weeding also reduces fine material which normally increases fire risk in plantations. In teak plantations, it is recommended that plantation's owners use a combination of manual and weed control methods. When applied correctly, chemical weeding reduces the frequency of weeding and minimizes weeding costs. Circular weeding to a diameter of 1m is usually continued for at least the first three years of growth after which trees would have developed deep roots and would not be affected by shallow rooted grasses. At three years fire risk would have been reduced by trees developing thick bark. The number and intensity of weeding vary with the intensity of weed growth. Generally, two to four weeding operations per year are required in teak plantations for the first three years.



Mechanical weeding

2) Fertilizing

Applying fertilizer when the trees reach 1, 2 and 3 years in age is recommended for medium and poor site. The recommended dose per tree is 50 g of NPK in the first year, 100 g in the second year and 150 g in the third year. On acidic soils, soils with a low pH or soils with limited calcium (Ca), the area around the trees should be treated with lime (dolomite) to raise the pH. The recommended dose of dolomite is 150–250 g per planting hole, applied at the same time as the manure or compost.



Example of applying fertilizer that rings the teak tree.

4 Intermediate Silvicultural Practices

4.1 Thinning

Thinning is the most important intermediate silvicultural practices for commercial plantation. The objective is to leave the better trees so future growth is concentrated on the higher value trees and to utilize all merchantable material produced by the stand during its rotation. Generally, there are five thinning methods applied in commercial plantations (1) low thinning (2) crown thinning (3) selection thinning (4) mechanical thinning and (5) free thinning. Low thinning is a common method applied to young teak stand.

The intensity of thinning refers to the regulation of stand density. Thinning that removes a greater proportion of the stand are heavier, whereas those that remove lesser proportions are lighter or less intense. As intensity increases, the frequency of thinning usually decreases. The time of first thinning does depend on management objectives, conditions of stand and site quality. First thinning can begin

once the crowns begin to touch each other. Live-crown ratio is the best indicator of tree vigor and ability to respond. Teak plantations, biologically, need to be thinned when the average live crown ratios fall 35%. Further loss of the live-crown ratio diminishes the potential of tree growth. Basal area of stand or stand density at the present time is another indicator that helps to make decision of when the stand need to be thinned or not.

Thinning cycle is the interval in years between successive thinning. The usual length of thinning cycle is from 4 to 6 years in young teak stand and is about 10 years for older stand. Stand of young trees should be thinned more frequently than stand of older or larger trees because they close more rapidly due to high growth rates and small crowns. Criteria that can be used to indicate the need for further thinning:

- (1) Declining live crown ratio of residual trees
- (2) Declining rates of diameter growth of residual trees
- (3) Accumulation of sufficient timber volume to justify operation.

Thinning can improve tree and stand vigor, enhancing both growth and tree health. However, there are risks associated with thinning operation:

- (1) Epicormic branching
- (2) Wind throw
- (3) Residual trees may be damaged during thinning operation, and wounded trees are easily damaged by diseases and decay.

4.2 Pruning

Pruning is carried out to remove the lower branches of plantation trees. Its primary purpose is to produce clear wood. The main type of pruning for commercial wood aims to improve the quality of timber by reducing the extent of knots on the potentially valuable lower part of the stem. Pruning can remove dead branches (dry pruning) or live branches (green pruning). The latter requires more care as the live cambium is exposed and hence there is a risk that pathogens and pests can use this as an entry point to attack the tree.

The practices used for pruning depend on size of the branch to be cut; whether or not the branch is safely and easily supported by one hand while cutting; and if a simple, single cut can be made with hand pruners, loppers, or a hand saw. Branches that are too large to be supported by hand should be removed using the “ternary method” (It was formerly called the “double cut”) to avoid tearing or splitting the bark and damaging the branch protection zone.

Traditionally, pruning has been carried out at all times of the year. There is now some evidence that it is not the best time to prune when the tree is coming into leaf or when it is just shedding its leaf. The ideal pruning times are just before bud burst in late summer or beginning of raining season.

Pruning is an expensive operation and therefore in practice should normally be planned for one operation up to 6 m. However, if timber is being grown specifically for a market, you may need more operation above 6 m. Prune no more than 30% (approximately 1/3) of the live crown to minimize the effects on the growth and development of the tree. The first corrective pruning should occur in young, vigorous timber stands before the lower branches become relatively large, and should follow early initial thinning. The best season to prune is dormant season (dry season). The best time to remove a branch is just before death or within several years thereafter.

1.5 On-site excursion and practices

1.5.1 Participants visited Thungkwian

Plantation at Hang Chat district, Lampang province to learn and observe teak plantation establishment and maintenance. This plantation is managed by Forest Industry Organization (FIO). The field excursion focused on plantation establishment (initial spacing, thinning operation, rotation age, harvesting). Participants also were trained in how to prune a teak tree properly.





FIO forest officials demonstrated how to prune teak tree with long pole chain saw.



Prof. Yongyut and Mr. Piya gave participants lecture on FIO teak plantation establishment.



Mr. Tosporn Vacharangkura explained how to prune teak tree properly.



Log Yard Thungkwian Plantation.

1.5.2 Participants visited Mr. Suchart Phunkerd's private teak plantation at Hang Chat district, Lampang province to practice how to select the trees in the stand for thinning operation following the procedure of tree selection they had learned in class room. This experience was valuable, because most participants have never carried out real field work.



A participant from Myanmar practiced pruning teak tree.



Khun Suchart, owner of teak plantation gave a welcome speech to all visitors.



Participants were divided into four groups for tree selection practice.



Measurement tree girth at breast height level.



Mr. Tosporn Vacharangkura explained how to identify tree crown class for thinning operation.



Participants ate snacks that made from agroforestry products.



Participants were divided into four groups for tree selection practice.



Participants from Myanmar drank passion fruit juice produced from agroforestry plots.

2. Selecting demonstration plots

To establish demonstration plots for showcase of sustainable teak forest management and the benefit of improved genetic materials including improved stand management, minimizing harvesting impacts and sustainable supply chain in on-farm teak growing for livelihoods of local communities and smallholders a field survey was conducted in Payao, Lamphang, Phrae and Nan provinces, northern Thailand. The basic information of the plots/sites was collected in order to identify potential sites to establish demonstration plots. The demonstration plots were selected on a basis of availability of infrastructure, capacity and motivation of local host organizations to support field training conducted by the project. After discussion among the project team the 5 demonstration plots were selected as follows:

2.1 Maegar silvicultural research station

Maegar Silvicultural Research station was initially known as Maegar Seed Orchard which is the first clonal seed orchard in Thailand and in the world. Purpose of its establishment is to produce genetically good seed to supply for plantation. The orchard locates at Moo 10 Maegar sub-district Muang district Phayao Province. The orchard is 23 km from Phayao town on Phaholyothin highway, coordinates at latitude 99° 55' E and longitude 19° 10' N (UTM 05951022100381). Topography is hilly with slope 10 to 30 degrees. Field trials and orchards are scattered inside the Mae –Tum national conservation forest. Elevation is 300 to 400 m above MSL. Average annual rainfall is 1293.68 mm, while average lowest and highest temperatures are 20.11 °c and 30.9 2 °c respectively. Rainy days are 97 days a year.



Maegar Silvicultural Research station

2.2 Ngao Silvicultural Research station.

Ngao Silvicultural Research Station was named in 2007. The station was once the well-known Teak Improvement Centre (TIC). The objectives of the center were 1) to improve the quality of teak in terms of growth rate, stem form, wood quality and resistance to pests and diseases through the breeding program 2) to produce genetically good seeds by the establishment of seed production areas and seed orchards including vegetative propagation, such as cuttings, tissue culture 3) to develop nursery and plantation establishment techniques suitable for large scale planting programs 4) to conduct researches supporting the improvement, seed procurement and planting programs, and 5) to encourage cooperation, including exchange of materials, information and experience with other institutions and organization both within and outside the country. It is located at Moo 3 Ban Huad sub-district Ngao district Lamphang Province. The station is 21.6 km. from Ngao town and 82.2 km from Lamphang city on Phaholyothin highway with the GPS coordinates of 2061054.839805 N and 594908.188355 E. The station's office is in Mae Huad teak plantation. Topography is mostly a broad expanse of flat land. Field trials, seed orchard and seed production area are inside the Ngao demonstration forest. Elevation is 336 m. above MSL. Average annual rainfall is 1082 mm., while the minimum and maximum annual temperatures are 3.9 °c and 43.5 °c respectively. Rainy day is 117 days a year.



Ngao Silvicultural Research Station

2.3 Khun Mae Kham Mee plantation

Khun Mae Kham Mee plantation is one of plantation under the Forest Industry Organization (FIO). plantation locates at Moo 6 Huay Rong and Phai Tone sub-district Rong Kwang district Phrae Province. The plantation is 57 km from Phrae city on route 1342 and 26.3 km. from Rong Kwang sub-district which have the GPS coordinates of latitude 18.466667 N and longitude 100.479722 E. Topography is hilly with slope of 10 to 30 degree. Elevation is 400 m. above MSL. Average annual rainfall is 1114.8 mm., while the average minimum and maximum annual temperatures are 21.6 °c and 33.2 °c respectively. Rainy days are 112 days a year.

Teak plantations were established in Khun Mae Kam Mee under the National Economics and Development Plan from 1968 to 1985, totaling 18 plots which cover 19587.40 rai (3133.98 hectare). The land of the plantation area has been registered as the land of plantation according to the Act of Plantation 1992. Khun Mae Kham Mee plantation obtained FSC certificate from Rainforest Alliance. The certification period is from 2016 to 2021.

The main activities of Khun Mae Kham Mee plantation include commercial teak plantation establishment and harvesting operations that are following the guidelines of FSC. The other important management activities are: fire management, road maintenance and conservation of natural forest nearby the plantation.



Khun Mae Kham Mee plantation

2.4 Mr. Suchart Phunkerd's smallholder teak plantation

The private teak plantation is in Hang Chat district, Lampang province. It was established in 2008 with initial spacing 2x4 m. The area of plantation is around 14.5 rai (2.32ha). The plantation had very good maintenance after establishment, therefore the survival rate of the teak stand is very high compared to teak plantations nearby, but there is no intermediate silvicultural practice, such as thinning and pruning in this plantation.



Mr. Suchart Phunkerd's teak plantation

2.5 Community-based teak plantations

The private teak plantations are in Ban Na-Lao Santisuk district, Nan province. The owner of the teak plantations is member of the small-scale growers of commercial forest community enterprise.

The number of members of the community enterprise are 61. The plantation areas of all members cover an area of around 3,000 rai (480 ha). The minimum area is 2 rai, whereas maximum area is around 60 rai. Most of teak plantations are in agriculture land reform. Most of the teak plantations were established in the year 1996-1997. There was not any silvicultural practices after establishment, except weeding 1- 3 years after planting. The following table lists purposes of selecting the demonstration plots in order to meet the goal of the project.

Selected demonstration plots	Purpose/ objective of demonstration/ field training
1.Maegar silvicultural research station	1.To conduct field training on teak seed production and vegetative propagation. 2.To establish clonal test 2 nd generation
2.Ngao silvicultural research station	1.To conduct field training on plus tree selection. 2.To establish community network for seedling production from improved genetic materials.
3.Khun Mae Kham Mee plantation	To conduct field training on minimizing harvesting loss.
4. Smallholder teak plantation (Mr. Suchart Poolkerd)	To conduct field training on thinning and pruning practices, and growth estimation.
5.Community-based teak plantation	To demonstrate community-based wood harvesting and processing through C&I / CoC for sustainable forest management.



APPENDIX

Awarding Training Certificate of Participation

By Mr. Suchat Kalyawongsa,
Director of Forestry Research and Development Office, Royal Forest Department



Training Evaluation Teak Propagation Technique and Silvicultural Practices

**5-9 August 2019 at Elephant Conservation Center,
Lampang Province, Thailand**

The training evaluation results were analyzed from questionnaires distributed to participants who attended the training workshop on Teak Propagation Technique and Silvicultural Practices, held during 5-9 August 2019 at Elephant Conservation Center, Lampang Province, Thailand. There were 44 participants submitting the completed evaluation questionnaires. Besides the collection of basic information of participants, the main objective of the evaluation was to assess the effectiveness and satisfaction level against the defined training objectives in order to improve logistic and content in the next training sessions.

Section 1 Personal information

There were 32 males (72.3%) and 12 females (27.27%) attending the training workshop. Approximately 62% of the total participants had ages between 20 and 40 years old, followed by ages of 40-60 and over 60 years old (Table 1).

Table 1 Number of participants by age class

Age (year)	No. of individuals	%
20-40	27	61.36
40-60	14	31.82
Over 60	3	6.82
Total	44	100.00

The majority of participants were Thai citizens (70.45%). Cambodian participants were ranked as the second largest group, while the percentage of Myanmar (9.09%) and Vietnamese participants were the same (6.82%) (Table 2).

Table 2 Number and percentage of nationalities among participants

Citizen	No. of individuals	%
Thailand	31	70.45
Cambodia	4	9.09
Lao PDR	3	6.82
Myanmar	3	6.82
Vietnam	3	6.82
Total	44	100.00

Twenty-four or 54.55% of Thai participants were affiliated with Royal Forest Department (RFD), while 15 participants were smallholders of forest plantations (mostly teak). Only five participants were from Forest Industry Organization (FIO), which has the main mission for economic forest plantations (Table 3),

Table 3 Number of participants and their affiliations

Affiliation	No. of individuals	%
Royal Forest Department	24	54.55
Forest Industry Organization	5	11.36
Smallholders	15	34.09
Total	44	100.00

The ITTO Teak Project also evaluated the education background of participants. The result indicated that approximately 63% of respondents have bachelor degree, while the percentages of participants either having lower or higher education were the same (18.18%) (Table 4). The result implied that most participants have capacity to improve their existing knowledge in teak propagation and silvicultural practices.

Table 4 Education background of participants

Education level	No. of individuals	%
Lower than bachelor degree	8	18.18
Bachelor degree	28	63.64
Higher than bachelor degree	8	18.18
Total	44	100.00

Most respondents are classified as smallholders of teak plantations (61.76%). Their privately owned plantation areas are less than 10 rai or 1.6 ha. About 29 percent of respondents have plantation areas ranging from 20 rai (3.2 ha), and the remaining 8.83% have more than 20 rai or 3.2 ha. The accumulated plantation areas of all 34 respondents are 330 rai with the average of 9.71 rai (Table 5).

Table 5 No of respondents and planted areas

Planted area (rai)	No. of individuals	%
0-10	21	61.76
11-20	10	29.41
>20	3	8.83
Total	34	100.00

Remark: Excluding public plantation areas (RFD and FIO)



Section 2 Satisfaction level and understanding

The check list questionnaire was designed and used to determine levels of satisfaction and subject understanding. There are nine questions, namely 1) obtain information prior to the training, 2) lecture on mother tree selection, 3) practice on teak propagation, 4) establishment of teak plantations, 5) lecture on intermediate silvicultural practices, 6) practice on intermediate silvicultural practices, 7) overall training contents, 8) training venue and accommodation, and 9) additional knowledge gained. Each question consists of five alternative answers or levels of satisfaction (very good, good, moderate, poor and very poor). The respondents selected only one answer that reflects his or her satisfaction.

Table 6 Level of satisfaction and understanding by training contents and logistic arrangements

Subject	Level of satisfaction/understanding (%)				
	Very good (score 5)	Good (score 4)	Moderate (score 3)	Poor (score 2)	Very poor (score 1)
1. obtain information prior to the training	31.81	29.55	25.00	9.09	4.55
2. lecture on mother tree selection and good quality materials	50.00	40.91	2.27	6.82	-
3. practice on teak propagation	43.18	50.00	6.82	-	-
4. establishment of teak plantations	45.45	40.90	6.82	6.82	-
5. lecture on intermediate silvicultural practices	38.64	40.91	20.45	-	-
6. Field practice on intermediate silvicultural practices	43.18	38.64	18.18	-	-
7. overall training contents	52.27	34.09	13.64	-	-
8. training venue and accommodation	56.82	31.82	11.36	-	-
9. additional knowledge gained	52.27	36.36	11.36	-	-

About 60% of the respondents have good or very good satisfaction on training information announcement and logistic arrangement prior to the actual training (e.g., provision of concept note, travel arrangement, communication with the project staff), while 13.5% were not satisfied. Practice on teak propagation was ranked as the highest satisfaction and/or understanding. This is due to all participants had opportunities to practice how to do root top cutting technique and grafting. The lecture on mother tree selection and propagation techniques was ranked as the second highest, but about 7% of respondents ranked this lecture as poor largely because there are a lot of technical terms and 18% of respondents have English language limitations.

About 85% of the respondents were satisfied with the lecture on the establishment of teak plantations (45% ranked it very high and 40% high). This is because the instructor (Mr. Boonlert Srisooksai) presented a lot of case studies from over 30 year experiences in forest plantations, especially teak. About 7% of the respondents classified this lecture as of moderate and/or poor satisfaction. Possibly, these respondents are from the RFD and FIO who are involved in teak plantations.

The lecture and field practice on intermediate silvicultural practices had similar evaluation levels and was ranked the lowest among 5 topics, but the accumulated percentages are close to 80%. However, the participants ranked the satisfaction and understanding level differently. Higher score was given for field practice (43% very good, and 38% good) possibly also as the result of language barriers.

Nevertheless, 52% of the respondents were very satisfied, while 34% were satisfied with this training course. Furthermore, approximately 88% of respondents gained additional knowledge and the training enhanced their capacity to perform as a trainer in their home country. For instance, Vietnamese, Cambodians and Laotians were very active during and after the lectures. They always asked questions and interacted with lecturers, while Thai participants were a little bit quiet and shy to ask questions and share their experiences. The percentage of satisfaction in training venue and logistic arrangement was similar to the knowledge gained item (Figure 1).

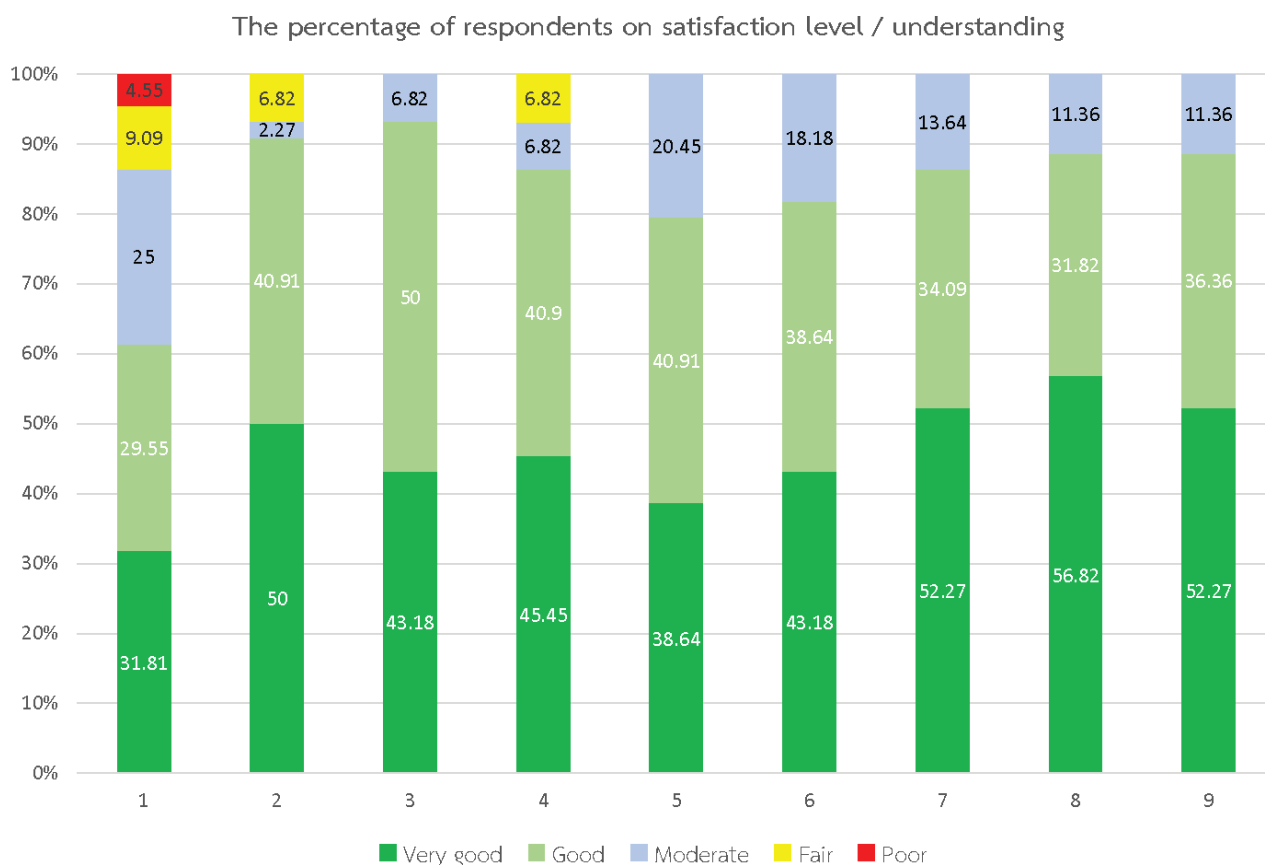


Figure 1 Percentage of satisfaction or understanding for each training session

Notes: 1) obtain information prior the training, 2) lecture on mother tree selection, 3) practice on teak propagation, 4) establishment of teak plantations, 5) lecture on intermediate silvicultural practices, 6) practice on intermediate silvicultural practices, 7) overall training contents, 8) training venue and accommodation, and 9) additional knowledge gained.

Section 3 Recommendations

The questionnaire also provided open-end questions and space for participants to present their feedbacks and recommendations to improve future training sessions. We obtained constructive comments and recommendations from 11 respondents. They are as below:



Comments and recommendations

1. In the next trainings, the vegetative propagation techniques and silvicultural practices of each member countries should be presented or discussed. And the demonstration of silvicultural practices in teak plantations should be done in another plantation that is government owned/managed.
2. Hope to improve practices and lecture about propagation and silvicultural practices next time.
3. Accommodation should have internet connection and there, should be time for discussions in groups with participants from each country to share knowledge and experience.
4. Please provide the technical guidelines for planting and management of teak plantations.
5. All participants should be introduced to each other with country and name of each participant posted on the desk they sit with their team. More practice should be applied and, the training should be for full 5 days as 3 days are too short.
6. Slide presentations by teachers must include hard copies for the participants. There must be some time for participants from the different countries to discuss, share and exchange knowledge and experience.
7. The training has provided new experiences to all of us but it was too short. Totally 5 days would be good for the presentations and training
8. In the next trainings, the vegetative propagation techniques and plus tree collection should be done by all participants and they should share experiences with the other country members. Classes in the vegetative propagation techniques should be added including bark grafting and cleftgrafting methods.
9. WIFI should be provided at the accommodation (translation).
10. Wood processing and livelihood income generation should be included (translation).
11. Group activities and team building activities are recommended (translation).

The training organizers thank respondents for providing valuable comments, accept their concerns and will improve the next training sessions accordingly.



List of Participants Attending the Training Workshop on Teak Propagation Technique and Silvicultural Practices

**5-9 August 2019 at Elephant Conservation Center
Lampang Province, Thailand**

Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply
Chains in the Greater Mekong Sub-region PP-A/54/331

NO.	Name-Surname	Role	Affiliation	E-mail/Tel
Project Staff				
1	Mr. Suchat Kalyawongsa	PSC com.	RFD	suchat_forester@yahoo.com
2	Dr. Saroj Wattanasuksakul	PSC com./Senior Expert	RFD	tic2508@gmail.com
3	Mrs.Chumnum Piananurak	Consultant# 2	Freelance	chumnunpian@gmail.com
4	Mr.Tosporn Vacharangkura	Consultant #5	Freelance	vtosp@hotmail.com
5	Prof. Yongyut Trisurat	RAM	Kasetsart University	fforyyt@ku.ac.th



NO.	Name-Surname	Role	Affiliation	E-mail/Tel
6	Miss. Saichon Mutarapat	Secretary	ITTO Teak Project	chon-ag44@hotmail.com
7	Miss. Suchanart Suyarat	Finance	ITTO Teak Project	plantz.sucha@gmail.com
RFD				
1	Mr. Hongsepijarn Buakhai	Technical Forestry Official	RFD	hongse57@gmail.com 092-2705771
2	Mr. Kritchana Nissa	Technical Forestry Official	RFD	092-4068844
3	Mr. Worapoj Khombai	Technical Forestry Official	RFD	093-2251588
4	Mr. Prapai Kaennark	Technical Forestry Official	RFD	081-6044916
5	Mr.Patawee Puthipairoj	Technical Forestry Official	RFD	080-1123095
FIO				
1	Mr. Somboon Kumsuwan	Chief of Huai Rabum Forest Plantation	FIO	065-0816320



NO.	Name-Surname	Role	Affiliation	E-mail/Tel
2	Mr. Sayan Mattayakhun	Chief of Lad Yao Forest Plantation	FIO	086-4465136
3	Mr. Rittee Kingtupluang	Chief of Mae Mo Forest Plantation	FIO	rittee_60@hotmail.com 098-7504228
4	Mr. Anuchit Kasian	Chief of Mae Sai Kham Forest Plantation	FIO	anuchitkachain@hotmail.com 083-9003143
5	Miss. Piamporn Sripatai		FIO	ninew_piams@hotmail.com 087-0563344
International Participants				
1	Mr. Dang Thinh Trieu		Vietnam	thinhtrieu@hotmail.com
2	Dr. Nguyen Van Bich		Vietnam	bichnv.fsiv@gmail.com
3	Mr. Dao Trung Duc		Vietnam	foresterk56@gmail.com
4	Mr. Bounthavy Chaleunsouk	Technical Staff	Laos	bounthavy99@hotmail.co.th
5	Mr. Saiyasith Phonphakdy	Technical Staff	Laos	saiyasith.p@yahoo.com



NO.	Name-Surname	Role	Affiliation	E-mail/Tel
6	Mr. Kikeo Singhalath	Technical Forest	Laos	singhalath00@gmail.com
7	Mr. Vichet Cheat	Technical Official	Cambodia	cheatvichet@yahoo.com
8	Mr. Sophea Phoung	Technical Official	Cambodia	simsophea91@gmail.com
9	Mr. Chandara Sin	Technical Official	Cambodia	sin.chandara@hotmail.com
10	Mr. Toch Kheng	Field Staff	Cambodia	khengtoch@gmail.com
11	Mr. Tin Hnaung Aye	Range Officer	Myanmar	tinhnaungaye@gmail.com
12	Ms. Shwe Lone	Technical staff	Myanmar	shwelone986@gmail.com
13	Ms. Phyu Phyu Hnin	Technical staff	Myanmar	phyuphyuhnin08@gmail.com
Smallholders				
1	Mr.Wipass Wasanasitthi		Farmer	081-9452394
2	Mr.Suchat Phunkerd		Farmer	089-9508510
3	Mr.Rungron Thangthongkun		Farmer	086-4921174



NO.	Name-Surname	Role	Affiliation	E-mail/Tel
4	Miss Chutima Janthongpakdee		Farmer	081-5651256
5	Mr. Montchai Pinthuprapa		Farmer	098-7463815
6	Mr.Vised Pheersai		Farmer	094-4739614
7	Mr.Thanathuek Thamdun		Farmer	097-2049663
8	Miss Kemarin Somwong		Farmer	087-1810096
9	Mr. Jongrak Srina		Farmer	099-8648360
10	Ms.Pirom Sadjawongkul		Farmer	080-1345829
11	Miss. Wipawan Wongsrikul		Farmer	081-5665901
12	Miss. Naphaphon Chumphai		Farmer	092-6514828
13	Mr. Adichart Chaitanuvong		Farmer	086-3860088
14	Mr. Praert Monkaew		Farmer	084-6128395
Supporting Staff for Training				
1	Miss. Kutlanitpitch Udomthanadech	Research Assistant	Mae Ngam Silvicultural Research Station(ngao.silvic@gmail.com



NO.	Name-Surname	Role	Affiliation	E-mail/Tel
2	Miss. banjanee suya	Staff	Northern Seed production Center	086-1179516
3	Miss. Apachara Meaungkom	Agriculture Staff	Mae Ka Silvicultural Research Station	088-4874590
4	Mr. Sutat Tapanyo	Research Assistant	Mae Ka Silvicultural Research Station	085-7101751
5	Mr. Lamduan Chanmoon	Agriculture Staff	Mae Ka Silvicultural Research Station	084-4890724
6	Miss. Phatcharin Yankhuan	Staff	RFD (Head Quarters)	097-9242301
7	Mr. Sompech Tasa	Staff	RFD (Head Quarters)	095-2783029



Concept Note



Joint Training Workshop on Teak Propagation Technique and Silvicultural Practice 5-9 August 2019 at Elephant Training Center, Lampang Province

Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region PP-A/54/331

1. Background and rationale

Teak (*Tectona grandis*) with its outstanding physical and aesthetic qualities is recognized as one of the most important and valuable hardwoods in the world. It has been used for many centuries for a range of products in furniture manufacturing and housing construction, as well as its cultural services. Natural teak forests covering an area of about 29 million hectares occur in central and southern India, Lao PDR, Myanmar and Thailand. However, natural teak forest area has reduced substantially in all native teak growing countries mainly due to over exploitation, agriculture expansion, and shifting cultivation. In particular, old-growth high-quality teak stands have declined significantly for many years and there is a high risk of losing their high diversity of genetic traits and wood characteristics.

The International Tropical Timber Council (ITTC) and International Union of Forest Research Organizations (IUFRO) at its 53rd Session in Peru and the Global Landscapes Forum in Bonn, Germany in 2017 approved an activity entitled “Enhancing Teak Management” to improve the management and marketing of both natural and planted teak in all three tropical regions. The Federal Republic of Germany through the Federal Ministry of Food and Agriculture financed the first stage of this activity in the Greater Mekong Sub-region (GMS). ITTO signed the Memorandum of Understanding (MoU) with Kasetsart University and assigned the Faculty of Forestry to serve as the Regional Project Manager to coordinate the implementation of the teak project with National Project Coordinators from 5 participating countries.



ITTO Teak Project in Mekong project aims to enhance the efficiency of natural teak forest management and forest plantations. Production and marketing by improving legal measures and regulations that facilitate sustainable teak production in the supply chain and enhance the quality of life for people and owners of small forest parks in the Greater Mekong Sub-region area. To enhance the efficiency of the smallholder community-based plantations and agroforestry system, the ITTO Teak Project in Mekong is planning to organize a training workshop on basic genetic improvement of teak and selection of materials for propagation, basic principles of plant propagation, techniques for propagating teak by using seeds and propagation without sex, principles of establishment of teak plantations. This activity is relevant to the Inception Report: Output 1, activity 1..3 and Output 2, activity 2..1)

2. Objective

- 1) To introduce participants to basic genetic improvement of teak and selection of materials for propagation.
- 2) To introduce participants basic principle of plant propagation.
- 3) To train participants on various techniques to propagate teak by using seed and vegetative materials.
- 4) To introduce participants to principle of teak plantation establishment.
- 5) To introduce participants to principle of intermediate silvicultural practice.
- 6) To train participants the technique of pruning, thinning, and coppicing of teak.

3. Participants of the meeting

This training Focus on providing knowledge to field staff and responsible office staff to become trainers (training for trainer) and are able to convey knowledge to interested people in planting teak in the future. Potential participants are from both Thailand and the participating countries. In addition, individuals, private sectors and small farmers are targeted. List of participants as follows:

1) Royal Forest Department	5	persons
2) Forest Industry Organization	5	persons
3) Private and smallholder teak plantations	20	persons
4) Officials or smallholders from the remaining 4 participating countries (3 persons each)	12	persons
Total	42	persons

It should be noted that the Project aims at having the same participants attending a consecutive training workshops throughout the project periods and become trainers later.

4. Work Plan and Process

- 1) Arrange a consultation meeting with Consultants#2 and #5 and project team (10 June 2019)
- 2) Propose a training plan and content (see table)
- 3) Notify relevant agencies in order to nominate training participants



- 4) Conduct reconnaissance survey to determine demonstration plots and field visit sites, as well as training facilities (8-10 July 2019).
- 5) Conduct actual training workshop consisting of lecture on theories, hand-on practices and study visits in nearby areas
- 6) Evaluate training satisfaction, summary and report to the Project Technical Committee and Project Steering Committee, respectively.

5. Language used in training

Thai and English (for trainees from abroad)

6. Training period time and venues

- 1) 5 Day's period (5-9 August 2019)
- 2) Lecture: Elephant Training Center, Hang Chat District, Lampang Province
- 3) Field practices and field visit: Northern Seed Center, Lampang Province; Mae Ka Silviculture Research Station, Phayao Province; Khun Mae Kham Mee Silviculture Research Station, RongKwang District, Phrae Province; Uttaradit Province

7. Responsible agency

ITTO Teak Project in Mekong 'Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region' PP-A/54331

8. Budget

Budget from the project to Enhancing Conservation and Sustainable Management of Teak Forest and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region (budget item activity C43: Training cost)

9. Expected outputs

- 1) Trainees are able to identify highly improved genetic materials to be used for their own conditions.
- 2) Participants are able to choose the right technique to propagate teak from different stages of materials and situation.
- 3) Participants are able to propagate teak using various techniques.
- 4) Participants know how to establish teak plantation.
- 5) Participants understand the plantation management and intermediate silvicultural practice of teak plantation.
- 6) Participants are able to perform pruning, and thinning techniques correctly.
- 7) Participants have an opportunity to exchange experience among each other and the trainers and plantation owner.

10. Monitoring and evaluation

- 1) Daily wrap-up and recommendation for adaptation
- 2) Deliver and gather a questionnaire before and after completion of training program
- 3) Summary and report to the Project Technical Committee and Project Steering Committee, respectively

TRAINING WORKSHOP PROGRAM
"Teak Propagation Technique and Silvicultural Practice"

5 August 2019

17.30 –19.00	Arrival of participants	Transportation provided from Chiang Mai Airport to Hotel at Elephant Training Center, Hangchat district, Lampang
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6 August 2019

07.00 – 08.00	Breakfast	
08.00 –08.30	Registration	Meeting Room of the Hotel,
08.30 –09.00	Opening ceremony and group photo	
09.00 –10.00	Lecture on Selection of High Quality Genetic Materials for Propagation	Mrs. Chumnun Piananuruk (consuktant#.2)
10.00 –10.15	Coffee Break	
10.15–11.00	Lecture on Seed Propagation and seedling/stump production of teak.	Mrs. Chumnun Piananuruk (consuktant#.2)
11.00–12.00	Lecture on Vegetative Propagation techniques of teak.	Mrs. Chumnun Piananuruk (consuktant#.2)
12.00–13.00	Lunch	
13.00–14.30	Field Practice on "Vegetative Propagation Techniques:- Budding and Rooted Cutting"	Mrs. Chumnun Piananuruk (consuktant#.2)and team
14.30 –14.45	Coffee Break	
14.45–16.30	Field Practice cont.	Mrs. Chumnun Piananuruk (consuktant#.2) and team
16.30 –17.00	free time	
17.00 –20.00	Welcoming Dinner	



7 August 2019

07.30 – 08.00	Breakfast	
08.00 –10.30	Lecture on "Establishment of Teak Plantation"	Mr. Boonlert Srisuksai (invited speaker)
10.30 –10.45	Coffee Break	
10.45 –12.00	Lecture on "Establishment of Teak Plantation" (cont.)	Mr. Boonlert Srisuksai (invited speaker)
12.00–13.00	Lunch	
14.30–16.00	Field Excursion “Thinning in teak plantation” at Thungkwian Teak Plantations	
16.30 –17.30	Free time	
17.30 –20.00	Welcoming Dinner	

8 August 2019

07.00 – 08.30	Breakfast	
08.30 – 10.00	Lecture on "Intermediate Silvicultural practice"	Mr.Tosporn Vacharangkura Consultant#5
10.00 –10.30	Coffee Break	
10.30 – 12.00	Lecture on "Intermediate Silvicultural practice"(cont.)	Consultant#5
12.00 –13.00	Lunch	
13.00 –14.00	Visit Elephant Training Center	
14.00 –14.30	Transport provided to Mr.Suchat Phunkerd’s teak plantation at Hangchat district, Lampang	
14.30 –16.00	Practicing on intermediate silvicultural practice at the plantation.	Lunch and break will be served during the practicing.

16.00 –16.30	Travel back to the Hotel at the Elephant Training Center.	
16.30 –17.30	free time	
17.30 –20.00	Welcoming Dinner	

9 August 2019

	Departure of All Participants	Transport provided to Chiang Mai Airport
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Remark

- Schedule may be changed as appropriate.

