BMEL-ITTO Project:
"Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region"

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Federal Ministry of Food and Agriculture

BMEL-ITTO Project:
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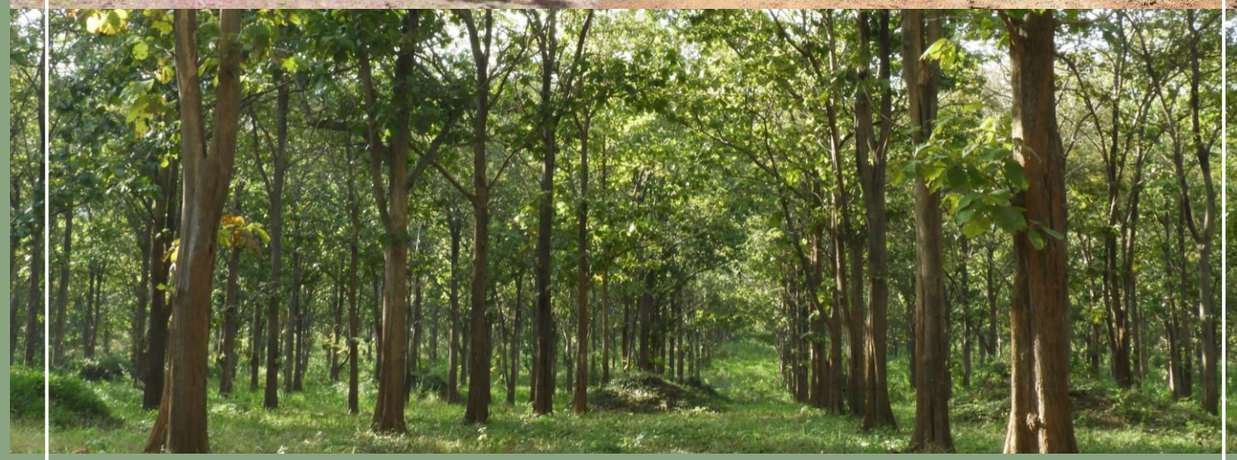
policy for engagement of smallholders in teak forest conservation, management, and teak product development and marketing

Promode Kant

Technical Report



Technical Report

PRODUCTION OF GOOD-QUALITY PLANTING MATERIAL

By

Promode Kant

BMEL-ITTO Project:

"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)

CONTENTS

ABBREVIATIONS

CDM	Clean Development Mechanism
DBH	Diameter at Breast Height
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization of the United Nations
FLR	Forest Landscape Restoration
FSC	Forest Stewardship Council
GMS	Greater Mekong SubRegion
HSWC	Hardwood Selection Working Circle
ITTC	International Tropical Timber Council
ITTO	International Tropical Timber Organization
LSWC	Local Supply Working Circle
MAI	Mean Annual Increment
MSS	Myanmar Selection System
MTE	Myanmar Timber Enterprise
PDR	People's Democratic Republic
PTC	Project Technical Committee
REDD+	Reducing emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks
TSWC	Teak Selection Working Circle
USA	United States of America
EU	European Union

Introduction

Background

Teak with its outstanding physical and aesthetic qualities is recognized as one of the most important and valuable hardwoods in the world. Natural and planted teak forests are found in about 70 tropical countries in Africa, Asia and Latin America. Given the importance of teak's prominent position in the global timber market and its potential to contributing to national economic growth and local livelihoods, the International Topical Timber Council (ITTC) at its 53rd Session in Peru in 2017 approved an activity entitled "Enhancing Teak Management" under ITTO Biennial Work Program for 2018-2019 as a comprehensive global activity to improve the management and marketing of both natural and planted teak in all three tropical regions. The project is titled "**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)** and the Global Landscapes Forum in Bonn, Germany, extended support to it in December 2017. The duration of the project is 3 years (36 months) from March 1, 2019 to February 28, 2022.

In November 2018, 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. ITTO has been supporting teak related projects with a focus on genetic resources conservation and sustainable management of natural and planted teak forests in Africa, Asia and Latin America since the 1990s. Based on the such extended work of ITTO on teak, this project aims to assist governments, local communities and smallholders to enhance natural teak forest management, production and marketing through the establishment of legal and sustainable wood supply chains to improve local economy and local communities' livelihood in the Mekong region. The teak project has commenced since 1 March 2019 in five countries, namely Cambodia, Lao PDR, Myanmar, Thailand and Vietnam with contribution of implementing agencies in the five countries.

Project Objective

The objective of the Project is to demonstrate legal and sustainable teak supply chains with the engagement of local communities, smallholders and government actors in the Greater Mekong sub-region (GMS).

The outputs of the project are

1) The conservation of teak genetic resources, sustainable management and use of natural teak forests and market accesses of teak from legal sources have been shown,

2) Community-based and smallholders teak forest management and agroforestry systems have been strengthened with improved legal and sustainable supply chains, and

3) Regional and international collaboration, information sharing and knowledge management, networking, policy development and outreach on the sustainable management of teak forests, including sustainable use of teak genetic resources have been strengthened.

Natural teak forests covering an area of about 29 million hectares occur in central and southern India, Lao PDR, Myanmar and Thailand. Within the Greater Mekong sub-region Myanmar has the largest area of natural teak forests (almost 16 million ha) and is the number one producer of teak logs in the world. Thailand has the second largest area of natural teak forests after Myanmar at an estimated 8.7 million ha, all of which are located in protected areas.

The participating countries in the Greater Mekong sub-region include Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. These five participating countries are home to more than 300 million people. It is a very dynamic and fast-changing region that has made significant socio-economic progress from 1990 onwards resulting in major impacts on natural and forest resources.

The Project Activity is aimed at assisting governments, local communities and smallholders to enhance natural teak forest management, production and marketing to facilitate the establishment of legal and sustainable wood supply chains while improving national economy and local communities' livelihood in the Greater Mekong Sub-region. The Activity provides an opportunity for the recipient countries to build-up sustainable forest management capacities and to further pursue their strategic objectives and policies on the sustainable development of teak forest resources, which are of particular livelihood improvement and ecological significance in all countries of the Greater Mekong Sub-region.

Principal Tasks

In order to implement the ITTO Teak Project in Mekong effective, the **Consultant#8: Forestry Policy** is responsible for analyzing policies and regulations that have a bearing on local communities and smallholders in natural and planted teak, teak management, and agroforestry systems to support sustainable livelihood programs and sustainable harvesting of teak timber in the five participating countries (Activity 2.4).

The principal tasks of the **Consultant No. 8** on **Forestry Policy** is to analyze and propose enabling policies and legal frameworks to support the establishment of community or small holders based teak forest management and agroforestry programs.

The specific functions and responsibilities include:

- Undertake a literature review, and compile relevant reports and information from the outputs of the activities focusing on promoting the engagement of community or small holders in teak forest management and teak-based agroforestry
- Assist in producing policy briefs summarizing outcomes of this activity in the English language in consultation with the Regional Activity Manager.
- Formulate enabling policies and legal frameworks to support the establishment of community or small holders based teak forest management and agroforestry programs in the participating countries – Cambodia, Lao PDR, Myanmar, Thailand and Vietnam
- Work closely with the Regional Activity Manager to organize a policy dialogues/ workshops organized by the Regional Activity Manager
- Present activity outcomes, results and findings to the Project Technical Committee (PTC)
- Incorporate comments provided by the PTC members and stakeholders in the final report.

- Compile all results and findings, incl. recommendations for follow-up actions, in a final report in the English language to be submitted to the Regional Activity Manager
- Available to provide recommendations and advises to National Coordinators, PTC members (if any).
- Undertake international travel, as and when required

The duration of the assignment is 2 man-months from 01 April 2019 to 28 February 2022.

Deliverables

The consultant is expected to submit the following outputs to the Regional Activity Manager:

i. Policy briefs focused on issues of community and small holders' engagement in teak conservation, management, product development and marketing (around 4 pages per issue; three issues - initial (introduction), mid-term (mid-term results) and final (final results)
ii. Report of assigned training/workshop
iii. A brief travel report (if any)
iv. Technical report – Enabling policies and legal frameworks to support the establishment of community or small holders based teak forest management and agroforestry programs in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam

Literature review

A thorough literature review of published articles as well as those accepted for publication on topics that have a bearing on this Consultancy work was taken up. The following is the summary of the review of some of the more relevant papers studied for this purpose.

(A) **Mapping of Natural Teak Forest and Teak Plantations in Mekong Region** is as yet unpublished chapter in the proposed book on Teak in the Mekong Region authored by Dr Chakrit Takuathung of the Kasetsart University and, as the title implies, maps the natural and planted teak in the Mekong region. Teak is distributed from 73°E in India to 104°30´E in Thailand and from about 25°30´ N in the Kachin State of Myanmar to its southern boundary at 9°N in India, 15°-16°N in Myanmar, and 16°30´N in Thailand over an estimated area of 29.04 million ha with 13.5 million ha growing in Myanmar alone. It was introduced to Java some 600 years back. Myanmar, India and Indonesia between themselves hold more than 95% of the world's natural and more than 75% of the world's planted teak forests. The plantation area reported in 1975 at 2.25 million ha increased to 4.35 million ha by 2010 even as the area and growing stock of natural teak forests has decreased significantly, even sharply as in Lao PDR where the extent of natural forests fell from nearly 70000 ha in 1976 to barely 1100 ha in 2021 and in Thailand from 16 million ha in 1960s to barely 8.7 million ha at present. In many countries of the region there is either a complete ban on logging in natural forests as in Thailand and Lao PDR or severely restricted as in India and the focus of countries' policies have shifted towards an emphasis on forest protection and conservation, setting aside wood production

targets. In Cambodia and vietnam there are no natural teak forests and the governments are encouraging teak plantations by smallholders as well as corporates.

(B) Thomas Enters' article titled **"Site, technology and productivity of teak plantationsin Southeast Asia"** published in January 2000 issue of Unasylva 51(201):55-61 gives a neat overview of the situation surrounding teak in the southeast Asia in presenting the conclusions and recommendations of a regional seminar organized by FAO's Forestry Research Support Programme for Asia and Pacific held in Thailand in early 1999. Owing to its very high economic value teak has a long history of protection and scientific management that began in mid nineteenth century in Myanmar through the agency of the East India Company from where it was introduced to India and Thailand well before the end of that century. Teak plantations have been raised over almost all of South and South East Asia since it is evident that the natural forests can not meet the ever increasing demand for this outstanding timber.

Once the exclusive domain of the governemnt forest departments Teak is today also attracting the farmers and a shift from large government owned to small farmer owned plantations can be seen throughout the region. This has inescapably led to shorter rotations from previously prevailing long rotations as small landholders can not wait for too long for the expected economic benefits. Advances in tree breeding and mass multiplication techniques have enabled the production of high quality planting material at scale with scores of private companies taking advantage of these technical developments. Incentives offered by many governments in the region has also encouraged tree growers into these ventures. But much way is yet to be covered as policies and laws restricting harvest and transport of teak, introduced to protect natural forests in the past but applicable on the teak grown in plantations, act as disincentives to private sector investment in teak.

Mean Annual Increments (MAI) in government owned plantations generally range from 2 to 5 m^3 per hectare and are often below the potential yield of the site owing largely to poor management and low or delayed inputs along with illegal and unsustainable removal, wildfires, infestations of insects and pests and disease outbreaks. When these limiting factors are addressed enhanced MAI from 8 to 12 m^3 per hectare can be expected. Yields of 15 to 20 m^3 per hectare per year on a short rotation of 20 years may be considered the upper limit and claims of higher yield levels should be treated with caution. Since site quality has a dominant role in deciding the productivity it is important that the criteria for site selection for teak plantations should be refined, harmonized and widely disseminated.

Enters further recommends that a network of permanent sample plots covering the entire range of growth conditions and management conditions should be established in the countries of the region and improved national tables giving growth and yield estimates under these wider ranges of site and treatment conditions should be prepared and made available to teak growers. Also, in order to facilitate comparisons common standards and definitions need to be adopted.

In suggesting potential areas for management research in teak Enters states that the impacts of long, medium and short rotations on environment and on teak production have not yet been systematically assessed. Some evidence exists regarding changes induced in site quality by teak plantations but the causes of productivity decline requires deeper research before firm advisories can be issued. Presently site quality assessments are based almost exclusively on growth parameters which is the right thing to do in case of commercial timber production but not when ecological and biodiversity values are considered more desirable where biophysical

and chemical characteristics may assume criticality. Site management to sustain and enhance productivity may involve changes in silvicultural prescriptions, soil conservation measures and fertilizer application.

For control of pests and diseases Enters recommends research on biological control measures, as by Bacillus thuringiensis and nuclear polyhedrosis virus, to facilitate large scale application and to overcome resistance. Mixed stands are claimed to act as barriers to the spread of infestations, but this needs to be established by hardcore research. Integrated pest management models that are effective as well as economical need to be designed.

With sharply increased demand for teak products in China, India, and across Europe and USA, and continually decreasing supplies from natural forests, investments in teak plantations have a good future ahead. Studies on historical prices for teakwood suggest an upward trend but more global,regional and national research is needed to assess the longterm demand, supply and price trends for teak taking into account the segmented nature of the market, and the variation in wood quality and wood dimensions.

Existing national grading systems for teak timber need to be reviewed and changed as necessary, taking into account the quality and dimensions obtainable from shorter rotation plantations in end harvest as well as thinnings. Investors in teak plantations expect interim incomes from small-diameter wood obtained from thinnings. Profitability is also affected by the higher proportion of sapwood, the variability in physical and mechanical properties, the appearance of the wood in comparison with larger diameter wood from natural forests and long rotation plantations. Difficulties in processing and marketing smaller dimensions also deters smallgrowers.

Enters observes that in areas with a long history of Teak plantations, short rotations and small dimensions do not seem to pose problem as not only wood utilization technologies have improved but diverse demand structures have also evolved over time thereby facilitating the use of smaller dimensions. The current and potential uses of small dimension plantation wood from teak plantations should now be assessed recognizing dynamic these changes.

On the cost-benefit analysis of long rotation plantations exceeding 50 years Enters estimates that with an MAI of 3 m^3 per hectare that includes all wood removed from thinnings and final felling, teak plantations would yield a rate of return of over 15 percent assuming low initial investments, no opportunity cost for land, marketability of wood from all thinnings, and continued increase in the prices of teak timber as suggested by the current trends.

Enters recommends carrying out rigorous cost-benefit analyses that take into account the different environmental conditions, management regimes, and accesible markets to prevent speculative investment based on misleading claims. These studies should include correctly valued labour and material inputs and should not ignore the true opportunity costs of land for a smallowner who does not have excess lands.

On certification Enters would like both the public and private sectors investing in teak to be aware of the measures to be taken, and the costs thereof, to comply with environmental standards required in certification process. Higher prices in niche markets where consumers are prepared to pay a premium price for teak obtained from sustainably managed areas are an incentive to produce certified timber. But the additional costs involved in obtaining certification, particularly for smallgrowers, are often prohibitive. And also the niche markets

willing to pay higher prices for certified timber are not accessible to most smallgrowers. It would require considerably more time for the widespread emergence of a clear consumer preferences for certified timber.

Intensively managed plantations that require continuous human attention has the potential to provide employment and income to the rural economy but very few studies have been carried out on the socio-economic benefits of Teak plantations. National and international agencies should strive to promote best practices in the management of teak. Such efforts are particularly required to ensure smallscale growers' ability to manage plantations sustainably.

Enters argues that existing policies and legislation in several countries are not conducive to private sector involvement in planting of teak with the tenure insecurity and restrictions on felling and transport of teak, intended to protect governemnt owned natural forests and plantations acting as disincentives and suggests a thorough review of current policies relating to tenure, royalties, taxes and rules and regulations covering the harvesting and transport of teak wood, and their impact on investment in teak plantations.

Enters finds the loan financing arrangements for raising tree plantations inadequate and mechanisms linking potential investors with teak growers underdeveloped, particularly for smallholders whose access to institutional financing is non-existent in most places. Investment in teak plantations of all sizes should be declared as a "green investment" and attractive financial and tax incentives provided to promote these teak plantations. The tax incentives can also be linked to the length of rotation which would help encourage the growing of larger sized teak timber.

Enters recommends strengthening of international collaboration in situ and ex situ conservation, provenance identification and testing, standardization of registration and description of clones, and formulation of common methodologies and procedures to allow comparison of results across countries. Collaborative efforts at the regional and global levels are particularly important for testing clones in a variety of sites and under diverse conditions and for developing technical guidelines for the exchange of genetic materials. National efforts to collect growth and yield data could be complemented through a network of permanent sample plots. The conservation of teak genetic resources and the monitoring and control of transboundary pests and diseases are other important areas for collaboration.

International collaboration on products and markets and for standardization of definitions in relation to technology, markets and prices is urgently needed. Such collaboration is particularly relevant for the standardization of grading rules for teak timber and for carrying out research on demand, supply and prices of varying grades of teak.

Enters recalls the collapse of several "teak schemes" across the tropical world in the recent past because of the unjustifiably high financial returns they had promised and emphasizes the need for transparent sharing of information across the public sector-private sector divide.

(C) The Department of Forests, Ministry of Agriculture and Forestry, Lao PDR, in its article titled **"Teak in the Lao People's Democratic Republic"** published by the FAO in https://www.fao.org/3/AC773E/ac773e0e.htm offers an overview of the status of teak in Lao PDR. The natural teak stands of Lao PDR are a continuation of the teak forests of Myanmar and Thailand and occurs throughout the north west of the country where the ecological conditions are similar. These natural teak forest used to cover an area of upto 20,000 ha in

Xayaboury Province west of the Mekong river on the Thailand border and upto 10,000 ha in Bokeo Province east of the Mekong river till a few decades back but have been rapidly depleting in the recent years and only a fraction of these original forests remain constituting approximately 15% of the total forest area of the country.

Teak is mostly found in Mixed Deciduous Forest, associated mostly with bamboo and trees of genus Lagerstroemia, Hopea, Dipterocarpus and Shorea, scattered individually or in groups forming pure stands. Forest management practiced in the past was a Modified Uniform System intended to convert the forests through clear felling by stages, encouraging regeneration by bamboo cut back and thinning in dense patches, and retaining high quality immature trees. Now felling in natural forests is prohibited. Teak plantations are raised by taungya with government assistance of subsidised seedlings. Important plantation activities are weeding and thinning.

The policies on the utilisation and management of natural resources were reviewed at the first National Conference on Forestry, held in Vientiane in May 1989 and emphasize the need to reduce shifting cultivation and control deforestation. The forest conservation, development strategies, and targets adopted to the year 2000 were to:

1. Protect the biological resources of existing forests and to develop and rehabilitate these resources, especially by improving the forest management and protection system presently operating.

2. Effectively maintain the economic utility of the forest resources and to ensure forest utilisation to appropriate use.

3. Link reforestation, forest protection and other forest development programmes to the creation of fixed locality settlements and food supply needs of the upland people, especially of those living in the northern region.

To achieve these goals the Government has sought to establish permanent habitations for 277,000 upland families practicing shifting cultivation and protect the watersheds of 80 streams and rivers by rehabilitation and protection of the forests situated in these watersheds and by the reforestation of the eroded areas.

Government forestry policies allow the allocation of forest lands, both degraded and well-forested, to local people on a household basis to manage and protect thereby granting security of land tenure to the rural people and to transmit their inheritance to the next generation. Government forestry units at all levels are expected to act as the servicing units for the local people and provide technical assistance in extension techniques for farming, forest and fruit tree planting, seed and fertilizer supply. District Protection Units are expected to send their officials to work directly in the commune as in-charge of forest management and protection at this level. Policy results expected are good quality forests and quality seed collection for plantations.

(D) Ko Ko Gyi and Kyaw Tint of Forest Department, Ministry of Forestry, Yangon, Myanmar, in their article titled **"Management status of natural teak forests"** published by the FAO present an excellent overview of teak forests and plantations in Myanmar.

Forest management in Myanmar has evolved over several centuries when the Myanmar kings formulated a system designed to maximize revenue and control over teak forests and exporting high value teak timber for ship building. Until recently the guiding principles of forest management in Myanmar had been derived from a policy document prepared in 1894. The Myanmar Forest Policy 1995 recognizes the following six imperatives:

1. Protection of soil, water, wildlife, biodiversity and environment;

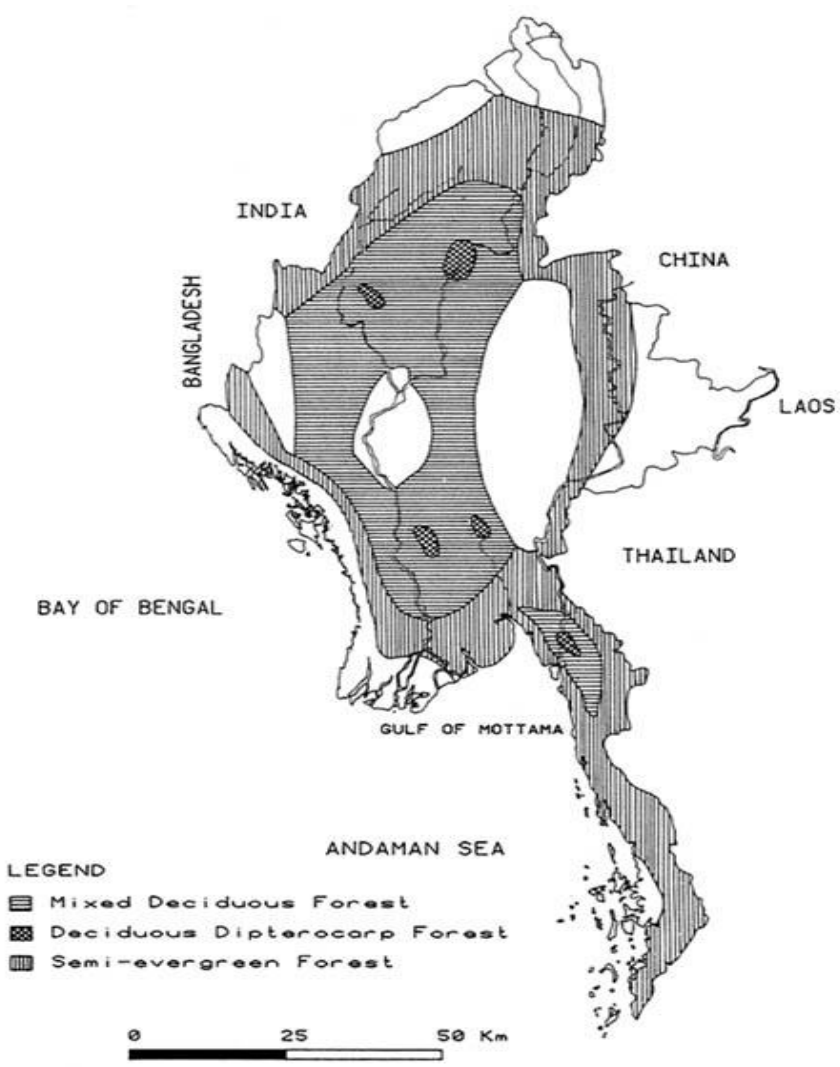
2. Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for the present and future generations;

3. Basic needs of the people for fuel, shelter, food and recreation;

4. Efficiency to harness, in a socio-environmentally friendly manner, the full economic potential of forest resources;

5. Participation of the people in the conservation and utilization of the forests; and

6. Public awareness of the vital role of the forests in the well-being and socio-economic development of the nation.



For management purposes the forests of Myanmar are organized in 1) teak selection working circle (TSWC, 16.5 million ha); 2) non-teak hardwoods working circle (HSWC, 17.9 million ha); and 3) local supply working circle (LSWC, 0.5 million ha) formed on the basis of accessibility and also on the nature and form of forest produce available. The TSWC and HSWC working circles are worked under the Myanmar Selection System (MSS) while in LSWC either coppice or coppice with standards systems are practiced. The working circles are divided into felling series for the convenience of working according to the drainage and the geographical situation and further sub-divided into compartments that are the basic management units except in LSWC where the annual coupes are the basic management units.

Under the Myanmar Selection System, a Felling Series is divided into 30 blocks of approximately equal yield capacity. Each year, selection fellings are carried out in one of these blocks and the whole forest is thus worked over in the felling cycle of 30 years. Under this system all marketable trees which have attained a fixed exploitable girth (73 cm DBH in moist teak forests and 63 cm DBH in dry teak forests) are selected for cutting.

Diseased trees that have not attained these sizes, but are marketable, are also selected for cutting if they are unlikely to survive till the subsequent felling cycle. If seed bearers are scarce, some high quality stems are retained as seed trees. Mature teak trees selected for exploitation are normally girdled and left standing for 3 years before being felled and extracted to make them loose sap, season the timber, and make it floatable, as the logs are normally transported by floating them down the streams and rivers. With regard to the practice of girdling teak, Brandis (1896) had observed "this excellent practice, as a matter of course, I maintained, but one of the many battles I had to fight during my Indian career was against those who condemned this practice as useless, as barbarous, as injurious to the timber, and likely to damage the reputation of Burma teak, while others described girdling as the outcome of German theories. In reality it was an old Burmese practice, to which the good reputation of Burma teak was mainly due."

Improvement fellings are carried out concurrently with girdling. In this operation, inferior tree species that are competing or suppressing teak trees are felled in favour of teak. Thinnings are carried out in crowded young teak stands.

The Myanmar Timber Enterprise (MTE), employing nearly 50,000 staff and operating 38 extraction and rafting agencies, holds a monopoly over the extraction and marketing of teak in the country. Stumping and dragging of teak logs to the edges of floating streams are carried out mostly by elephants and on some occasions by oxen and water buffaloes. MTE today own nearly 3,000 elephants and uses upto 6,000 for timber harvesting hiring them from the private sector. Elephant logging is the least damaging to the standing trees and environment. Bulldozers and other machinery are used mainly for road construction and the loading, unloading and transport of logs. A completely mechanized extraction will not be economically feasible as only about 2-3 trees/ha/cycle are harvested, and the operation would also be destructive to the remaining trees and environment under the MSS.

(E) The Forest Science Sub-Institute of Southern Vietnam of the Ministry of Forestry, Government of Vietnam, in their article titled **"The management and prospects of teak in Vietnam"** published by the FAO present an overview of teak growing in Vietnam. Vietnam has no natural teak forests. It was first introduced in the country by the French in the end years of the nineteenth century and planted along roads and in public parks around French buildings. As the climatic and edaphic conditions in the south are more suitable for teak, it was planted on a small scale from 1952 and by the 1960s there were nearly 300 ha of plantations mainly

concentrated in Dong Nai and Songbe Provinces most of which were destroyed during the War. Since then teak planting has been encouraged by the Government.

Plantation teak wood is of lower value compared with many indigenous species but as its growth rate is much higher than that of these high quality indigenous species, the Ministry of Forestry is promoting its development in large-scale plantations. Since its rotation period is longer than that of fast-growing species such as eucalypts and acacias, private investors prefer these species over teak as a result teak is mainly planted by the Government financed by national funds.

At present the main considerations on teak are 1) genetic improvement of teak seed sources; 2) mapping of suitable teak planting sites; and 3) development of comprehensive technical packages of raising, tending and thinning of teak plantations.

So far the genetic improvement of teak seed sources has relied on the existing plantations but with their narrow genetic base this must change quickly. Thus, genetic improvement work on Vietnamese teak becomes a top priority through provenance trials from the best exotic sources and their comparison with local seed sources under different environments in southern Vietnam, and the establishment of seed orchards and development of micro-propagation techniques for supplying improved planting materials to the smallholders as soon as possible.

(F) In their article titled **"Teak plantations in Vietnam"** submitted for publication in the IITO Book on Teak in the Mekong Region, Dr Dang Thinh Trieu, Tran Lam Dong and Nguyen Van Bich of the Silviculture Research Institute, Vietnamese Academy of Forest Sciences, review the history of teak in Vietnam and describes its current status. Teak, introduced to Vietnam in early 20th century, has high adaptation to a wide range of climate condition from the North to the South in Vietnam. It has been planted mainly as a monoculture plantation (89.3%) and only occasionally as mixed species plantation (10.7%). The productivity of teak in Vietnam ranged 7-16 m^3/ha/year across different ecological conditions and economic returns from teak plantations are significantly higher compared to those of short rotation species such as acacia and eucalypt. Major challenges for greater acceptance of teak by smallholders in Vietnam are its long harvesting rotation and lack of availability of high quality planting stock. For smallholders who cannot afford to invest in long-rotation crops, teak based agro-forestry is a potential model which can help them earn significant incomes in the years before harvesting. Although teak timber value is much higher than acacia and eucalypt timber in Vietnam, the value chain of teak timber in Vietnam is still disadvantaged in comparison with acacia and eucalypt timber. Research on value chain and promotion of using teak timber in the wood industry in Vietnam may increase the demand for teak timber and its plantations.

(G) Tosporn Vacharangkura in his article titled **"Effects of First Thinning on Growth and Stem Form of Teak Plantation in Thailand"** to be published in the ITTO Book on Teak in Mekong has reported a thinning experiment in Uttaradit Province in northern Thailand involving removal of basal area at levels of 0% (control), 30% (light), and 50% (moderate) and growth measurement after four years. Results reveal moderate thinning provided the largest mean basal area and mean stem volume of individual trees in the stands compared with the other treatments while increase in total stand volume per hectare was the largest in lightly thinned plots and differed significantly from control plots, but no significant difference was noticed from moderately thinned plots.

A part of total stand volume in control plots was lost through natural mortality. In the thinned plots, natural mortality was significantly lower compared to the conrol plots. The mean DBH increment of all trees as well as the mean DBH increment of the dominant trees increased with increasing thinning intensity. The mean DBH increment of all trees in control plots was similar to those in lightly thinned plots. In contrast, total height increment of all trees and the dominant trees were not affected by thinning intensity. Live-crown ratio, slenderness ratio, and absolute form factor of the trees in the stand were affected by different thinning intensities. Live-crown ratio increased with greater thinning intensity while the opposite happened to the slenderness ratio. The absolute form factor was smallest in control plots, and different thinning intensities had clear effects on the absolute form factor. Thus, thinning intensity resulted in improved growth and yield of stands as well as individual tree sizes and tended to have positive effects on stem form.

(H) Anis Fauzi, Anto Rimbawanto of the Centre for Forest Biotechnology and Tree Improvement, Yogyakarta, Indonesia, in their article titled "**Teak Small Holder Plantation in Indonesia for Improving Livelihood"** accepted for publication in the ITTO Book on Teak in the Mekong Region state that small holder plantations of teak are an important source of timber in Indonesia as well as in other tropical countries in Africa, South and Central America. Forestry Law No. 41 of 1999 of Indonesia defines a small holder plantation as forest belonging to people with holdings of at least 0.25 ha planted with 50% tree species mixed with other crops or trees of around 500 stems per ha. Over 1.5 million small-holder farmers in Java, Indonesia, manage nearly half a million hectares of tree-based agroforestry systems, with teak being the most common tree crop. The small to medium scale industry in Java receives up to 80% of small sized logs of diameter less than 30 cm from smallholder plantations. Small holder plantations have the potential to produce up to 8.2 million m^3 of teak every year in Indonesia alone. Teak from these plantations is widely used in Indonesia's furniture industry, therefore, the future of small-holder teak plantations looks bright. Farmers' economic gains can be maximized if they can have easy access to high-quality planting stock, apply proper silviculture techniques, and use a cooperative system for marketing their produce.

(I) Rimbawanto and Nurtjahjaningsih of the Centre for Forest Biotechnology and Tree Improvement, Indonesia, in their article titled **"Indonesia's Teak Resources, Breeding and Biotechnology"** accepted for publication in the ITTO Book on Teak in the Mekong Region state that since teak is a slow-growing species with rotations of several decades it is important to be assured in advance of the quality and productivity of teak that would be produced after such a long wait. Published data on teak productivity ranges from 5 to 10 m^3/ha/year under long rotation and 10 to 20 m^3/ha/year under short rotation of up to 20 years with a mean productivity of 0.03 m^3 per tree in a year under suitable conditions. In Java the productivity of selected clones is between 0.028 to 0.043 m3/tree/year. A trial in west Java of clone of Nusantara superior teak shows MAI of 0.039 m3/tree/year. Genetic improvement is dependent on a species' existing pool of genetic variation understanding which is important for matching a well-adapted seed source to a suitable physiographic location. A study on genetic diversity of teak resources in Indonesia has reported that genetic diversity among 30 populations of teak was moderate with He 0.184 and mean genetic distance between populations of 0.441. Compared with other native origins the teak populations from Myanmar have the highest genetic diversity, allelic richness, and moderate genetic divergence and, thereore, Myanmar teak genetic resources should be prioritized for in-situ conservation efforts. DNA markers are rapidly being developed and applied for the genetic study of teak, such as genetic conservation of teak, and genetic improvement. DNA markers are also being used to support timber legality, such as distinguishing species, the population of a species and individuals of the same species.

(J) Dr Nopparat Kaakkurivaara in her article titled **"Teak timber harvesting"** accepted for publication in the ITTO Book on Teak in the Mekong Region states that harvesting and extraction operations are the activities that generally cause the most significant impacts on forest and environments in forestry. The impact of harvesting and extraction can be reduced through proper planning and control of harvesting operations using sound principles, systems, and techniques that have stood the test of time. Successful harvesting should be (a) technically feasible considering physical limitations, engineering knowledge, and environmental relationship of the forest, (b) economically viable considering the costs and benefit of short and long range consequences, (c) environmentally sound considering impacts on the natural and social environment, and (d) institutionally feasible considering laws and regulations, landowner objectives, and social values. The most common cause of accidents during harvesting is the workers' lacks of knowledges or skills and repeated training is the most effective tools for reducing risks. Wearing suitable Personal Protective Equipments (PPE) provides protection when all other control measures cannot adequately eliminate or minimize risks to a worker's health and safety.

(K) Dr Chumnun Piananurak in her article titled **"Teak plus tree selection and propagation techniques used in Thailand"** accepted for publication in the ITTO Book on Teak in the Mekong Region states that the characteristics for selection of Plus trees are dependent on the end use of the wood produced. Since teak fetches highest prices when usable as veneer, marine decking, furniture, etc., its stem form and wood texture are the most important traits for selection. Once selection is completed its propagation is carried out both by seed and vegetative means. Propagation by seeds is the technique mostly used by small farmers and, therefore, there is a need to establish more seed orchards to produce enough high quality seeds for plantation. Vegetative propagation is carried out by budding, rooted cutting and tissue culture each of which have their specific advantages and disadvantages and suitable technique should be used in order to obtain highest advantage on balance. Budding is most successful when propagating mature material because budded shoots are rejuvenated and become suitable for carrying out rooted cutting or tissue culture. The technique is, therefore, recommended for application in first stage propagation of Plus trees subsequent to which other techniques can be used as needed. Rooted cutting is the cheapest, most successful, and easiest method to propagate juvenile material of teak but is less successful when mature material is used. In the establishment of clone bank, clonal test, or clonal seed orchards, where a large number of clones but only a few seedlings per clone are involved, budding technique may be used to first rejuvenile mature material and then undertake rooted cutting of the rejuvenile shoots to produce seedlings. In the case of mass production of elite plants, it is preferable to use tissue culture to produce juvenile stock plants for rooted cutting. When there are enough stock plants, rooted cutting is more useful than tissue culture.

(L) Dr Doreen Goh in her article titled "**Clonal Teak for Sustainable Plantation Establishment"** accepted for publication in the ITTO Book on Teak in the Mekong Region presents an overview of the work undertaken by Bioscape Company in the selection, mass production, and dissemination of clonal teak for multiple purposes, in particular, on the establishment and upkeep of genetically-diverse clonal plots, provides strong evidence for the long-term sustainability of teak. She states that dwindling supplies from natural teak forests have led to high demand for teak timber from plantations that are primarily from seedling material with unpredictable yield and quality. Planting stock of clonal origins using selected outstanding genotypes is most suited to maximize returns on investments in teak plantations raised on suitable sites. The greater the selection intensity for quality traits in planted teak, the

higher will be the commercial gain. The risks of biodiversity loss associated with cloning can be minimized by broad-basing the genetics source. The cloning process adopted for mass multiplication of nursery cuttings and tissue culture plants has proven to be highly successful leading to the worldwide exportation of clonal teak to countries across four continents by the Company.

(M) Pachas et al in their paper titled **"Teak (Tectona grandis) silviculture and research: applications for smallholders in Lao PDR"** published in Australian Forestry, 2019, Vol 82, No. SUP1 state that Laos has restricted logging in natural forests and has banned exportation of round logs and squared logs to arrest the decline in natural forests and teak is now regarded as a 'special species' which affords special protections under the law. It is an important high-quality forest plantation resource in Laos and has been successfully adopted by smallholders in northern Laos mainly in Luang Prabang province. The large adoption by Lao smallholders may be attributed to political and socioeconomic factors of the 1990s such as an expanding road network, implementation of the land allocation processes, and access to credit up to 40–60% of the estimated value of plantation. The total area of teak woodlots in Luang Prabang province was mapped using aerial photography, registering a total of 15 342 ha, with an average woodlot size of less than 1 ha, with 83% located less than 1 km from a road.

Smallholders' access to improved teak planting stock in Lao PDR is currently restricted and mechanisms to achieve the delivery of improved planting stock to smallholders at an affordable price and in sufficient quantity remains a significant challenge that must be addressed if the impacts of genetic improvement are to be realised by smallholder tree farmers in Laos.

Pruning is typically required to maximise the production of high-quality teak timber. It is best to prune young teak up to 50% of the tree total height at the first thinning The first pruning should be carried out when the stand reaches a total height of 4–5 m, second pruning when the stand reaches 9–10 m in height and the last pruning should be done when the stand reaches 12 m of total height.

Thinning to manage inter-tree competition is recognised as a key component of intensive teak plantation management to produce high-quality timber. It refers to the progressive removal of small, forked, damaged or otherwise low-value trees from the stand with the aim of enhancing the growth of the retained trees, and improving stand health and quality. Thinning is more important in teak than many other forest tree species, as teak is highly intolerant of competition from neighbouring trees. When crowns of teak trees overlap, the stem form progressively deteriorates as the suppressed tree attempts to 'move' away from its larger neighbours. Thinning should aim to remove approximately one half of the standing trees in order to have a positive impact on the basal area and volume increments post-thinning. This is particularly so when the stand has been overstocked for many years and contains a high proportion of small and suppressed trees.

Lao farmers typically misunderstand 'thinning' to be selective harvesting of the largest trees as they reach a merchantable size. Repeated selective harvesting of the best trees means that many older teak woodlots are degraded and stocked primarily with poorly formed suppressed trees of low value. Demonstration sites, training and extension activities are required to overcome these misunderstandings and assist farmers to adopt better management practices. An alternative that will allow farmers to produce high-quality timber is to reduce the initial stocking to approximately 600 trees/ha using a planting configuration of 4 × 4 m or a paired teak row of 2 × 2 × 12 m in an agroforestry plot. Intercropping teak with perennial crops is

recommended for farmers with limited land and sufficient labour, in order to maintain annual cash incomes for a longer period of up to 5–8 years and to produce high-quality teak.

(N) Dr. Apichart Kaosa-ard of Forest Resources Department, Chiang Mai University, Thailand, in his paper **"Management of Teak Plantations: Overview of problems in teak plantation establishment"** published by the FAO states that teak has been planted across the tropics with the main objectives of producing high quality timber within a period of 40-80 years. The productivity of good teak plantations ranges from 8 to 10 m^3/ha/year. Site quality, seed supply and silvicultural management largely determine the growth and quality of the plantations.

The rotation age can be greatly reduced through site selection. Teak grows well on moist sites but for high quality timber there should be a dry period of 3-5 months duration. The soil should be deep, well drained, alluvial with high calcium and organic matter and pH of 6.5 to 7.5.

The supply of improved seed for planting programmes is a major problem especially in countries with no natural teak forests. Regular supplies of high quality seeds in large quantities can only be obtained through the establishment of Seed Production Areas and Seed Orchards. Clonal propagation by tissue culture is also a good for mass production of planting stock and needs the intervention and support of the government to make it technically and economically feasible for smallgrowers.

Well thought out silvicultural management is very important to ensure both the growth rate and quality in teak plantations. It is a light-demanding species making intensive weeding most important in plantations till the first five years. Also initial spacing has marked effects on the growth, quality and establishment cost of these plantations. In poor site quality areas plantations should be established with close spacing. First and second thinnings are conducted at ages 5 and 10 years in close spaced plantations using a simple mechanical thinning technique. Subsequent thinnings are carried out using relevant Site Index and Stand Density Tables as thinning guidelines.

Planting time also plays an important role on initial growth and survival of the plantation. The most suitable time for planting teak is the beginning of rainy season. The outbreak of defoliators and stem borers is often a serious problem with no practical method for controlling these insects.

(O) Kollert, W. and Cherubini, L. 2012 in their report titled "**Teak resources and market assessment 2010"** published in the FAO Planted Forests and Trees Working Paper FP/47/E, Rome have summarized their findings as follows:

i. Teak is a small proportion of world timber production and trade being less than 2% in volumes but in terms of value it is much larger being a high-value hardwood and is a major component of the forest economies of many tropical countries. Planted teak forests have attracted large investments from the private sector in Africa, Asia and Latin America and constitute the only planted hardwood resource that is increasing in terms of area.

ii. Natural teak forests are estimated to cover 29.035 million ha in India, Lao PDR, Myanmar and Thailand almost half which is in Myanmar. The area of planted teak forests across 38 countries is estimated to be 4.346 million ha, of which 83% is in Asia, 11% in Africa, and 6% in tropical America. Taking into account the data missing from 22 teak-growing countries, this figure certainly underestimates the actual area of planted teak forests.

iii. Planted teak is the only valuable hardwood that constitutes a globally emerging forest resource. Compared with previous surveys, the planted teak area has increased greatly in Africa (Benin, Ghana, Nigeria, United Republic of Tanzania), Central America (Costa Rica, El Salvador, Guatemala, Nicaragua, Panama), South America (Ecuador, Brazil) and Asia (India, Indonesia, Myanmar, Lao PDR).

iv. Planted teak forests are predominantly (77%) younger than 20 years. The prevailing age class distribution shows recent efforts to establish planted teak forests, but the current enthusiasm of many corporate and private investors for planted teak will maintain the youthful age structure and, in order to improve the economic rate of return, will tend to shorten the rotation period. This will lead to a significant increase in the supply of small-dimension logs grown in short rotations not exceeding 20 years.

v. In Africa, Asia and the Caribbean most planted teak forests are owned by governments, generally the forestry or agricultural administration, but in Central and South America state governments own merely between 1% and 12% of planted teak forests, while the private sector holds 88% in Central America and 99% in South America. Teak is not currently a priority species in community forestry, although there are a number of cases of smallholder teak plantations which have contributed to the improvement of rural livelihoods.

vi. The reported growth rates of planted teak are contentious. Many growth predictions continue to appear in literature, predicting very high growth rates above 20m^3 /ha/year but the actual long-term productivity of planted teak has often turned out lower than predicted. Its growth performance depends on the quality of the planting material and management practices. The mean annual increment (MAI) reported by 26 countries appears rather modest and lies, for most regions, between 2 and 14 m^3 /ha/year, except for some high-intensity investment schemes in Central and South America.

vii. The world's total teak supply from natural and planted forests adds up to 2 to 2.5 million m3 of which only about 0.5 million m^3 is estimated to be from natural forests. Nearly 60% of teak produced comes from India, Indonesia and Myanmar. The estimated market share of teak logs on the total tropical roundwood production by volume is less than 2%.

viii. Myanmar is the only country producing quality teak from natural forests as India, Lao PDR and Thailand have logging bans in natural forests or log export bans in place. The maximum sustainable supply of quality teak from Myanmar is likely to be in the order of 0.4 million m^3 annually and is expected to go down due to increasing deforestation and also competing demand for ecological services from natural teak forests.

ix. The global teak market has been and will continue to be governed by trends in the Asian market. Asia holds more than 90% of the world's teak resources and India alone manages 38% of the world's planted teak forests. The high international demand for general utility teak has broadened the traditional teak supply base from natural forests in Asia to include fast-grown, small-diameter plantation logs from Africa and Latin America.

x. Indian demand dominates the teak market with major teak trade flows worldwide directed towards India, while its own considerable teak production is processed within the country. Eleven out of fourteen reporting countries name India as their number 1 importer, absorbing 70% to 100% of global teak exports including shipments of plantation logs and sawn timber

from Africa and Latin America. In Africa, significant exporters are Benin, Ghana, the United Republic of Tanzania and Togo. In Latin America, Ecuador, El Salvador, Guatemala and Brazil, are important teak exporters.

xi. Obtaining prices for teak logs and sawn timber is difficult because no common international log grading rules have been established, most exporting countries' definition of log dimensions as well as measuring units are different. Teak prices are very closely related to wood quality which is determined by dimension, bole shape in terms of roundness and straightness, heartwood/sapwood ratio, regularity of annual rings, number of knots, colour, texture and the soundness of the butt log. Teak from natural forests sells at comparatively high prices as teak harvested from plantations is typically smaller in size and rarely reaches the dimensions and quality that fetches the best prices.

(P) Raymond Keogh in his article titled **"THE FUTURE OF TEAK AND THE HIGH-GRADE TROPICAL HARDWOOD SECTOR: Solving the Tropical Hardwood Crisis with Emphasis on TEAK"** published as an FAO Working Paper FP/44E FAO in Sept 2009 states that the increasing demand for high-grade tropical hardwoods depends mostly on deforestation and degradation of natural forests and this has created tropical hardwood crisis at a global scale. Demand for tropical hardwoods is expected to rise to 136 million m3 /year by 2050. He summarizes his findings as follows:

i. It is not practical to satisfy this humongous demand for hardwood from natural forests alone. This crisis can be resolved only by meeting the demand for hardwood from sustainably managed natural forests and complementing hardwood plantations. A realistic solution would be to create a large hardwood production estate made up of output from several large hardwood plantations.

ii. The maximum amount of natural tropical forest under sustainable management by 2050 is estimated to be 36 million ha producing an output of 36 million m^3 annually. In order to make up the shortfall a high-grade tropical hardwood plantation estate of 10 million ha (producing an average output of 10 m^3 /ha/year) would be needed to satisfy demand on a sustainable basis.

iii. Current output from natural teak forests and teak plantations make only a small contribution to the overall hardwood demand. In fact both natural teak forests and plantations as a whole are being exploited on a non-sustainable basis and are part of the tropical hardwood crisis rather than a bulwark against it.

iv. The teak plantation sector can be transformed from its present position of sub-optimal activities, through a phased approach, into a powerful and lucrative developmental tool that will provide basic solutions to overcoming the tropical hardwood crisis.

(Q) Jayaraman and Shivaraju in their brief paper titled **"Productivity of teak plantations in Kerala, India"** published in Teaknet Bulletin in April 2012 have stated that the total extent of teak plantations in Kerala was assessed at 69797 ha in the year 1995. Traditionally, teak is grown under rain-fed conditions in the State under a least intensive form of management with a rotation of 50-60 years. A 1996 evaluation of the productivity of the teak plantations in Kerala based on a state-wide sample survey had indicated a MAI of 2.423 m^3/ha at 60 years. A comparison with potential MAI of 4.968 m^3/ha at 60 years under site quality class I with full stocking as reported in the All India yield table for teak revealed the wide gap between the actual and potential yield levels. An assessment of site quality distribution of the area showed

that this was because only 5% of the area actually fell under site quality I, 38% was of site quality II, 48% of site quality III while around 9% fell under site quality IV. About 0.1 per cent of the total area was estimated as degraded. The MAI of total yield which includes main crop, and accumulated yield of thinning, at 60 years worked out to 3.110 m^3/ha. One of the reasons for low productivity was traced to the poor stocking of the plantations. Based on basal area, nearly 48% of the plantation area was estimated as under-stocked, 26% classed as over-stocked and the remaining 26% carried fully stocked stands. Among the under-stocked plantations 33% of the area showed very poor stocking with stocking ratio of less than 0.5. Nearly 88 per cent of the plots showing under-stocking by basal area were under-stocked by number of trees also confirming that the under-stocking resulted due to less than
expected number of trees in many stands.

Findings from a more extensive evaluation of the status of teak plantations in the State in 2011 were similar. Total area under teak plantations was 56509 ha with much plantation area having been diverted to national parks and wildlife sanctuaries. Nearly 85% of the plantations were above 30 years of age. The status of teak plantations in the Territorial Divisions of Kerala was assessed with respect to the site quality distribution and stocking and the current levels of productivity were ascertained. Each plantation was evaluated through a systematic sampling plan using sample plots along transects. Measurements were taken from plots of size 24 m x 24m laid along randomly placed transects in the plantations.

An assessment of site quality distribution of the area showed that only 3% of the area fell under site quality class I whereas nearly 33% of the area was of site quality class II and 56 per cent was of site quality class III. Around 8 per cent of the area fell under site quality class IV. There was considerable variation in site quality distribution over the different Divisions. Nemmara and South Nilambur Divisions recorded a good share of area under better site quality classes (SQ I and SQ II) whereas Thiruvananthapuram, Wayanad, Ranni, Kottayam and Kothamanagalam had larger area under poorer site quality classes.

Based on basal area density, under-stocked plantations were more common in North Nilambur, Munnar, Thenmala and Malayattoor Divisions. Over-stocked plantations occurred more frequently in Ranni, Punalur and Kannur and it was partly due to the presence of larger number of trees in the stand rather than due to the better growth of trees. This is reflected in the MAI of commercial volume attained in these Divisions with average MAI at 2.420 m^3/ha at 60 years.

This value is based on the standing volume of trees and thus excludes yield from thinning. Estimate of the yield from accumulated thinning was not available for the current period. However, the correspondence between the current and previous estimates of the productivity of the standing crop, with a gap of 15 years, was astounding in the sense that the productivity level has recorded neither an increase nor decrease in spite of the recent efforts by the authorities to improve the stocking levels of the plantations by skipping thinning.

(R) Bhat K M, P B Priya & P Rugmini (2001) in their paper titled **"Characterisation of juvenile wood in teak"** published in Wood Science and Technology, Vol 34, 2001, present the results of their study on juvenile wood properties of teak to assess the utilisation potential of teak as a short rotation crop. Compared to mature wood, it is characterised by wide rings, short fibres, small diameter, low vessel percentage, high cell wall, wide microfibrillar angle and relatively low or almost similar mechanical properties. While the average modulus of elasticity and modulus of rupture in juvenile wood are 85% and 82% respectively of the mature wood value, the longitudinal compression strength is similar. With relatively small fibrillar

angle of 15° and the scope for genetic selection of individual trees, teak juvenile wood has potential for desired dimensional stability. The segmented regression models and visual interpretation of radial patterns of variation in anatomical properties reveal that juvenility in plantation grown teak extends up to 25 years depending on the growth rate and plantation site. Regression models explaining the age-related variations in juvenile wood properties range from simple, linear to exponential, reciprocal and quadratic equations. Fibre length, microfibrillar angle, vessel diameter/percentage and ring width appear to be the best anatomical indicators of age demarcation between juvenile and mature wood, although maturation age often varies among the properties. The projected figures for proportion of juvenile wood in plantation grown teak at breast height are 80–100% at age 20 and and 25% at 60 years.

(S) Roshetkoa et al (2013) in their article titled **"Teak agroforestry systems for livelihood enhancement, industrial timber production, and environmental rehabilitation"** published in the journal Forests, Trees and Livelihoods, 2013, reports the contributions of teak systems to smallholders' livelihoods in Indonesia, where farmers have been producing teak for over 50 years.

The center of the Indonesian teak industry is Central Java where the industrial demand for teak timber is 1.5 –2.2 million m^3 per year. Perum Perhutani, the state-owned forest enterprise, is the largest manager of teak plantations with 2.4 million ha producing just about 0.5 million m^3 of teak timber annually. The shortfall in supply is sourced from smallholder and community producers on Java, other teak-growing regions, imports from overseas, and illegal harvests from Perhutani plantations.

There are 1.5 million smallholder farmers in Java managing 444,000 ha of treebased agroforestry systems, where teak is the dominant tree crop. In other parts of Indonesia, there is an additional 800,000 ha of smallholder agroforestry, where teak is one of the many species raised. Teak production is seen as an attractive alternative source of livelihoods and gets considerable support from the national government's rehabilitation and regreening program. Smallholder teak production has become an important source of raw material for the Javanese furniture industry with 80% of the teak used by small to medium producers being small-diameter logs of sizes less than 30 cm dbh supplied by smallholder farmers.

Elsewhere in tropics also smallholder teak production has emerged as an important constituent of rural livelihood. In northern Laos, teak is a key component of integrated smallholder farming systems that reduce risk and diversify farm production and has enabled
farmers to give up shifting cultivation to tree cultivation, reducing labor needs that can then be allocated to other household or off-farm opportunities. In Thailand, teak is considered suitable for smallholders because of its high value, high demand, and ease of cultivation that fit local farming systems to diversify production and income but farmers need assistance to adopt teak for short-term economic returns.

Smallholder farmers in Togo grow teak on their farms to increase household income, even though it competes with the production of staple crops such as maize and cassava. Agricultural land and labor are scarce and food security is important and still farmers are willing to plant teak to improve family assets. Under local conditions, 15-year rotations provide the best returns for poor farmers. For similar reasons, smallholder farmers in southern Benin grow teak on short rotation to produce poles of 5 –15 cm. In Nigeria, teak enables farmers to participate in national afforestation activities and contribute to national environmental goals. Growing teak extends

fallow periods, rehabilitates soil fertility, diversifies farm production, and increases household income.

The biophysical and market conditions in Panama have create opportunities for smallholder teak production that needs to be nurtured by giving farmers access to land, technical information, market knowledge, and quality germplasm. Similar observations and recommendations have been made for smallholder teak in Costa Rica.

Besides timber teak also has many other uses. Oil extract from teak leaves and wood is used as a traditional medicine to treat skin diseases in India. Teak leaves are made into a compress to hasten the healing of skin wounds. Dyes from the leaves and buds are used as henna and to dye cloth. Dried teak leaves can be used at low concentrations (no more than 5 – 25%) as a dry season feed supplement for goats and sheep. Dried leaves are used as roof thatching in Bangladesh. Sawdust of teak is used in Indonesia to make incense. Hyblaea puera, a caterpillar commonly found on teak, is relished as a food in Java. Branches and wood waste can be an important source of wood energy. Teak vinegar is used to make local medicines, cosmetics, and insecticides and teak seeds are used to make rosaries.

In Java there are four smallholder teak production systems, namely, Kitren, Tegalan, Pekarangan, and line plantings. Kitren are woodlots dominated by teak while Tegalan are upland systems where trees and annual crops are intercropped. Pekarangan are dominated by tree species, with annual crops commonly cultivated in the understory. Kitren and Tegalan are commonly found within 1.5 km from the owner's house while Pekarangan are located adjacent to the owner's house.

Men and women share the responsibility for managing these systems. Women are primarily responsible for the management of Pekarangan systems. Depending on the distance of the plot from the home, women are also responsible for management of agricultural crops in the Kitren and Tegalan systems. Men are responsible for timber tree management in all systems while women are involved in firewood collection and harvesting.

Tegalan were the most common and larger of the teak systems, accounting for 50.6% of smallholder teak system parcels, averaging 0.47 ha. Kitren accounted for 21.9% of the parcels, averaging 0.31 ha. Pekarangan also accounted for 21.9% of the parcels, averaging 0.24 ha. Kitren had the highest tree density and the least species diversity. Across all systems, teak accounted for 55.9% of the trees. Overall, timber species (including teak) accounted for 77.0% of trees, fodder species 15.0%, spice, nut, and condiment species 3.4%, and fruit 2.2%. An overwhelming majority of 82% of farmers reported intercropping their teak systems with agricultural crops. The most common intercrops were cassava (26.6%), peanuts (23.8%), upland rice (18.0%), soybeans (8.1%), and long bean (2.9%).

Traditional smallholder tree management is not intensive or proactive. They rarely used quality germplasm with 72% of farmers having established teak systems with wildings, 30% used local seedlings, and 20% used coppice. Only 12% of farmers had ever used improved quality seedlings provided free through government reforestation programs. Weed control and fertilizer application was practiced by 73% of farmers, but only because of agricultural crop growing on the ground and similarly pruning was undertaken by 55% for the benefit of the agriculture crop below with the pruned trees retaining branch stubs of 10 –15 cm long which generally reduced timber quality. Thinning was practiced but with the primary objective to

harvest timber, poles, or fuelwood often removing the best quality trees. Although coppice was commonly used to establish teak systems, coppice thinning was not practiced.

The direct costs of raising and maintaining teak to the farmers is low. Most farmers use locally available planting material by way of wildlings, seedlings, or coppice. Some farmers also received improved quality seedlings free of cost from government and other institutions. Management costs for fertilizers and weeding were associated with annual crop production while planting and other tree management activities were conducted when opportunity costs were low for other on-farm or off-farm activities.

Key actors in the smallholder teak timber marketing chain were farmer producers, local traders, wholesalers, and processors. Farmers connect with the marketing chain through the local or large-scale traders and had only limited access to market information except what they gather from neighbouring farmers who had made sales in recent past. Women are not involved in smallholder teak transactions, either as seller or buyer. Standing trees are the standard unit of sale for farm-grown teak with the traders being responsible for harvest and transport. Traders visit the farm to measure and assess the tree and negotiate the price for individuals or blocks of trees. Negotiation is done without clear quality or value standards. Some are able to improve their negotiating position by offering the trees to two or more buyers while others were willing to accept the price offered. Timber quality is variable with some trees having severe defects like hollow stems that are detected only post-harvest. The market offers higher prices for older, larger trees but only 14% of farmers harvested trees based on economic maturity.

Policy Recommendations

Comprehensive Recommendations for supporting Community and Smallholder Teak Plantations

Teak comes up very well both within the forests ecosystems as well as on cultivated lands of the Mekong subregion. Till a few decades back almost the entire production of teak timber in the world used to come from publicly owned forests managed by government forest departments. But the situation today is markedly different with a large part of demand for teak timber being met by private teak growers. As more and more growers are entering the field the problems they face in growing the best produce, in managing the crop to maturity, in growing interim crops for regular incomes, in harvesting and transporting timber, and fetching the best prices for their produce, are also increasing. There is pressure on them to get their plantations certified by authorized agencies because rich developed countries would not allow finished products made of uncertified wood enter their countries. But the cost of such certification is clearly beyond the reach of the most well placed of the smallholders. As the world warms up there are increasing incidences of fires, insect attacks and diseases which often originate in adjacent large natural forest areas. There are also new opportunities like the market and non-market appraoches of the Paris Climate Agreement where the smallholder teak planter hopes to be linked up with the evolving opportunities that can make him more competitive in the market place.

Efforts have been made in all the countries of the Mekong region to address the problems of this section of teak growers. But much more needs to be done because private smallholder teak planters continue to face difficulties in their ventures. This policy brief presents governance and management issues involved in various countries of the region and suggests changes required.

Defining smallholders

In the heavily populated Mekong subregion the per capita land availability is very low ranging from 0.12 ha in Vietnam to 0.34 ha in Thailand. Land holding in the region is typically small with as many as 85% landholding in Vietnam, 38% in Laos, 34% in Myanmar, and 23% in Thailand being less than 1 ha. The Lomé Statement for Smallholder Forest Landscape Restoration (FLR) in West Africa of November 2019 notes that smallholders "are most often classified according to their size, which can vary from less than one hectare up to 10 hectares and more. Legally, smallholders can be individuals, family or clan structures, communities, churches or associations. Within the framework of FLR, smallholders include tree planters (woodlots for timber or fuelwood), tree crop producers and farmers who incorporate trees in their farming systems, as well as those who restore and protect remaining natural forests."

What would be considered smallholding will, thereore, be context specific. Given the nature of landholdings it would perhaps be appropriate to consider landholdings upto 2 ha as

smallholdings in Vietnam and upto 5 ha in other countries of the region for the purpose of raising tree plantations.

Smallholders shifting from growing food to growing trees

Till about three decades back the owners of these smallholdings were almost exclusively subsistence farmers relying exclusively on family labour but the situation has gradually changed since 1980s with rapid expansion of the southeast Asian economy giving attractive employment opportunities to the landless and those living the life of subsistence. With self-labor no longer available for cultivation of their lands many began either renting out their lands for cultivation or opting for tree based crops like rubber and teak among others.

Teak on community lands

This is usually confined to those hills in the region where shifting cultivation is still being practiced as in parts of Lao PDR, Myanmar and Cambodia where indigenous people live in communities. In Lao PDR the policies on the utilisation and management of natural resources emphasizes the need to reduce shifting cultivation and control deforestation. To achieve these goals the Government has sought to establish permanent habitations for 277,000 upland families practicing shifting cultivation and protect the watersheds of 80 streams and rivers by rehabilitation and protection of the forests situated in these watersheds and by the reforestation of the eroded areas. These people so settled are allocated forest lands, both degraded and well-forested, to manage and protect on a household basis thereby granting security of land tenure to the rural people and enable transmission of their inheritance to their heir. Government forestry units at all levels are expected to act as the servicing units for the local people and provide technical assistance in extension techniques for farming, forest and fruit tree planting, seed and fertilizer supply.

These policy measures, combined with expanding road network and access to credit up to 40–60% of the estimated value of plantation, have led to teak being successfully raised over considerable extent of hill lands in Luang Prabang province in northern Lao. However, one clear outcome of this household centric approach in Lao PDR is the conversion of community centric shifting cultivation covering large sized community owned hillsides to individually held small sized teak plantations that are, in practice, no different from smallholder teak plantations elsewhere in the region.

Other countries of the region like Myanmar that still have many communities practicing shifting cultivation may also encourage similar shift away to family owned teak plantations and teak based agroforestry over such lands. However, this will have to be primarily a socio-political decision that would decide whether these countries are willing to hasten the process of conversion of community owned land assets of indigenous hill peoples accessible to the entire communities on the basis of their needs into small sized individual family assets that completely excludes others in the communities. This is because this process will also result in fundamental, deepset, social changes at a great pace with consequences for the overall governance of the countries.

Delineating better sites

Site quality has a dominant role in determining the productivity, and profitability, of teak plantations and, thereore, it is important that the smallholders should be guided and encouraged to opt for the best available sites. Criteria for site selection for teak plantations should be refined, harmonized and widely disseminated.

A network of permanent sample plots covering the entire range of growth conditions and management conditions should be established in the countries of the region and improved national tables giving growth and yield estimates under in different parts of this range of site and treatment conditions should be prepared and made available to teak growers.

Presently site quality assessments are based almost exclusively on growth parameters but increasingly ecological and biodiversity values are also becoming important even for smallholder plantations particularly when they hope to benefit from national and international financing geared towards Sustainable Development Goals. The growth and yield estimates for these sites should, therefore, be prepared in such a manner that the farmer is able to understand the moderation in yield when ecological goals are also expected to be fulfilled. This will better prepare him for negotiating the prices of these societal and ecological goals with the relevant authorities.

Enhancing site quality

Site management to sustain and enhance productivity may involve changes in silvicultural prescriptions, soil conservation measures and fertilizer application. Existing protocols, where they exist, are inadequate and serve only large government and private plantations. The government forest departments of the region may develop these protocols specifically for smallholder plantations and make them easily accesible to all concerned.

High quality planting stock

Smallholders most often use the planting stock available closest to the planting site and realize their teak crop is of poorer quality when it is too late to do anything. Low returns on account of low quality and quantity of teak timber produced then deters more smallholders from opting for teak. Sometimes high-quality teak planting stocks are available through large plantation companies but these are high priced and incur considerable costs in transportation or tied to conditions that smallholders are reluctant to agree to. The smallholders expect assured quality of planting stock delivered at reasonable prices at locations that are manageable for them.

The forestry departments of the region may produce certified high-quality teak planting stock offering a good range of choices that are well advertised, and make it available through local extension offices of all land related government departments like horticulture, animal husbandry and agriculture departments besides their own outlets. The planting stock should be offered at low prices but not free of cost so as to avoid wastage. Since there are primary schools in the remotest villages it would be useful to engage the services of resident teachers as short term planting material stockholders and extension workers during the planting season.

Discouraging speculative investments

In the decades of 1980 and 1990 there was a surge of specultive investment in teak plantations across the tropical lands in the expectations of excessive profits with cost-benefit analysis of long rotation plantations exceeding 50 years suggesting return on investment of 15% with an MAI of 3 m^3 per hectare including all wood removed from thinnings to final felling assuming low initial investments, no opportunity cost for land, marketability of wood from all thinnings, and continued increase in the prices of teak timber. The expectations of the investors were rarely met leading to large scale disappointment and collapse of the so-called teak schemes across the tropical world. Had a rigorous cost-benefit analyses been undertaken before going into the venture taking into account the true opportunity cost of the land to the smallholder in addition to the site and environmental conditions, management regimes, and accesible markets this large scale speculative investment based on misleading claims could have been easily avoided.

The governments of the countries of the region should commission rigorous cost-benefit analysis of teak plantations on all likely sites within their countries at different rotations taking into account the true labour costs and the opportunity costs of the land under plantation to be carried out by their forestry universities and institutions. This will not only give a true picture to potential investors in smallhold teak plantations but also build capacity for quality cost analysis within their own institutions.

Tenure security and felling permission

Smallholders in some countries of the region, particularly Thailand, have this fear that if they plant trees on their lands they may not be allowed to fell the trees and use the land for agriculture or for house construction at a future date. This is more likely to happen on trees planted on landholdings located on steep slopes, on other ecologically fragile areas, and on places of tourist interest with high expectations of green surroundings. Thus, while the smallholder would continue to be the owner of his land, his economic choices related to his land become severely restricted once trees are planted on it.

It needs to be appreciate that the only reason a smallholder plants teak on his land is to maximize his earnings and not for aesthetic purposes or for binding soils, and certainly not for inviting restrictions on his existing freedoms on the enjoyment of his land assets. If such social objectives are to be added to his personal goals in planting teak by the government under extraordinary circumstances for public good then, as a matter of principle, the government must be willing to compensate the smallholder for all the consequential losses incurred by him. In the interest of promoting teak planting by smallholders every country in the region should make incorporate this principle in their policies.

Restrictions on transport

Existing policies and legislation in some countries of the region place restrictions on the transport of teak harvested from private lands by farmers. But these restrictions, introduced during colonial times to protect governemnt owned natural forests from illegal felling, act as severe disincentive for smallholders who find it difficult to obtain the required permissions to transport their timber to the sawmills and market and often become victim of corrupt practices.

Many states in India that had the same restrictions have now removed them atleast for species that are not found in natural forests in the neighbouring districts which has greatly eased the situation for tree growers. The task of protection of teak in natural forests belonging to the State is a duty of the larger society and of the State, the cost of which should be borne by the State and not by individual smallholders who take to teak growing as a normal economic activity. And now DNA based technology is available that can establish the source of timber. This technology needs to be further refined and made easier and quicker which task can be undertaken by countries like Thailand and India that have the technological knowhow.

It is strongly recommended that the governments of the countries in the Mekong region may consider removing the restrictions on transport of teak from plantations altogether and instead rely on in-situ protection of their natural teak resources using appropriate technologies.

Attracting investment in smallholder teak plantations

Sourcing funds for financing long term investments in teak plantations is a difficult task on account of the plethora of risks involved. Even when there are potential investors willing to risk their capital in such ventures like the European and American Pension Funds mandated to invest a small part of their portfolios in such green investments, there are no official mechanisms that can link them with genuine smallholder teak growers.

The forestry departments of the countries of the region should provide a platform on which genuine smallholder teak growers are brought in touch with potential green investors. Investment in teak plantations of all sizes should be officially declared as a "green investment" and attractive financial and tax incentives provided to promote these teak investments. The tax incentives can also be linked to the length of rotation which would help encourage the growing of larger sized teak timber.

Loan financing of smallholder teak plantations

Institutional assistance for loan financing for raising teak plantations across the region is inadequate at best and often absent altogether. Loan financing for these long-term investments pose serious problems and currently there are not many instruments that can satisfactorily link the financial institutions providing loans with the teak growers needing loans. The forestry departments of the countries of the region should provide a platform on which genuine smallholder teak growers are brought in touch with financial institutions mandated and willing to extend loans to smallholder teak plantations.

Tax Relief

As the availability of public lands for raising teak plantations are limited everywhere due both to ecological constraints and competing demands for other uses, the trend is to encourage raising teak plantations over private lands by individuals, communities and companies through subsidies and other incentives. In India the income accrued from agriculture is exempted from income tax without any upper limit and, since tree growing is considered agricultural activity, there is no income tax on the sale of trees harvested. This is a major attraction for tree growers and is worthy of emulation. It is, therefore, recommended that the countries of the region may exempt income from tree growing from income tax.

Support under REDD+ and Article 6 of Paris Agreement

Teak forests in their natural zone provide a range of ecosystem services that are highly valuable for the welfare of larger global and national societies including mitigation of, and adaptation to, climate change. The forest departments and other authorities in the Mekong subregion have long been discussing about additional incomes for community and individual tree planters by way of carbon credits for mitigating climate change through carbon sequestration, and through other ecological services that the forests and tree plantations render to the society. Teak growers across the region expect their governments to enact policies and take steps that enable them to financially benefit from these new possibilities.

The very rigid eligibility conditions of the Clean Development Mechanism (CDM) under the Kyoto Protocol, the excessive technical complexities and very high transactional costs involved in implementing CDM projects placed the smallholder teak plantations outside the reach of this facility. REDD+, which stands for reducing emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks, addresses a part of the limitations of the CDM but REDD+ is essentially meant for national or sub-national level efforts where the achievements in sequestering carbon have to be measured against the national or subnational baselines. This means that till a country, or atleast a significantly sized region within it, is prepared and ready for REDD+ the communities and smallholding teak growers would not be able to access financial benefits from the climate change mitigation services that they provide to the world.

Article 6 of the Paris Agreement on Climate Change has provisions for both market and non-market mechanisms in support of climate change mitigation and adaptation activities that need to be utilized creatively to finance smallholder teak plantations. The recently held COP26 at Glasgow in Nov 2021 had made much progress in finalizing rules for operationalizing these mechanisms in practice and some more guidelines are expected to be finalized by the subsidiary bodies of the UNFCCC in June 2022 following which ITTO may commission a small pilot activity to test ways to use these Article 6 mechanisms in support of the smallholder teak plantations.

The forestry departments of the countries of the region should explore the possibility of creating provisions for pooling the smallholder plantations into larger sized carbon sequestration schemes like REDD+ and other schemes that enable payment for ecological services rendered by these tree plantations. The country negotiators in UNFCCC, UNCCD and CBD Conferences of Parties should be asked to bring these concerns into international negotiations appropriately for ensuring that the international systems arrived at enable the participation of smallholders through cooperative efforts and the participation costs are kept low.

Developing markets for short rotation timber

Smallholders can not wait for half a century for harvesting teak and getting returns on their investment. For them even twenty years is a long rotation. Investors in large teak plantations also expect interim incomes from small-diameter wood obtained from thinnings. Profitability is affected by the higher proportion of sapwood in short rotation teak, the variability in physical and mechanical properties, and the appearance of the wood in comparison with larger diameter wood from natural forests and long rotation plantations. Difficulties in processing and marketing smaller dimensions also deters smallgrowers.

In Java, Indonesia, short rotations and small dimensions do not seem to pose problem since demand for small sized teak has evolved over time and with improvements in utilization technologies thereby facilitating the use of smaller dimensions. And in recent years teak has been harvested in as short a time as 8 years in places where small sized teak fetches good value in the market. The current and potential uses of small dimension plantation wood from teak plantations should now be assessed recognizing these dynamic changes.

For hastening this process of market acceptance of small sized teak from short rotation plantations the governments of the countries in the region should promote the use of small timber utilization technologies that are already in use in Indonesia and elsewhere and also encourage further innovations. Chemical treatment of higher sapwood timber can impart it greater strength, longevity, and protection against insect attack. Specific time bound projects should be awarded to forestry universities to conduct research on these subjects.

Also, in order to facilitate comparisons between teakwood of different sizes and localities, common standards, definitions and nomenclature need to be adopted across the teak producing countries. This is a very big task not entirely within the capacity of producing countries in the Mekong region but it can begin here adopting features and language that would make the standards evolved acceptable all over the world over time. Existing national grading systems for teak timber need to be reviewed and changed as necessary, taking into account the quality and dimensions obtainable from shorter rotation plantations in end harvest as well as thinnings.

International collaboration is required to be promoted on products and markets and for standardization of definitions in relation to technology, markets and sizes. Such collaboration is particularly relevant for the standardization of grading rules for teak timber and for carrying out research on demand, supply and prices of varying grades of teak.

On pruning, thinning, and girdling before harvest

Pruning is typically required to maximise the production of high-quality teak timber. It is best to prune young teak up to 50% of the tree total height at the first thinning. The first pruning should be carried out when the stand reaches a total height of 4–5 m, second pruning when the stand reaches 9–10 m in height and the last pruning should be done when the stand reaches 12 m of total height.

Thinning is an important tool for ensuring high quality and higher volume product at the end of rotation. It results in improved growth and yield of stands as well as individual tree sizes and tends to have positive effects on stem form. But many smallgrowers use it to remove best quality trees years before the rotation period which results in reduction in both quality and quantity of the timber produced at the end of rotation.

The extension wings of the forestry departments of the region may hold regular workshops in localities that have large number of teak plantations to demonstrate best thinning and pruning practices. The final decision on thinning, however, must be left to the teak growers because sometimes their immediate need of money may be more important to them than the returns that may come at the end of rotation.

Girdling trees well before harvest at rotation age has been an age old practice in Myanmar that makes the tree loose sap and get seasoned ready for immediate use as timber. But this also results in loosing growth that would have occurred during the period between gridling and harvest which is important in short rotation plantations. If girdling is done in summers just three months before harvest at 20 year rotation the loss in growth may be insignificant but the possibility of immediate use may enhance its commercial value considerably. The forestry departments of the region may examine this closely in different localities and seasons and advise the smallholder teak growers in the neighbourhood accordingly.

On harvesting teak in natural forests

Harvesting of teak in natural forests is banned in Thailand since 1989 where most of these natural forests having been declared Protected Areas. Teak harvesting in natural forests of Lao PDR is also prohibited since 1989 with most of the naturally grown teak entering markets is said to be coming from shifting cultivation areas of north-western uplands of the country and from left over harvested teak logs. There is also a ban on export of logs from the country but there are problems in effective implementation of the ban.

In Myanmar teak harvesting in natural forests is carried out under the Myanmar Selection System with both allowable annual harvest and marking of harvestable trees being done by the Forest Department while the actual act of tree felling, conversion and transport to depots, and sale, is conducted by the sole authorized government agency, the Myanmar Timber Enterprises.

While this has promoted teak plantation activities within Thailand and also in neighboring Cambodia, Laos and Vietnam it has also led to increased demand for teak harvesting in natural teak forests of Myanmar where restrictions on natural teak harvesting are limited by the principles of sustainable forest management. There are also reports of increased illegal logging of natural teak in Myanmar close to its borders with Thailand.

While the total ban on teak felling in natural forests everywhere is often lauded as a very effective approach to conservation of this great gift of nature, in the opinion of this author the benefits are overvalued and the outcomes are not without great risks. The increased risks are in having precious natural forests with large number of old and often diseased and decaying trees that become host to very huge infestations of *Hyblaea puera*, a leaf defoliator commonly found on teak, and other local pests. During drought season these old decaying trees greatly increase the risk of fire as they provide plentiful fuel to the fires.

Also in National Parks and other Protected Areas with natural teak forests too high a density of teak trees discourage grass growth on the forest floor reducing the carrying capacity for wild ungulates which in turn affects the populations of predators. So a regular but moderate selection felling of old, dead and dying teak trees is advisable in in these forests.

Containing environmental damage and accidents during harvesting

Harvesting and extraction operations are the activities that generally cause the most significant impact on the environment. The impact of harvesting and extraction can be reduced through proper planning and control of harvesting operations using sound principles, systems, and techniques that have stood the test of time. Successful harvesting should be (a) technically feasible considering physical limitations, engineering knowledge, and environmental relationship of the forest, (b) economically viable considering the costs and benefit of short

and long range consequences, (c) environmentally sound considering impacts on the natural and social environment, and (d) institutionally feasible considering laws and regulations, landowner objectives, and social values.

The most common cause of accidents during harvesting is the workers' lacks of knowledges or skills and repeated training is the most effective tools for reducing risks. Wearing suitable Personal Protective Equipments (PPE) provides protection when all other control measures cannot adequately eliminate or minimize risks to a worker's health and safety.

The extension wings of the forestry departments of the region should conduct annual workshops in each important teak plantation district to communicate with the teak growers on the best harvesting practices.

On certification

There is increasing demand from EU and North American countries for certification of timber exported to their countries in raw or processed form. And since the economies of the Mekong region rely to a considerable degree on their exports there is pressure on the teak producers to get their timber certified. Higher prices in niche markets where consumers are prepared to pay a premium price for teak obtained from sustainably managed areas are an incentive to produce certified timber. But the costs of complying with the environmental standards required in certification process are quite high and often prohibitive for smallholders. And also the niche markets willing to pay higher prices for certified timber may not be accessible to all smallgrowers. It would be quite a while before a clear consumer preference for certified timber emerges in a widespread market for timber and its products.

The choice to go for certification or not is best left to the teak grower but for this choice to have any real meaning there should first be easily accessible, and internationally acceptable, certifiers within their physical and economical reach. In this the ITTO can play a role by helping set up an autonomous independent certification body for the Mekong region on the lines of international certifiers like the Forest Stewardship Council (FSC).

Reducing losses by theft, fires, diseases and insect attacks

Illegal felling of valuable teak trees by miscreants is a major concern of smallholders particularly those whose lands are located in remote sites away from the watchful eyes of villagers. They are not able to engage the services of plantation watchers as big plantations do because of the high cost of individual plantation watchers. The smallholders expect a reasonable degree of protection of their standing assets as an important duty of the State.

The forestry departments of the countries of the region may identify hotspots of theft and organize villagers to combat the problem in these areas. Selected villagers can also be given, after due training and under competent supervision, the legal powers of a forest official to book offences against the culprits. But this has to be done with great care and under close supervision otherwise it has the potential of creating conflicts within village communities.

The smallholders are able to deal with the fires, diseases and insect attacks on their teak trees located within agricultural fields close to the habitations but they sometimes find their plantations located adjacent to the government forests exposed to fires that originate within forests and cannot be controlled by outside efforts. Less often they face similar problems with

tree diseases and insect attacks, too, that originate within adjacent large sized government forests. A clear expectation of the smallholders is that reducing these losses is the responsibility of the State.

While these expectations of the smallholders can not be fully satisfied by the governments of the region because it would encourage tendencies to turn private responsibilities into public duties there can be little doubt that government policies should actively prevent the escape of fires, and insects and pests, from government forests to the adjacent teak plantations by smallholders. Prevention of escape of fires and of plant diseases and insect attacks from government forests to adjacent plantations of smallholders must be accepted as a public duty and a protocol for taking adequate and timely steps must be developed in consultation with smallholders and followed strictly. For this purpose well managed firelines, cleared of all vegetation and debris, along the boundaries between fireprone government forests and smallholder teak plantations would reduce the chances of fires, diseases and insects spreading outwards. It must, however, be made clear that the protocol does not lessen the duty of the smallholder towards the protection of his own land and crops growing there.

On research

There are several areas related to teak and its planting by smallholders for economic purposes that need to be explored thoroughly to enable governments to lay down appropriate policies to promote this economic activity over larger extents of lands suitable for growing teak in the countries of the region. In the paragraphs below the more important of these have been described briefly.

An important area for research is the impact of complete ban on teak felling in natural forests and Protected Areas, including thinnings that were planned earlier, on the quality of habitat for wild animals by way of availability of ground flora as feedstock for herbivores, effect on water sources, frequency and intensity of forest fires, and on the socio-economic conditions of the indigenous people residing inside and in close vicinity of these forests. The forest departments of Universities in the region should be encouraged by the country governments and the ITTO to undertake several independent research projects on different sites so that a truer picture may emerge of the realities on the ground which can then be utilized to review the ban on teak felling in natural forests.

There are unsubstantiated claims of teak plantations having a deletrious effect on the productivity of agricultural lands downstream and even on the site quality of forests below. These needs deeper investigations by forestry universities and research institutions in collaboration with agricultural universities and quick dissemination of the outcomes as they emerge.

Another potential area for management research in teak is the impact of long, medium and short rotations in teak natural forests and plantations on soil, ground vegetation, water regime, and on teak production which have not yet been systematically assessed and are subject to much speculation. This research task is also best undertaken by forestry universities and research institutions in the region and ITTO is well placed to facilitate this process.

Research is recommended on biological control of pests and diseases that are common in teak plantations in the region in order to facilitate large scale application of these measures by smallholders. and to overcome resistance. Raising mixed plantations instead of pure teak plantations may also help control the spread of infestations but this needs to be established by data based research. Integrated pest management models that are effective as well as economical need to be designed.

Smallhold investors in teak plantations expect assured periodical interim incomes from their lands from agricultural crops in the first three to four years and later from small-diameter wood obtained from thinnings. This requires research on incomes from suitable agricultural cover crops under different site qualities and from wood obtained under different thinning regimes.

On generating rural employment

Intensively managed plantations requiring continuous care have the potential to provide considerable employment and income to the rural economy and thereby provide a crucial public good which needs to be acknowledged in policies and appropriately compensated through tax relief or subsidies. Very few studies have, however, been carried out on the socio-economic benefits of teak plantations. The country governments of the Mekong region should, with the help of bilateral or multilateral international financing agencies, commission the forestry universities and institutions in their countries to undertake such studies. The outcome of these studes can help decide the quantum of compensation or relief to the smallholder teak planters for the services rendered to the Society.

On international collaboration

There is need to strengthen international collaboration in exsitu conservation for provenance identification and testing, and formulation of common methodologies and procedures to allow comparison of results across countries. Collaborative efforts at the regional and global levels are particularly important for testing clones in a variety of sites and under diverse conditions and for developing technical guidelines for the exchange of genetic materials. National efforts to collect growth and yield data could be complemented through a network of permanent sample plots. The conservation of teak genetic resources and the monitoring and control of transboundary pests and diseases are other important areas for collaboration.

Obtaining prices for teak logs and sawn timber is difficult because no common international log grading rules have been established, most exporting countries' definition of log dimensions as well as measuring units are different. Teak prices are very closely related to wood quality which is determined by dimension, bole shape in terms of roundness and straightness, heartwood-sapwood ratio, regularity of annual rings, number of knots, colour, texture and the soundness of the butt log. Teak from natural forests sells at comparatively high prices as teak harvested from plantations is typically smaller in size and rarely reaches the dimensions and quality that fetches the best prices.

The ITTO is best placed to facilitate this kind of collaboration by bringing two or three forestry universities of the region work on a collaborative project of this nature with institutions in Japan, South Korea, Australia, India and other countries that have the requisite technological know-how. The fact that the countries named above have existing bilateral agreements of cooperation and assistance in the field of environment and forests with most countries in the Mekong region will help in joint financing of such a project.

Annexure 1

Policy Brief No. 1

Teak in Mekong Subregion
A historical perspective of the evolving policies

by
Dr Promode Kant[1]

Before the entry of European colonial powers in the Mekong subregion in the 18th century the forests, unlike cultivated lands, were under the direct control of the local rulers but free access to timber and other forest resources was usually accorded to the neighboring people with some oversight to ensure that when used for trade the local rulers also get a part of the earnings. Since mostly teak was used for trade across the borders the Alompra (or Alaungpaya) dynasty of Myanmar had declared teak as Royal tree the felling, transport and sale of which required permission from local authorities. As export demand for teak, mainly for naval ship for expanding empires and establishing businesses across the globe, increased the rulers began allotting blocks of forests for a price permitting the purchaser to fell as many trees as they liked in any manner and take out of the country.

With the entry of the colonial powers these felling operations, hitherto limited by the financial capacities of the forest lessee, covered far greater areas and destruction became evident everywhere. In 1826 Tenasserim province of Burmah was ceded to the British East India Company under the Treaty of Yandaboo and in 1827 Dr Nathaniel Wallich, Superintendent of Botanical Garden at Calcutta, reported that the forests of the province were better than anywhere else under the East India Company's sphere of influence. There was a rush to exploit these forests and in 1829 these forests were thrown open to any exploiter who could pay the ad-valorem value on the timber taken out of the forests to a port of exit.

Massive destruction followed and in 1837 the East India Company engaged the services of an eminent Naturalist of the time, Dr Johann Wilhelm Welfer, to examine the status of forests of Tenasserim. He reported low teak inventories and inadequate regeneration and recommended raising of teak plantations rather than relying exclusively on natural forests. Welfer's report led to the cancellation of all existing teak extraction leases in 1841 by the new Superintendent of Forests, Captain Tremenheere, and new leases were issued with sufficient safeguards. But there was no effective mechanism to enforce the safeguards in the forests and the enforcement of regulations at the port of exit, when timber had already been felled and transported at considerable expenditure, led to strong protests from the business community and the East India Company overruled the Superintendent and allowed the former system to prevail.

In 1852 the East India Company annexed the province of Pegu (now called Bago) with its teak forests reckoned the best in the whole world citing increasing conflicts between the British

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traders and the King of Ava in Upper Myanmar as the reason for the act. The Company declared that

"all the forests are the property of the Government, and no general permission to cut timber therein will be granted to anyone"[2]

and appointed a new Superintendent, Dr John McClelland, a medical doctor with keen interest in nature, for Pegu forests.

The beginnings of policies that encouraged sustainable management

McClelland noticed heavy felling of young trees in easy access in lower parts of hills close to streams that was clearly encouraged by trade practices in vogue and felt it stuck at the very roots of scientific forest management. Deeply disturbed, he wrote a detailed report to the then Governor General of East India Company in Calcutta a single sentence of which, quoted countless times, contains the central principle of scientific forestry:

"A forest may be regarded as a growing capital, the resources of which are the young trees, and unless these are preserved and guarded to maturity, it is obvious the forest must necessarily degenerate from the nature of an improving capital to that of a sinking fund."[3]

As a control measure McClelland suggested two policy measures[4]. One was to levy single duty on logs irrespective of its value to discourage harvesting of small trees and the second the management of forests by the government where merchants would only be able to harvest trees marked by the government.

This report, it is said, heavily influenced the then Governor General of East India Company, Lord Dalhousie, in issuing the "Minutes on Forest Policy" of 1855, making all teak the property of the state, regulated its trade, and initiated a new approach to forest management in which the private interests were subordinated to the rights of the state over nature and the state was to be involved in all forestry operations – deciding how much to harvest annually, marking specific trees for felling, and transporting harvested products to the depots - directly. The Minutes were critical of the monopolistic role of big timber traders and favored smaller traders over the larger ones for harvesting and transport of timber on behalf of the government.

Involving communities: Taungya in teak

It fell to Dr Dietrich Brandis, who succeeded McClelland as the Superintendent of Pegu forests in 1856, to translate into practice what scientific forestry actually meant in tropical forests. He made an estimate of what could be the annual allowable cut from the forests of Pegu spread over some eight million hectares. But, perhaps even more important, Brandis devised a way in which the people of Pegu, the Karen, considered hostile to the British, could benefit from the increasing value that teak was offering.

Till then the Karen people, practicing shifting cultivation, would clear a patch of forests by felling trees, burning and mixing ash with the soil, cultivate for three years, and then return to the same site after about two decades. Brandis offered them an attractive sum of money if they

[2] Empire Forestry and the Origins of Environmentalism by Gregory Allen Barton
[3] Dan Handel, Into the Woods, Cabinet magazine, Issue 48/Trees, cabinetmagazine.org, 2012
[4] Forests of India, by Stebbings

also plant teak along with their crops and leave a certain number of sturdy teak saplings behind as they move to new sites. Thus was born the Taungya cultivation that then spread across the tropical world, a novel agroforestry practice, an early prototype of sustainable forest landscape management by communities.

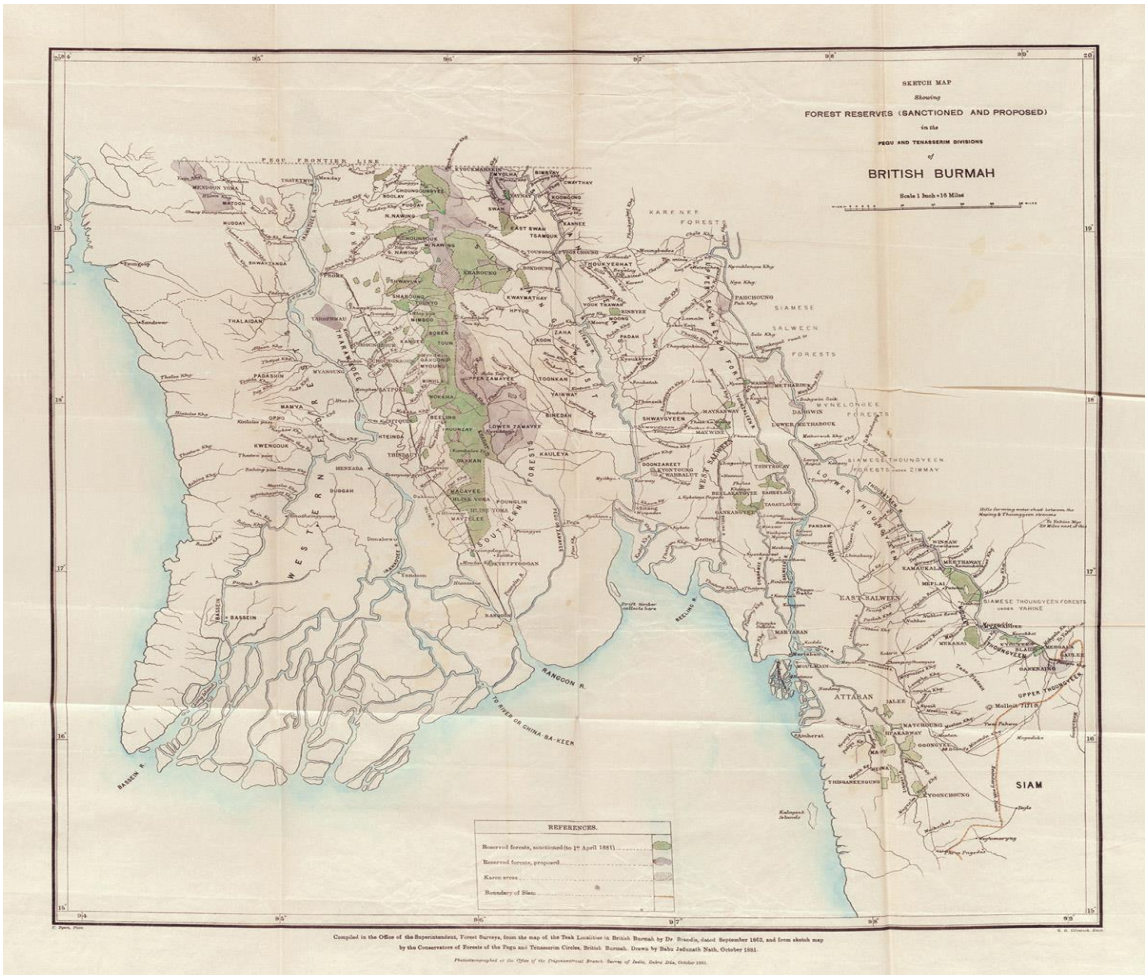

Fig 1: Sketch map of the existing and proposed forest reserves in Pegu and Tenasserim divisions of British Burmah in 1861. The Karen areas and the boundary of Siam at that time are also shown (Source: Into the Woods by Dan Handel, Cabinet Magazine, Issue 48, 2012)

French colonial influence: limited by circumstances

Compared to the British East India Company, the French East India Company was more neutral to how the Rulers in various parts of Vietnam, Laos and Cambodia conducted their internal trade practices. Its objectives were far more political than commercial from the beginning perhaps also because there was no natural teak, the timber most in demand for the imperial navies, in Vietnam and Cambodia and very little in the north-western region of Laos bordering Thailand. This resulted in very limited French influence in timber related policies in these countries. In the Vietnam peninsula timber harvest and trade practices largely evolved in response to the demands from the neighboring markets of China and changes were slow and limited by relatively decentralized nature of political control in these countries with remarkable autonomy in the hands of local tribal communities. The French did try to introduce teak in Vietnam in the early years of the twentieth century, but it was limited to planting along roads and in public parks around French buildings and had no impact on teak trade.

Adjusting itself delicately and deftly between the two European big powers of the day, Thailand remained politically independent but had to cede control over its teak forests in northern territories to the British[5] who primarily wanted to prevent the French from increasing their imperial expansion and accessing the great Teak resources of the country for ship building. King Mongkut of Siam, after signing the Bowring Treaty in 1855 giving the British extraterritorial privileges in managing teak trade in the northern vassal states with the British Vice Counsel in Chiang Mai holding magisterial powers of the Court to settle trade disputes involving British subjects, famously stated[6] his choice was whether to swim upriver and make friends with the crocodile (the French) or to swim downstream to the sea to be with the whale (the British). He obviously found the whale, that kept a cuddly but firm hold for the next three quarters of a century, a more manageable partner.

Current policies related to teak

Harvesting of teak in natural forests is not permitted in Thailand since 1989 with most of these natural forests having been declared protected areas. While this has promoted teak plantation activities within Thailand and also in neighboring Cambodia, Laos and Vietnam it has also led to increased demand for teak harvesting in natural teak forests of Myanmar where restrictions on natural teak harvesting are limited only by the principles of sustainable forest management. There are also reports of increased illegal logging of natural teak in Myanmar close to its borders with Thailand.

Teak harvesting in natural forests of Lao PDR is also prohibited since 1989 with most of the teak entering markets coming from shifting cultivation areas in its north western hills and also from left over harvested teak logs from previous harvesting. There is a ban on export of logs from the country but there are problems in effective implementation of the ban.

In Myanmar teak harvesting is carried out under the Myanmar Selection System with both allowable annual harvest and marking of harvestable trees being done by the Forest Department while the actual act of tree felling, conversion and transport to depots, and sale, is conducted by the sole authorized government agency, the Myanmar Timber Enterprises.

A deep policy overhaul is needed

In view of high demand for teak timber Governments in all countries of the region encourage teak planting by government forest departments over public lands as also incentives to people and communities for establishing teak plantations. As the availability of public lands for raising teak plantations are limited everywhere due both to ecological constraints and competing demands for other uses, the trend is to encourage raising teak plantations over private lands by individuals, communities and companies through subsidies and other incentives.

But much work remains to be done in this direction since there are still a host of policies[7] and laws in all the countries of the region that in one way or the other act to discourage private sector investment in teak foremost of which are the restrictions on felling and transport of teak that were put in place for protecting teak in natural forests and on public lands. Many more

[5] Forestry as Foreign Policy: Anglo-Siamese Relations and the Origins of Britain's Informal Empire in the Teak Forests of Northern Siam, 1883-1925, by Gregory Barton and Brett Bennett
[6] Cambridge History of Southeast Asia, Nicholas Tarling
[7] Site, technology and productivity of Teak plantations in Southeast Asia, by Thomas Enters

roadblocks are offered by a range of land and fiscal policies relating to lease tenures, land conversions from agriculture to tree cultivation, royalties and taxes.

Sourcing funds for financing long term investments that hardwoods like teak require the risks that deter financing to be evaluated. Loan financing for these long-term investments pose serious problems and currently there are not many instruments that can satisfactorily link the financial institutions providing loans with the teak growers needing loans. Teak forests in their natural zone provide a range of ecosystem services that are highly valuable for the welfare of larger global and national societies including mitigation of, and adaptation to, climate change, biodiversity enrichment, soil and moisture conservation and regulation of air pollution among others. The larger global and national societies should, therefore, be persuaded to share the risks that private investors face in long term teak plantations and funding mechanisms that identify such sharable risks would need to be devised. The national society that benefits from the "green investments" in teak forests should also be able to extend tax incentives to the investors in teak plantations, particularly to those managing teak on a long-rotation basis.

Another aspect of policy intervention that needs to be explored fully is the promotion of public-private partnership in managing existing teak forests and growing more. This partnership has to go beyond merely sharing investment burdens for it to succeed at scale. One such area that requires private partnership is research which has so far been entirely in public domain. While competing interests, and resulting need for secrecy, cannot always be avoided in the case of research in teak growing by private companies making big investments there are clearly areas of cooperation that should be explored and expanded through policy measures.

Protecting the interests of small-scale unorganized teak growers is a major challenge before the policy makers. They require extension services through institutional arrangements and also access to international support mechanisms for new and evolving technologies, financing under the many international agreements on biodiversity, climate change and limiting pollution. Increased access to marketing of teak products in high end international markets by small growers would also help them significantly.

A comprehensive review of all these fiscal and land policies, and regulations related to harvesting, transport and export and import is needed to assess their impact on private investment in large and small sized teak plantations by commercial ventures, individuals and communities, and even household plantings. Such a review should be able to identify specific financial incentives at global, national and local levels, and the legal and institutional environment in which these incentives are placed, that are most efficient and cost effective in leading to the desired changes.

Annexure 2

Policy Brief No. 2

Making teak an attractive agroforestry tree for smallholders in the Mekong Subregion

by
Dr Promode Kant[8]

Teak, easily the most favored timber across the world that has a ready market everywhere, is native of South and South East Asian countries and comes up very well both within the forests ecosystems as well as on cultivated lands of the Mekong subregion. The farmers of this region are aware of the potential of this resource and they, including smallholders, are usually keen to enhance their incomes by growing it on medium rotation as an agriculture intercrop and also sometimes as exclusive plantations on marginal lands low on agriculture productivity.

There is no single official definition of smallholding because what could be considered small in one country may be seen quite large in another. The context decides what is a smallholding. The Lomé Statement[9] for Smallholder Forest Landscape Restoration (FLR) in West Africa of November 2019 notes that smallholders "are most often classified according to their size, which can vary from less than one hectare up to 10 hectares and more. Legally, smallholders can be individuals, family or clan structures, communities, churches or associations. Within the framework of FLR, smallholders include tree planters (woodlots for timber or fuelwood), tree crop producers and farmers who incorporate trees in their farming systems, as well as those who restore and protect remaining natural forests."

In the heavily populated Mekong subregion the per capita land availability is very low with Vietnam at 0.12 ha being at the bottom, followed by Myanmar at 0.24 ha while the extents for the remaining three countries of Cambodia, Laos and Thailand are almost similar at 0.36 ha, 0.33 ha and 0.34 ha respectively. Land holding in the region is typically small with as many as 85% in Vietnam, 38% in Laos, 34% in Myanmar, and 23% in Thailand being less than 1 ha[10]. The data for Cambodia could not be accessed. Given this nature of landholding it appears judicious to take 1 ha and less of landownership in a family as a good measure of smallholding in the crowded Mekong subregion.

Till about three decades back the owners of these smallholdings were almost exclusively subsistence farmers but the situation has gradually changed since 1980s with rapid expansion of the southeast Asian economy giving attractive employment opportunities to the landless and those in the subsistence zone. Smallholders with self-labor no longer available for most part of the year for cultivation began either renting out their lands for cultivation or opting for tree based crops like rubber and teak among others. As demand for teak rose fueled by the massive appetite of the Chinese for high value timber accompanied with increased domestic demand teak planting and rearing also increased greatly across the subregion.

[8] Dr Promode Kant, formerly of the Indian Forest Service, Director, Institute of Green Economy, Noida NCR, India
[9] www.itto.int/news/workshop_discusses_smallholder_forest_landscape_restoration_and_local_development_in_west_africa/
[10] OECD-FAO Agricultural Outlook 2017-2026 © OECD/FAO 2017

Many of these smallholding farmers, however, met with disappointment as they did not realize their expected earnings from teak leading to slowing of fresh teak planting. Extensive discussions with practitioners across the countries of the subregion suggests a range of factors responsible for lower than anticipated earnings by smallholders which would need to be addressed by the countries of the region:

Poor quality of planting stock: The smallholders most often use the planting stock available closest to the planting site and it is only after several years many of them realize their teak crop is of poorer quality by which time it is too late to do anything. Low returns on account of low quality and quantity of teak timber produced then deters more smallholders from opting for teak. Sometimes high-quality teak planting stocks are available through large plantation companies but these are usually high priced and incur considerable costs in transportation or tied up with conditions that smallholders are reluctant to agree to. The smallholders expect assured quality of planting stock delivered at reasonable prices at locations that are manageable for them.

Loss by way of theft of standing teak timber: Illegal felling of valuable teak trees by miscreants is a major concern of smallholders particularly those whose lands are located in remote sites away from the watchful eyes of villagers. They are not able to engage the services of plantation watchers as big plantations do because of the high cost of individual plantation watchers. The smallholders expect a reasonable degree of protection of their standing assets as an important duty of the State.

Loss by way of fire, diseases and insect attacks: While the smallholders are able to deal with the fires, diseases and insect attacks on their teak trees located within agricultural fields close to the habitations they sometimes find their plantations located adjacent to the government forests exposed to fires that originate within forests and cannot be controlled by outside efforts. Less often they face similar problems with tree diseases and insect attacks, too, that originate within adjacent large sized government forests. A clear expectation of the smallholders is that reducing these losses is the responsibility of the State.

Linkage with carbon sequestration and PES schemes: Ever since long-term carbon sequestration in forest and trees was recognized as a measurable climate change mitigation benefit under the UNFCCC, the forest departments and other authorities in the Mekong subregion have been giving hopes of additional incomes for tree planters by way of carbon credits. Similar hopes have also existed for payment of other ecological services that the tree plantations render to the society. But now it is realized that for reasons of enormous technical complexities and high costs involved smallholders by themselves cannot hope to create standalone Carbon Sequestration as well as other Payment for Ecosystem Services (PES) projects. They expect the State to act in such a way that the climate change mitigation and other ecological benefits that accrue to the global society bring financial benefits to them, too.

Policy recommendations:

Protecting the interests of small-scale unorganized teak growers is a major challenge before the policy makers in the countries of the subregion. The smallholders' expectations noted above are not unreasonable and working on fulfilling these would go a long way in ensuring that teak planting and management by smallholders gets a major boost. The following policy recommendations are, therefore, made:

1. Produce certified high-quality teak planting stock offering a good range of choices that are well advertised, and make it available through all forest, horticulture and agriculture department offices and extension facilities throughout the countries of the region. The planting stock should be offered at low prices but not free of cost so as to avoid wastage. Since there are primary schools in the remotest villages it would be useful to engage the services of resident teachers as short term planting material stockholders and extension workers during the planting season.

2. Make theft of standing teak timber difficult by quickly moving towards restricting market to certified timber only. But since it would take a few years before certification of timber could be made universal across the countries it would be useful to identify hotspots of theft and organize villagers to combat the problem in these areas. Selected villagers can also be armed, after due training and under competent supervision, with the legal powers of a forest official to book offences against the culprits.

3. Prevention of escape of fires and of plant diseases and insect attacks from government forests to adjacent plantations of smallholders must be accepted as a public duty and a protocol for taking adequate and timely steps must be developed in consultation with smallholders and followed strictly. It must, however, be made clear that the protocol does not lessen the duty of the smallholder towards the protection of his own crop.

4. The forest departments should explore the possibilities of creating provisions for pooling the smallholder plantations into larger sized carbon sequestration schemes like REDD+ and other schemes that enable payment for ecological services rendered by these tree plantations. The country negotiators in UNFCCC, UNCCD and CBD Conferences of Parties should be asked to bring these concerns into international negotiations appropriately for ensuring that the international systems arrived at enable the participation of smallholders through cooperative efforts and the participation costs are kept low.

Annexure 3

Policy Brief No. 3

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

Comprehensive Policy Recommendations for supporting Community and Smallholder Teak Plantations in the Greater Mekong Sub-region

by
Dr Promode Kant[11]

Teak comes up very well both within the forests ecosystems as well as on cultivated lands of the Mekong subregion. Till a few decades back almost the entire production of teak timber in the world used to come from publicly owned forests managed by government forest departments. But the situation today is markedly different with a large part of demand for teak timber being met by private teak growers. As more and more growers are entering the field the problems they face in growing the best produce, in managing the crop to maturity, in growing interim crops for regular incomes, in harvesting and transporting timber, and fetching the best prices for their produce, are also increasing. There is pressure on them to get their plantations certified by authorized agencies because rich developed countries would not allow finished products made of uncertified wood enter their countries. But the cost of such certification is clearly beyond the reach of the most well placed of the smallholders. As the world warms up there are increasing incidences of fires, insect attacks and diseases which often originate in adjacent large natural forest areas. There are also new opportunities like the market and non-market appraoches of the Paris Climate Agreement where the smallholder teak planter hopes to be linked up with the evolving opportunities that can make him more competitive in the market place.

Efforts have been made in all the countries of the Mekong region to address the problems of this section of teak growers. But much more needs to be done because private smallholder teak planters continue to face difficulties in their ventures. This policy brief presents governance and management issues involved in various countries of the region and suggests measures to be taken.

Defining smallholders

In the heavily populated Mekong subregion the per capita land availability is very low ranging from 0.12 ha in Vietnam to 0.34 ha in Thailand. Land holding in the region is typically small with as many as 85% landholding in Vietnam, 38% in Laos, 34% in Myanmar, and 23% in Thailand being less than 1 ha. The Lomé Statement for Smallholder Forest Landscape Restoration (FLR) in West Africa of November 2019 notes that smallholders "are most often

[11] Dr Promode Kant, formerly of the Indian Forest Service, Director, Institute of Green Economy, Gurugram, India

classified according to their size, which can vary from less than one hectare up to 10 hectares and more. Legally, smallholders can be individuals, family or clan structures, communities, churches or associations. Within the framework of FLR, smallholders include tree planters (woodlots for timber or fuelwood), tree crop producers and farmers who incorporate trees in their farming systems, as well as those who restore and protect remaining natural forests."

What would be considered smallholding will, thereore, be context specific. Given the nature of landholdings it would perhaps be appropriate to consider landholdings upto 2 ha as smallholdings in Vietnam and upto 5 ha in other countries of the region for the purpose of raising tree plantations.

Smallholders shifting from growing food to growing trees

Till about three decades back the owners of these smallholdings were almost exclusively subsistence farmers relying exclusively on family labour but the situation has gradually changed since 1980s with rapid expansion of the southeast Asian economy giving attractive employment opportunities to the landless and those living the life of subsistence. With self-labor no longer available for cultivation of their lands many began either renting out their lands for cultivation or opting for tree based crops like rubber and teak among others.

Teak planting on community lands

This is usually confined to those hills in the region where shifting cultivation is still being practiced as in parts of Lao PDR, Myanmar and Cambodia where indigenous people live in communities. In Lao PDR the policies on the utilisation and management of natural resources emphasizes the need to reduce shifting cultivation and control deforestation. To achieve these goals the Government has sought to establish permanent habitations for 277,000 upland families practicing shifting cultivation and protect the watersheds of 80 streams and rivers by rehabilitation and protection of the forests situated in these watersheds and by the reforestation of the eroded areas. These people so settled are allocated forest lands, both degraded and well-forested, to manage and protect on a household basis thereby granting security of land tenure to the rural people and enable transmission of their inheritance to their heir. Government forestry units at all levels are expected to act as the servicing units for the local people and provide technical assistance in extension techniques for farming, forest and fruit tree planting, seed and fertilizer supply.

These policy measures, combined with expanding road network and access to credit up to 40–60% of the estimated value of plantation, have led to teak being successfully raised over considerable extent of hill lands in Luang Prabang province in northern Lao. However, one clear outcome of this household centric approach in Lao PDR is the conversion of community centric shifting cultivation covering large sized community owned hillsides to individually held small sized teak plantations that are, in practice, no different from smallholder teak plantations elsewhere in the region.

Other countries of the region like Myanmar that still have many communities practicing shifting cultivation may also encourage similar shift away to family owned teak plantations and teak based agroforestry over such lands. However, this will have to be primarily a socio-political decision that would decide whether these countries are willing to hasten the process of conversion of community owned land assets of indigenous hill peoples accessible to the entire communities on the basis of their needs into small sized individual family assets that

completely excludes others in the communities. This is because this process will also result in fundamental, deepset, social changes at a great pace with consequences for the overall governance of the countries.

Delineating better sites

Site quality has a dominant role in determining the productivity, and profitability, of teak plantations and, thereore, it is important that the smallholders should be guided and encouraged to opt for the best available sites. Criteria for site selection for teak plantations should be refined, harmonized and widely disseminated.

A network of permanent sample plots covering the entire range of growth conditions and management conditions should be established in the countries of the region and improved national tables giving growth and yield estimates under in different parts of this range of site and treatment conditions should be prepared and made available to teak growers.

Presently site quality assessments are based almost exclusively on growth parameters but increasingly ecological and biodiversity values are also becoming important even for smallholder plantations particularly when they hope to benefit from national and international financing geared towards Sustainable Development Goals. The growth and yield estimates for these sites should, therefore, be prepared in such a manner that the farmer is able to understand the moderation in yield when ecological goals are also expected to be fulfilled. This will better prepare him for negotiating the prices of these societal and ecological goals with the relevant authorities.

Enhancing site quality

Site management to sustain and enhance productivity may involve changes in silvicultural prescriptions, soil conservation measures and fertilizer application. Existing protocols, where they exist, are inadequate and serve only large government and private plantations. The government forest departments of the region may develop these protocols specifically for smallholder plantations and make them easily accesible to all concerned.

High quality planting stock

Smallholders most often use the planting stock available closest to the planting site and realize their teak crop is of poorer quality when it is too late to do anything. Low returns on account of low quality and quantity of teak timber produced then deters more smallholders from opting for teak. Sometimes high-quality teak planting stocks are available through large plantation companies but these are high priced and incur considerable costs in transportation or tied to conditions that smallholders are reluctant to agree to. The smallholders expect assured quality of planting stock delivered at reasonable prices at locations that are manageable for them.

The forestry departments of the region may produce certified high-quality teak planting stock offering a good range of choices that are well advertised, and make it available through local extension offices of all land related government departments like horticulture, animal husbandry and agriculture departments besides their own outlets. The planting stock should be

offered at low prices but not free of cost so as to avoid wastage. Since there are primary schools in the remotest villages it would be useful to engage the services of resident teachers as short term planting material stockholders and extension workers during the planting season.

Discouraging speculative investments

In the decades of 1980 and 1990 there was a surge of specultive investment in teak plantations across the tropical lands in the expectations of excessive profits with cost-benefit analysis of long rotation plantations exceeding 50 years suggesting return on investment of 15% with an MAI of 3 m3 per hectare including all wood removed from thinnings to final felling assuming low initial investments, no opportunity cost for land, marketability of wood from all thinnings, and continued increase in the prices of teak timber. The expectations of the investors were rarely met leading to large scale disappointment and collapse of the so-called teak schemes across the tropical world. Had a rigorous cost-benefit analyses been undertaken before going into the venture taking into account the true opportunity cost of the land to the smallholder in addition to the site and environmental conditions, management regimes, and accesible markets this large scale speculative investment based on misleading claims could have been easily avoided.

The governments of the countries of the region should commission rigorous cost-benefit analysis of teak plantations on all likely sites within their countries at different rotations taking into account the true labour costs and the opportunity costs of the land under plantation to be carried out by their forestry universities and institutions. This will not only give a true picture to potential investors in smallhold teak plantations but also build capacity for quality cost analysis within their own institutions.

Tenure security and felling permission

Smallholders in some countries of the region, particularly Thailand, have this fear that if they plant trees on their lands they may not be allowed to fell the trees and use the land for agriculture or for house construction at a future date. This is more likely to happen on trees planted on landholdings located on steep slopes, on other ecologically fragile areas, and on places of tourist interest with high expectations of green surroundings. Thus, while the smallholder would continue to be the owner of his land, his economic choices related to his land become severely restricted once trees are planted on it.

It needs to be appreciate that the only reason a smallholder plants teak on his land is to maximize his earnings and not for aesthetic purposes or for binding soils, and certainly not for inviting restrictions on his existing freedoms on the enjoyment of his land assets. If such social objectives are to be added to his personal goals in planting teak by the government under extraordinary circumstances for public good then, as a matter of principle, the government must be willing to compensate the smallholder for all the consequential losses incurred by him. In the interest of promoting teak planting by smallholders every country in the region should make incorporate this principle in their policies.

Restrictions on transport

Existing policies and legislation in some countries of the region place restrictions on the transport of teak harvested from private lands by farmers. But these restrictions, introduced during colonial times to protect governemnt owned natural forests from illegal felling, act as

severe disincentive for smallholders who find it difficult to obtain the required permissions to transport their timber to the sawmills and market and often become victim of corrupt practices.

Many states in India that had the same restrictions have now removed them atleast for species that are not found in natural forests in the neighbouring districts which has greatly eased the situation for tree growers. The task of protection of teak in natural forests belonging to the State is a duty of the larger society and of the State, the cost of which should be borne by the State and not by individual smallholders who take to teak growing as a normal economic activity. And now DNA based technology is available that can establish the source of timber. This technology needs to be further refined and made easier and quicker which task can be undertaken by countries like Thailand and India that have the technological knowhow.

It is strongly recommended that the governments of the countries in the Mekong region may consider removing the restrictions on transport of teak from plantations altogether and instead rely on in-situ protection of their natural teak resources using appropriate technologies.

Attracting investment in smallholder teak plantations

Sourcing funds for financing long term investments in teak plantations is a difficult task on account of the plethora of risks involved. Even when there are potential investors willing to risk their capital in such ventures like the European and American Pension Funds mandated to invest a small part of their portfolios in such green investments, there are no official mechanisms that can link them with genuine smallholder teak growers.

The forestry departments of the countries of the region should provide a platform on which genuine smallholder teak growers are brought in touch with potential green investors. Investment in teak plantations of all sizes should be officially declared as a "green investment" and attractive financial and tax incentives provided to promote these teak investments. The tax incentives can also be linked to the length of rotation which would help encourage the growing of larger sized teak timber.

Loan financing of smallholder teak plantations

Institutional assistance for loan financing for raising teak plantations across the region is inadequate at best and often absent altogether. Loan financing for these long-term investments pose serious problems and currently there are not many instruments that can satisfactorily link the financial institutions providing loans with the teak growers needing loans. The forestry departments of the countries of the region should provide a platform on which genuine smallholder teak growers are brought in touch with financial institutions mandated and willing to extend loans to smallholder teak plantations.

Tax Relief

As the availability of public lands for raising teak plantations are limited everywhere due both to ecological constraints and competing demands for other uses, the trend is to encourage raising teak plantations over private lands by individuals, communities and companies through subsidies and other incentives. In India the income accrued from agriculture is exempted from income tax without any upper limit and, since tree growing is considered agricultural activity, there is no income tax on the sale of trees harvested. This is a major attraction for tree growers

and is worthy of emulation. It is, therefore, recommended that the countries of the region may exempt income from tree growing from income tax.

Support under REDD+ and Article 6 of Paris Agreement

Teak forests in their natural zone provide a range of ecosystem services that are highly valuable for the welfare of larger global and national societies including mitigation of, and adaptation to, climate change. The forest departments and other authorities in the Mekong subregion have long been discussing about additional incomes for community and individual tree planters by way of carbon credits for mitigating climate change through carbon sequestration, and through other ecological services that the forests and tree plantations render to the society. Teak growers across the region expect their governments to enact policies and take steps that enable them to financially benefit from these new possibilities.

The very rigid eligibility conditions of the Clean Development Mechanism (CDM) under the Kyoto Protocol, the excessive technical complexities and very high transactional costs involved in implementing CDM projects placed the smallholder teak plantations outside the reach of this facility. REDD+, which stands for reducing emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks, addresses a part of the limitations of the CDM but REDD+ is essentially meant for national or sub-national level efforts where the achievements in sequestering carbon have to be measured against the national or subnational baselines. This means that till a country, or atleast a significantly sized region within it, is prepared and ready for REDD+ the communities and smallholding teak growers would not be able to access financial benefits from the climate change mitigation services that they provide to the world.

Article 6 of the Paris Agreement on Climate Change has provisions for both market and non-market mechanisms in support of climate change mitigation and adaptation activities that need to be utilized creatively to finance smallholder teak plantations. The recently held COP26 at Glasgow in Nov 2021 had made much progress in finalizing rules for operationalizing these mechanisms in practice and some more guidelines are expected to be finalized by the subsidiary bodies of the UNFCCC in June 2022 following which ITTO may commission a small pilot activity to test ways to use these Article 6 mechanisms in support of the smallholder teak plantations.

The forestry departments of the countries of the region should explore the possibility of creating provisions for pooling the smallholder plantations into larger sized carbon sequestration schemes like REDD+ and other schemes that enable payment for ecological services rendered by these tree plantations. The country negotiators in UNFCCC, UNCCD and CBD Conferences of Parties should be asked to bring these concerns into international negotiations appropriately for ensuring that the international systems arrived at enable the participation of smallholders through cooperative efforts and the participation costs are kept low.

Developing markets for short rotation timber

Smallholders can not wait for half a century for harvesting teak and getting returns on their investment. For them even twenty years is a long rotation. Investors in large teak plantations also expect interim incomes from small-diameter wood obtained from thinnings. Profitability is affected by the higher proportion of sapwood in short rotation teak, the variability in

physical and mechanical properties, and the appearance of the wood in comparison with larger diameter wood from natural forests and long rotation plantations. Difficulties in processing and marketing smaller dimensions also deters smallgrowers.

In Java, Indonesia, short rotations and small dimensions do not seem to pose problem since demand for small sized teak has evolved over time and with improvements in utilization technologies thereby facilitating the use of smaller dimensions. And in recent years teak has been harvested in as short a time as 8 years in places where small sized teak fetches good value in the market. The current and potential uses of small dimension plantation wood from teak plantations should now be assessed recognizing these dynamic changes.

For hastening this process of market acceptance of small sized teak from short rotation plantations the governments of the countries in the region should promote the use of small timber utilization technologies that are already in use in Indonesia and elsewhere and also encourage further innovations. Chemical treatment of higher sapwood timber can impart it greater strength, longevity, and protection against insect attack. Specific time bound projects should be awarded to forestry universities to conduct research on these subjects.

Also, in order to facilitate comparisons between teakwood of different sizes and localities, common standards, definitions and nomenclature need to be adopted across the teak producing countries. This is a very big task not entirely within the capacity of producing countries in the Mekong region but it can begin here adopting features and language that would make the standards evolved acceptable all over the world over time. Existing national grading systems for teak timber need to be reviewed and changed as necessary, taking into account the quality and dimensions obtainable from shorter rotation plantations in end harvest as well as thinnings.

International collaboration is required to be promoted on products and markets and for standardization of definitions in relation to technology, markets and sizes. Such collaboration is particularly relevant for the standardization of grading rules for teak timber and for carrying out research on demand, supply and prices of varying grades of teak.

On pruning, thinning, and girdling before harvest, in smallholder plantations

Pruning is typically required to maximise the production of high-quality teak timber. It is best to prune young teak up to 50% of the tree total height at the first thinning. The first pruning should be carried out when the stand reaches a total height of 4–5 m, second pruning when the stand reaches 9–10 m in height and the last pruning should be done when the stand reaches 12 m of total height.

Thinning is an important tool for ensuring high quality and higher volume product at the end of rotation. It results in improved growth and yield of stands as well as individual tree sizes and tends to have positive effects on stem form. But many smallgrowers use it to remove best quality trees years before the rotation period which results in reduction in both quality and quantity of the timber produced at the end of rotation.

The extension wings of the forestry departments of the region may hold regular workshops in localities that have large number of teak plantations to demonstrate best thinning and pruning practices. The final decision on thinning, however, must be left to the teak growers because

sometimes their immediate need of money may be more important to them than the returns that may come at the end of rotation.

Girdling trees well before harvest at rotation age has been an age old practice in Myanmar that makes the tree loose sap and get seasoned ready for immediate use as timber. But this also results in loosing growth that would have occurred during the period between gridling and harvest which is important in short rotation plantations. If girdling is done in summers just three months before harvest at 20 year rotation the loss in growth may be insignificant but the possibility of immediate use may enhance its commercial value considerably. The forestry departments of the region may examine this closely in different localities and seasons and advise the smallholder teak growers in the neighbourhood accordingly.

On harvesting teak in natural forests

Harvesting of teak in natural forests is banned in Thailand since 1989 where most of these natural forests having been declared Protected Areas. Teak harvesting in natural forests of Lao PDR is also prohibited since 1989 with most of the naturally grown teak entering markets is said to be coming from shifting cultivation areas of north-western uplands of the country and from left over harvested teak logs. There is also a ban on export of logs from the country but there are problems in effective implementation of the ban.

In Myanmar teak harvesting in natural forests is carried out under the Myanmar Selection System with both allowable annual harvest and marking of harvestable trees being done by the Forest Department while the actual act of tree felling, conversion and transport to depots, and sale, is conducted by the sole authorized government agency, the Myanmar Timber Enterprises.

While this has promoted teak plantation activities within Thailand and also in neighboring Cambodia, Laos and Vietnam it has also led to increased demand for teak harvesting in natural teak forests of Myanmar where restrictions on natural teak harvesting are limited by the principles of sustainable forest management. There are also reports of increased illegal logging of natural teak in Myanmar close to its borders with Thailand.

While the total ban on teak felling in natural forests everywhere is often lauded as a very effective approach to conservation of this great gift of nature, in the opinion of this author the benefits are overvalued and the outcomes are not without great risks. The increased risks are in having precious natural forests with large number of old and often diseased and decaying trees that become host to very huge infestations of Hyblaea puera, a leaf defoliator commonly found on teak, and other local pests. During drought season these old decaying trees greatly increase the risk of fire as they provide plentiful fuel to the fires.

Also in National Parks and other Protected Areas with natural teak forests too high a density of teak trees discourage grass growth on the forest floor reducing the carrying capacity for wild ungulates which in turn affects the populations of predators. So a regular but moderate selection felling of old, dead and dying teak trees is advisable in in these forests.

Containing environmental damage and human injuries during harvesting

Harvesting and extraction operations are the activities that generally cause the most significant impact on the environment. The impact of harvesting and extraction can be reduced through proper planning and control of harvesting operations using sound principles, systems, and

techniques that have stood the test of time. Successful harvesting should be (a) technically feasible considering physical limitations, engineering knowledge, and environmental relationship of the forest, (b) economically viable considering the costs and benefit of short and long range consequences, (c) environmentally sound considering impacts on the natural and social environment, and (d) institutionally feasible considering laws and regulations, landowner objectives, and social values.

The most common cause of accidents during harvesting is the workers' lacks of knowledges or skills and repeated training is the most effective tools for reducing risks. Wearing suitable Personal Protective Equipments (PPE) provides protection when all other control measures cannot adequately eliminate or minimize risks to a worker's health and safety.

The extension wings of the forestry departments of the region should conduct annual workshops in each important teak plantation district to communicate with the teak growers on the best harvesting practices.

On certification

There is increasing demand from EU and North American countries for certification of timber exported to their countries in raw or processed form. And since the economies of the Mekong region rely to a considerable degree on their exports there is pressure on the teak producers to get their timber certified. Higher prices in niche markets where consumers are prepared to pay a premium price for teak obtained from sustainably managed areas are an incentive to produce certified timber. But the costs of complying with the environmental standards required in certification process are quite high and often prohibitive for smallholders. And also the niche markets willing to pay higher prices for certified timber may not be accessible to all smallgrowers. It would be quite a while before a clear consumer preference for certified timber emerges in a widespread market for timber and its products.

The choice to go for certification or not is best left to the teak grower but for this choice to have any real meaning there should first be easily accessible, and internationally acceptable, certifiers within their physical and economical reach. In this the ITTO can play a role by helping set up an autonomous independent certification body for the Mekong region on the lines of international certifiers like the Forest Stewardship Council (FSC).

Reducing losses incurred by smallholders by theft, fires, diseases and insect attacks

Illegal felling of valuable teak trees by miscreants is a major concern of smallholders particularly those whose lands are located in remote sites away from the watchful eyes of villagers. They are not able to engage the services of plantation watchers as big plantations do because of the high cost of individual plantation watchers. The smallholders expect a reasonable degree of protection of their standing assets as an important duty of the State.

The forestry departments of the countries of the region may identify hotspots of theft and organize villagers to combat the problem in these areas. Selected villagers can also be given, after due training and under competent supervision, the legal powers of a forest official to book offences against the culprits. But this has to be done with great care and under close supervision otherwise it has the potential of creating conflicts within village communities.

The smallholders are able to deal with the fires, diseases and insect attacks on their teak trees located within agricultural fields close to the habitations but they sometimes find their plantations located adjacent to the government forests exposed to fires that originate within forests and cannot be controlled by outside efforts. Less often they face similar problems with tree diseases and insect attacks, too, that originate within adjacent large sized government forests. A clear expectation of the smallholders is that reducing these losses is the responsibility of the State.

While these expectations of the smallholders can not be fully satisfied by the governments of the region because it would encourage tendencies to turn private responsibilities into public duties there can be little doubt that government policies should actively prevent the escape of fires, and insects and pests, from government forests to the adjacent teak plantations by smallholders. Prevention of escape of fires and of plant diseases and insect attacks from government forests to adjacent plantations of smallholders must be accepted as a public duty and a protocol for taking adequate and timely steps must be developed in consultation with smallholders and followed strictly. For this purpose well managed firelines, cleared of all vegetation and debris, along the boundaries between fireprone government forests and smallholder teak plantations would reduce the chances of fires, diseases and insects spreading outwards. It must, however, be made clear that the protocol does not lessen the duty of the smallholder towards the protection of his own land and crops growing there.

On research

There are several areas related to teak and its planting by smallholders for economic purposes that need to be explored thoroughly to enable governments to lay down appropriate policies to promote this economic activity over larger extents of lands suitable for growing teak in the countries of the region. In the paragraphs below the more important of these have been described briefly.

An important area for research is the impact of complete ban on teak felling in natural forests and Protected Areas, including thinnings that were planned earlier, on the quality of habitat for wild animals by way of availability of ground flora as feedstock for herbivores, effect on water sources, frequency and intensity of forest fires, and on the socio-economic conditions of the indigenous people residing inside and in close vicinity of these forests. The forest departments of Universities in the region should be encouraged by the country governments and the ITTO to undertake several independent research projects on different sites so that a truer picture may emerge of the realities on the ground which can then be utilized to review the ban on teak felling in natural forests.

There are unsubstantiated claims of teak plantations having a deletrious effect on the productivity of agricultural lands downstream and even on the site quality of forests below. These needs deeper investigations by forestry universities and research institutions in collaboration with agricultural universities and quick dissemination of the outcomes as they emerge.

Another potential area for management research in teak is the impact of long, medium and short rotations in teak natural forests and plantations on soil, ground vegetation, water regime, and on teak production which have not yet been systematically assessed and are subject to much speculation. This research task is also best undertaken by forestry universities and research institutions in the region and ITTO is well placed to facilitate this process.

Research is recommended on biological control of pests and diseases that are common in teak plantations in the region in order to facilitate large scale application of these measures by smallholders. and to overcome resistance. Raising mixed plantations instead of pure teak plantations may also help control the spread of infestations but this needs to be established by data based research. Integrated pest management models that are effective as well as economical need to be designed.

Smallhold investors in teak plantations expect assured periodical interim incomes from their lands from agricultural crops in the first three to four years and later from small-diameter wood obtained from thinnings. This requires research on incomes from suitable agricultural cover crops under different site qualities and from wood obtained under different thinning regimes.

On generating rural employment

Intensively managed plantations requiring continuous care have the potential to provide considerable employment and income to the rural economy and thereby provide a crucial public good which needs to be acknowledged in policies and appropriately compensated through tax relief or subsidies. Very few studies have, however, been carried out on the socio-economic benefits of teak plantations. The country governments of the Mekong region should, with the help of bilateral or multilateral international financing agencies, commission the forestry universities and institutions in their countries to undertake such studies. The outcome of these studes can help decide the quantum of compensation or relief to the smallholder teak planters for the services rendered to the Society.

On international collaboration

There is need to strengthen international collaboration in exsitu conservation for provenance identification and testing, and formulation of common methodologies and procedures to allow comparison of results across countries. Collaborative efforts at the regional and global levels are particularly important for testing clones in a variety of sites and under diverse conditions and for developing technical guidelines for the exchange of genetic materials. National efforts to collect growth and yield data could be complemented through a network of permanent sample plots. The conservation of teak genetic resources and the monitoring and control of transboundary pests and diseases are other important areas for collaboration.

Obtaining prices for teak logs and sawn timber is difficult because no common international log grading rules have been established, most exporting countries' definition of log dimensions as well as measuring units are different. Teak prices are very closely related to wood quality which is determined by dimension, bole shape in terms of roundness and straightness, heartwood-sapwood ratio, regularity of annual rings, number of knots, colour, texture and the soundness of the butt log. Teak from natural forests sells at comparatively high prices as teak harvested from plantations is typically smaller in size and rarely reaches the dimensions and quality that fetches the best prices.

The ITTO is best placed to facilitate this kind of collaboration by bringing two or three forestry universities of the region work on a collaborative project of this nature with institutions in Japan, South Korea, Australia, India and other countries that have the requisite technological know-how. The fact that the countries named above have existing bilateral agreements of

cooperation and assistance in the field of environment and forests with most countries in the Mekong region will help in joint financing of such a project.

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