4th World Teak Conference

Global Teak Market: Challenges and Opportunities for Emerging Markets and Developing Economies

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Thematic Papers

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This Thematic Paper is the outcome of 4th World Teak Conference and the purpose of these papers is to provide the information on the five Thematic areas of this conference

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PREFACE

Teak (*Tectona grandis*) has gained worldwide recognition as the most preferred tropical hardwood reputed for its exceptionally superior physical, mechanical and aesthetic qualities. Teak is one of the tropical hardwoods in high demand for the luxury market and for heavy duty applications. Since the 1980's, this species has attracted large-scale investments from the private sector in approximately 70 countries throughout tropical Asia, Africa, Latin America and Oceania. Growing private investment in teak plantations is a clear indication of the perceived potential of the species. Ghana is one of the major teak growing countries in Africa and approximately 70% of the species planted in Ghana is teak. Beyond Asia, Ghana is the highest area of planted teak. It is in this context, that the 4th World Teak Conference 2022 is being organized and coordinated by the Forestry Commission of Ghana in association with the International Teak Information Network (TEAKNET) India, International Tropical Timber Organization, Japan and the International Union of Forest Research Organizations, Vienna with the technical support of Food and Agricultural Organization of United Nations.

The Conference's theme *"Global Teak Market: Challenges and Opportunities for Emerging Markets and Developing Economies"* will focus on economic, social, technical and environmental issues that have an impact on the production, marketing and trade of teakwood. The scientific programme is developed in 5 major sessions that encompasses all aspects of teak plantation management, genetics, marketing and trade, community farming and forest landscape restoration. The sessions are designed to highlight the problems faced by the teak sector and develop appropriate solutions. The 4th World Teak Conference would be a great opportunity to facilitate the transfer of knowledge, develop strategies in a post COVID scenario and develop business opportunities in the teak sector. To further the Conference Themes, thematic papers were developed on key aspects in each theme and presented here for the benefit of our teak stake holders.

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CONTENT

Smallholder teak farming: value-addition management for enhancement of livelihoods in Southeast Asia

Key messages

- Smallholder teak producers are important sources of raw material for national and international teak industries, however, the potential of these systems is hindered by management, market and governance issues.
- To improve the quality and quantity of timber produced in smallholder teak systems, farmers should use superior quality germplasm, plant teak at wider spacing (4 x 4 m, 6 x 6 m, to 4 x 10 m) and adopt more intensive thinning, pruning and intercropping practices.
- Intercropping with annual or perennial crops improves teak survival and growth, diversifies production and income, and strengthens food security; intercropping can be practised throughout the entire rotation by maintaining wider distances between rows of teak.
- Smallholder teak producers can improve their market position by producing logs that meet market specifications, engaging in group marketing, and developing shared-value business strategies with traders to reduce transaction costs, achieve economies of scale, facilitate teak supplies, and improve economic returns for all parties.
- Government, research and development agencies and the private sector all have important roles to play in improving the management, market integration and governance of smallholder teak production systems.

Executive summary

Teak (*Tectona grandis* Linn. F.) is one of the most valuable tropical hardwoods in the world. Native to South Asia and peninsular Southeast Asia — specifically India, Myanmar, Lao PDR and Thailand — teak is now grown in more than 70 countries in Asia, Africa, Latin America and the Caribbean (Kollert and Kleine, 2017a). Commercial demand for teak timber exceeds sustainable yield from plantations and natural forests, thereby creating opportunities for enterprising small holder farmers. Smallholder teak production systems were well established in Asia by the 1960s and are now common throughout the tropics. Smallholder systems account for approximately one-fifth of the global teak estate and are an important source of raw material for national and international teak industries (Roshetko and Perdana, 2017). Smallholders are resource optimizers. They deploy their limited capital, labour and other inputs to generate the best returns to address their short-term livelihoods' needs: annual crops are prioritized over teak; farmers minimize direct cash investments in developing their teak systems. This makes teak agroforestry systems — the intercropping of annual and perennial crops with teak — a particularly attractive and viable option for smallholders. Yet, the potential of smallholder teak systems is hindered by limited access to good quality germplasm, poor silvicultural management, limited access to markets and information, and policy disincentives. These obstacles can be addressed through the following regulatory and development actions. Government agencies should assist teak farmers and the teak industry by simplifying timber trade regulations to minimize transaction costs and eliminate extra-legal fees. The private sector and government agencies should regularly publish information on market specifications and prices for teak logs. Development, extension and research agencies should facilitate access to quality germplasm and provide training in silviculture management and marketing, including shared-value business strategies in collaboration with the private sector. Progressive implementation of these actions will lead to improvements in the quantity and quality of smallholder teak production to the benefit of farm families and the teak sector. Increased production of teak and companion species will enhance farm incomes and livelihoods.

Introduction

Smallholders cultivate teak primarily to diversify production, reduce financial and biological risks, generate income, accumulate wealth (trees as living assets), and support food security. Teak cultivation also enables rural families to reduce on-farm labour requirements and enables them to engage in off-farm employment, including those involving temporary migration. While most smallholder teak production is intended for market sale, some is purposed to build more durable, better quality homes. Farmers also plant teak as an improved fallow crop, which yields a valuable product while contributing to farm rehabilitation and landscape restoration.

Smallholder teak is a small component of the 4.4–6.9 million hectares of global teak plantations, 80% of which is in Asia, primarily in India, Indonesia and Myanmar (Kollert and Kleine 2017b). A study by the Food and Agriculture Organization of the United Nations (FAO)

in 2012 reported that smallholder teak plantings comprised 19% of plantations in Asia, 19% in Africa, 31% in Central America, and 34% in South America (Kollert and Cherubini 2012); accounting for approximately 20% of the global teak area at the time of the study. Currently, smallholder teak production is already an important source of raw material for national and international teak industries (Roshetko and Perdana 2017, Midgley et al 2017).

Projections indicate the global demand for teak will continue to grow (Kollert and Walotek 2017) and opportunities for smallholder teak production will likewise continue to expand. However, the potential for smallholders is hindered by management, market and governance issues. This policy brief summarizes the current situation with regards to value addition and provides recommendations for enhancing it. The brief focuses on Asia, where most of the global teak estate exists. Its recommendations are equally applicable to smallholders in Africa and Latin America.

Current situation

Most smallholder teak producers in Asia are small-scale farmers cultivating 0.5–2.0 hectares. Up to half of their holdings may be under some type of teak production system (Roshetko and Perdana, 2017). Teak cultivation can be segregated in monocultures or integrated in mixed production systems with annual or perennial crops. Many farmers prefer mixed systems to reduce risks and diversify crops, production and income for household security. The preference for either monoculture or mixed systems is influenced by land pressure and availability of household labour. Farmers in Indonesia consider teak production a cultural heritage (Perdana et al 2012). In Lao PDR, planting teak can establish land claims (Newby et al 2012).

The planting density of teak varies greatly: 2 x 2 m, 2 x 3 m, 3 x 3 m, 4 x 4 m, 6 x 6 m. On rocky soil and steep slopes, spacing is often irregular. In teak monocultures and mixed tree cropping systems, tree spacing often becomes irregular as trees die, are harvested for sale or removed owing to poor performance, and natural regeneration of valued species is fostered.

Worldwide, smallholder teak systems were often established at close spacing — 2 x 2 or 2 x 3 m — because support from government and development agencies emphasized tree density to encourage reforestation and soil conservation. In Asia and the Pacific these support programs often provided free seedlings, technical support (training and information) and some cash enticement. Germplasm quantity was prioritized over genetic and physical quality. When external support ceased, most farmers self-sourced germplasm from wildlings, local seedlings and coppice growth. This is why teak trees in individual smallholder systems may vary greatly in size, growth rate and quality, even when the trees are reportedly the same age. The inflow of germplasm of superior or improved genetic quality to smallholder teak systems is limited.

Similarly, when smallholder teak plantings were first promoted, silvicultural management was rarely prioritized by support agencies. The importance and advantages of thinning and pruning was not emphasized. As a result, most farmers remain reluctant to thin their teak systems. Thinning is viewed as a loss of future income, not as a means to improve the quality, growth

and value of the residual stand. While some farmers do conduct pruning and thinning, they usually do so to produce fuelwood or harvest a few trees to meet cash needs. Silvicultural operations are rarely implemented to maximize teak production and value.

Smallholders have developed innovative intercropping practices. Industrial plantations and smallholder systems often conduct intercropping during the first 1–3 years after tree planting (known as 'taungya'). The weed control, soil cultivation and fertilizer applied for annual crop production improves teak survival and growth; income from annual crops offsets the establishment costs of the teak. Smallholders innovate by not limiting intercropping to the tree-establishment phase. They practise intercropping with trees of all ages; when stand conditions are conducive, labour and agricultural inputs available, and market opportunities attractive. In Indonesia, this type of intercropping is called 'tumpangsari'. Generally, smallholder teak systems only receive weed control and fertilizer application when the system is intercropped.

The level of silvicultural management smallholders are able and willing to adopt is greatly influenced by household characteristics. Farmers with more experience, exposure and education tend to be more willing to try or adopt silvicultural practices. Literacy also has a positive influence on adoption. Household assets are equally important factors. Larger landholding, secure tenure and more household labour all result in adopting more intensive management. Higher household income, both on- and off-farm, also enables the adoption of silvicultural practices (Sabastian et al 2014). More knowledge, more income, more land, more labour, more trees, more management.

Smallholders are resource optimizers. They deploy their limited capital and household labour to generate the best returns, with annual crops prioritized over teak. Farmers minimize the cash costs of developing teak systems. They self-source local germplasm for teak establishment; fertilizers and weeding costs are only incurred when cultivating the annual crop. Planting and other tree management activities are conducted when opportunity costs are low for other on- or off-farm activities (Perdana et al 2012, Newby et al 2012). This investment approach is reasonable because rotation ages are long and teak is not a main contributor to household livelihoods or income. Teak is generally cultivated as a 'living saving account', harvested to meet cash needs such as weddings, school fees, large medical expenses, social commitments and emergencies (Perdana et al 2012).

Farmers' roles in teak value-chains are limited to producer. Local and large-scale traders control market information and access to processors. Farmers prefer to interact with traders as individuals because both financial needs and tree assets (age, size, species) vary greatly by household. Price negotiation is based on individual or blocks of trees, without clear standards for quality or value. The market rewards larger trees with higher prices, but farmers often sell trees before they reach economic maturity. Generally, farmers gather market information from individuals who recently sold trees and by offering the trees to multiple traders. Regardless, farmers usually receive prices that are below market values because of their limited access to information and weak negotiating position (Perdana et al 2012; Perdana and Roshetko 2015).

However, it is acknowledged that traders provide vital services in the teak value-chain and face multiple risks. Traders manage the activities from harvest, transport and delivery to processors. They bulk logs from many sources to achieve economies of scale; and identify and negotiate best prices with buyers (processors). Traders are responsible for obtaining government permits and bearing related costs. Also, some traders provide loans (prepayments) to farmers who use their trees for collateral. Each service represents costs that may not be recovered for various reasons. Additionally, the physical quality and market value of the logs may decline over time (Perdana and Roshetko 2015). These services result in high risk and transaction costs for traders, leading to lower prices for farmers.

As a result of the historical context under which they evolved, many smallholder teak systems can be considered overstocked, slow growing and of suboptimal quality. Farmer producers, traders and supporters of smallholder teak production-value chains are aware of these circumstances and eager to facilitate improvement of the sector. The following section contains recommendations towards that goal.

Recommendations for value addition

Germplasm: Exploration and testing of teak genetic resources has resulted in significant tree improvement. Superior genetic material of teak — provenances, varieties, landraces and clones — has been identified (Graudal and Moestrup 2017). Generally, smallholder teak farmers do not have access to this superior material and continue to rely on local teak material of unknown or inferior quality. Government, research and development agencies that support smallholder teak development should facilitate the dissemination of the best quality genetic material matching local conditions. Farmers can be trained in seed production, collection and management to multiply germplasm and sustain local supplies of superior material into the future. Farmers have proven capable of successfully managing teak seed and seedling supply pathways. The mass production of teak clones by rooted cutting is possible. This process must be based on the selection of plus trees that are superior for local conditions (Monteuuis and Goh 2017). Clonal hedge gardens can be used to multiply superior genetic material. The mass production of clones can be an effective way to disseminate superior genetic material to smallholder teak producers. Leadership by technical support agencies and capacity building for operational staff would be required (Page 2021).

Spacing: Smallholder teak systems should be established at 4 x 4 or 6 x 6 m spacing. This reduces the demand for planting material and the need for intensive thinning and provides opportunities for intercropping. The distances between rows of teak can be widened to 10 m to facilitate intercropping with annual or perennial species throughout the entire teak rotation. In most cases, 4 x 4 m may be preferred because it balances efficient site utilization with silvicultural and intercropping management options. Spacing of 6 x 6 m is effectively final density and will require active replanting of seedling losses in the first 6-12 months, depending on rainfall patterns, after the planting. Also, at this wider spacing, branch growth and diameter will be greater, requiring more intensive pruning to retain log quality. It is strongly recommended that smallholder teak systems no longer use planting densities of 2 x 2 or 2 x 3 m. This high density requires heavy thinning within the first few years, an operation which most farmers are not likely to implement. It is also wasteful if superior quality germplasm is used for establishment.

Thinning and pruning: Thinning and pruning regimes should be based on rotation age and market specification, targeting log diameter and length that are rewarded with premium prices. At all planting densities, trees should be pruned to a single stem (singling) in the first 6-12 months after planting. Additional singling operations may be necessary in the during the next 3-4 years. General recommendations based on research results are provided for target rotation ages of 30 and 20 years. At a spacing of 4 x 4 m with a 30-year rotation, a 50% thinning should be conducted in year 5, followed by a 25% thinning in year 15. Pruning should be 60% of total tree height in years 4, 10 and 15. This will maximize stem diameter (value) of the residual trees. However, teak wood volume/ha is maximized if 25% thinnings are conducted in both year 5 and 15 (Khasanah et al 2015). For rotations of 20 years with initial spacing of 4 x 4 m (625 trees/ha), thinning should reduce tree density to 400/ha in year 3, to 300/ha in years 5–6, and to 200–250/ha in years 8–10. Branch pruning should be conducted in year 1-2 to a height of 2 m, in years 3–4 to 4 m, and in years 7–10 to a height of 10 m. On wet fertile sites, pruning may be necessary yearly for the first 3-4 years (Jenkin 2019).

In existing smallholder teak systems where spacing is 2 x 2 to 3 x 3 m, thinning should be conducted to reduce density to approximately 625 trees/ha (4 x 4 m spacing). Pruning to 60% of total tree height should be conducted. Ideally, this should occur when trees are 3–5 years-old (Roshetko et al 2013). Thereafter, thinning and pruning regimes should emulate the recommendations provided in the previous paragraph. In all cases, branches should be pruned near the bole without leaving branch stubs. Thinning and pruning will improve the quality, growth and value of the residual stand. These positive effects should be emphasized to encourage farmers to adopt these practices. Government, research and development agencies

should strengthen the adoption of silviculture practices by developing extension material and supporting training.

Intercropping: Intercropping during the establishment phase — 1–3 years after tree planting — is recommended to improve teak survival and growth, offset the costs of plantation establishment and diversify production. Thereafter, management decisions regarding intercropping should be based on the availability of labour and agricultural inputs, livelihood and food security priorities, and market demand for agricultural products. Crop-production practices appropriate for local conditions should be followed. Species that are commonly cultivated with teak include maize, rice, soybeans, cassava, peanut, adlay millet (Job's tears), beans, vegetables, ginger species, banana, various fruit and timber trees, and perennial commodity crops like cacao and coconut. In many locations, cropping calendars for teak and annual crops are complementary (Table 1).

Table 1. Cropping calendar for teak agroforestry systems in Gunungkidul, Indonesia (Roshetko et al *in production*)

Activity	**Months**											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Annual crops												
1. Land preparation and ploughing												
2. Application of organic fertilizer												
3. Planting annual crops												
4. Weed control												
5. Harvesting annual crops												
6. Harvesting cassava												
Teak and other timber crops												
1. Nursery practice, including procurement of seed and wildlings												
2. Preparing tree spacing and planting pits												
3. Planting tree germplasm (seed, seedlings and wildlings) and ginger crops												
4. Pruning of teak												
5. Thinning of teak												
6. Harvesting of teak conducted when families require cash												

Market integration and policy incentives: As a first step towards improving their market position, farmers should produce quality teak logs that meet minimum market requirements for diameter and length. Logs that meet such standards are rewarded with premium prices. Farmers can achieve this by adopting silvicultural practices that improve the quality, growth and value of the residual trees. Application of the silvicultural practices can be adjusted to meet households' needs for periodic income. Farmers should also engage in group marketing to strengthen their negotiating position by selling larger quantities of logs to traders. This could

be part of a shared-value business strategy were groups of farmers collaborate with traders to reduce transaction costs and facilitate teak supply, enhancing economic value for all parties. This would require traders to be transparent regarding market information, particularly prices, and facilitate market access for the farmers' marketing group. Farmers would need to be more flexible in their management and harvesting practices to help the group and traders achieve economies of scale in log quantities and quality. Governments could provide incentives to smallholder teak producers and the teak industry by simplifying timber trade regulations to minimize transaction costs and eliminate extra-legal fees. They could also regularly publish information on market specifications and prices for teak logs. The private sector could be a partner in providing this information (Perdana et al 2012, 2015).

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Cost-benefit analysis of teak investments and promoting responsible trade & markets of teakwood

Key messages

1) Teak is one of the most valuable tropical hardwoods of the world that is in high demand for its beauty, strength and stability, natural resistance and wide array of applications.

2) Natural teak forests have declined substantially in all native teak growing countries (India, Lao PDR, Myanmar and Thailand). Nevertheless, teak is one of the few emerging valuable hardwoods that has been grown increasingly in planted forests in about 70 tropical countries. For most of these countries, teak represents a good opportunity to produce quality timber and is a major asset for the forestry economy attracting large investments from the private sector.

3) Data and information on the profitability of teak investments, that is found in the literature and on the internet, is rather difficult to interpret due to a lack of background information and necessary detail. Much controversy has been generated by the promotion of teak plantation investments based on fabulous growth and yield projections and unrealistic pricing scenarios, which have provided opportunities to exaggerate rates of return and deceive even cautious investors.

4) Investments in teak plantations growing under suitable site conditions with genetically superior planting material and good management practices can yield attractive and robust internal rates of return (IRR) of more than 10%.

5) The major teak trade flows worldwide are directed towards India, which imports more than two thirds of the global teak exports. Myanmar remains the dominant supplier of teakwood, but the high international demand for general utility teak in India and China has broadened the traditional teak supply base from natural forests in Asia to include plantation logs from Africa and Latin America.

6) The International Tropical Timber Organization (ITTO), the International Union of Forest Research Organizations (IUFRO) and the Food and Agriculture Organization of the United Nations (FAO) over the past decades have been actively involved in profound research and intensive development work for the conservation and sustainable management of natural and planted teak forests, and the legal and sustainable wood supply.

7) Key recommendations for further action of all relevant national and international forestry institutions and other concerned stakeholders include:

   - Improve the statistical database on teak forests to provide more reliable information on the development of teak resources and wood removals.

   - Improve the international marketability of teak by developing and adopting an agreed set of log grading rules in collaboration with global buyers to reduce market constraints and to improve the marketability of teak wood products taking into consideration the quality and dimensions of logs from plantations as well as from natural forests.

   - Provide impartial and unbiased cost-benefit analysis for potential investors in publications, internet portals or information leaflets. TEAKNET could take a leading role in publishing such information on-line on its website.

   - Improve statistical information on teak roundwood production and trade to considerably improve the assessment of the significance of the international teak trade and to give policy- and decision-makers, investors and managers a better understanding of the important role that teak resources play in the provision of wood products for the national economies of many countries.

   - Support small-scale teak production systems for smallholder farmers to diversify farm production, support food security, generate income and reduce financial risk.

Introduction

Teak (*Tectona grandis* Linn. f.) is one of the most valuable tropical hardwoods of the world. Together with other high-grade hardwoods such as mahogany and rosewood, teak is sought in the global markets for its beauty, strength and stability, natural resistance and wide array of applications ranging from heavy duty construction and railways, utility poles for transmission lines, ship building and yacht furnishing, quality furniture, interior joinery, veneers, flooring, to cultural uses (see fig.1).

Fig.1: The U Bein bridge (Amarapura, Mandalay, Myanmar) was built around 1850 and is believed to be the oldest and longest (1.2 km) teakwood bridge in the world. *Photo: W. Kollert*

Natural teak forests cover an area of ca. 29 million hectares, nearly half of which grow in Myanmar (Kollert & Cherubini, 2012). Since 1980 the natural teak forest area has declined substantially in all native teak growing countries (India, Lao PDR, Myanmar, Thailand) mainly due to overexploitation (legal and illegal), agricultural expansion, shifting cultivation, population pressure, and grazing. In addition, the targeted removal of the best quality teak trees (creaming) from the natural populations has most likely resulted in the genetic impoverishment of residual stands. As a consequence, the survival and sustainable use of the remaining natural teak forests is highly endangered. Realizing the decline in natural teak resources, all native teak growing areas have shifted to more conservative approaches thereby halting the erosion of this precious resource from natural systems.

Nevertheless, teak is one of the few emerging valuable hardwood species that has been grown increasingly in planted forests in about 70 countries throughout tropical Asia, Africa, Latin America and Oceania. For most of these countries teak represents a good opportunity to produce quality timber and is a major asset for the forestry economy attracting large investments from the private sector (Kollert & Cherubini, 2012). Planted teak forests span 4.35 – 6.89 million ha worldwide and is considered the top ranked species in at least 20 countries as per the State of the World's Forest Genetic Resources (FAO, 2014). From an economic standpoint teak offers a multitude of products which include timber, pulp, food, wood energy, and non-wood forest products which facilitates its nomination as a priority species for conservation and management.

Current situation and Observations

Profitability of teak investments. Considering the declining supply from natural teak forests, the long-term prospects for plantation-grown teak appear promising, and demand is likely to increase. Much information on the profitability of teak investments, in particular from short-rotation plantations, is found in the literature and on the internet, but it is rather difficult to interpret due to a lack of background information and necessary detail. Economic data and teak prices are mostly based on a case-by-case basis, and correspond to a mix of heterogeneous material from different countries due to a lack of systematic or consistent grading rules with corresponding values for particular products. Some of these data qualify as wishful thinking rather than a reflection of actual values. For this reason much controversy has been generated in several countries by the promotion of teak plantation investments based on fabulous growth and yield projections and unrealistic pricing scenarios, which have provided opportunities to exaggerate rates of return and deceive even cautious investors (Pandey and Brown, 2000).

Teak plantations under suitable site conditions with genetically superior planting material and good management practices can yield attractive and robust achieve internal return rates of more than 10% (eg. large scale private teak plantations in Ghana). This is mainly due to substantial economies of scale and cost-reducing management interventions such as intercropping with food crops by nearby farming communities which reduces maintenance costs (Kollert and Walotek, 2017).

Teak logs of large dimensions and high quality combined reduce the attractiveness of commercial investments as the longer rotation and capital commitment periods and the greater investment risks may only partially be compensated by higher timber prices. The long rotation coupled with an expected lower return on capital invested has made it difficult to interest private investors in high-quality teak production without supportive, secure and stable government policies. Hence, the widespread practice of establishing and managing teak plantations on short rotations, not exceeding 20 years, will continue to lead to a significant increase in the supply of small-dimension teak on the international market and continue to make the luxury items of former times a rare commodity. Logs from planted teak forests are typically smaller in size and will hardly ever reach the dimensions grown in old-growth natural forests. As a result they do not have the same technical characteristics of natural teak and do not reach such high prices.

Long-term price trends. Teak price indices have been developed from publicly available long-term time series published in ITTO's Tropical Timber Market Reports since 1998 (Walotek, and Glauner, 2017). These indices measured in US$ per cubic meter indicate the superior status of natural teak timber as

compared to plantation grown teak. In the Indian market the average cubic meter-related value of plantation grown teak is about half the value of natural teak from Myanmar. However,

in recent years the market appears to have recognized a higher value for plantation grown teak, the price index of which has grown more rapidly than that of natural teak.

Global trends in teakwood trade. The major teak trade flows worldwide are directed towards India, which imports more than two thirds of global teak exports including shipments of plantation logs and sawn timber from Africa and Latin America, while its own considerable teak production is processed within the country. Thus, the global teak market will continue to be governed by trends in the Asian market that holds more than 90% of the world's teak resources. Since 2000, the global trade in teak logs of the major importing countries (India and China) has more than doubled in terms of volume and more than quadrupled in terms of value. Teak exports of Indonesia consist primarily of furniture exceeding an annual value of more than US$ 100 million.

One increasingly important consideration influencing trade in plantation-grown teak are forest management certification and legality issues. The timber markets of North America and Europe have responded legislatively through the Lacey Act (USA) and the European Union Timber Regulations (EUTR). India, one of the major teak markets, has also called for buying products made from certified wood only for promoting sustainable forest management, under the 'Green Good Deeds movement'. Other markets will likely follow suit soon.

Emerging traders in Africa and Latin America. Myanmar remains the dominant supplier of teakwood, but the high international demand for general utility teak in India and China 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. The emerging teak roundwood traders in Africa are Ghana, Côte d'Ivoire, Benin, Togo, Nigeria and Tanzania (for sawnwood). In Latin America, Ecuador, Costa Rica, Panama, Colombia and Brazil (for sawnwood) have continuously expanded their trade volumes since 2000, reaching a peak in recent years, and this trend is likely to continue (see fig.2).

Fig. 2: Teak plantation logs (scantlings) made in Ecuador for export to India. *Photo: W. Kollert*

Lack of uniform international log grading rules constitutes a serious market constraint. The major challenge for teak growers is to produce internationally recognized quality wood. Despite considerable international debate over many years the global teak trade is hampered by a lack of international standards and consistency in measuring and establishing volumes and qualities for teak logs, which results in widespread uncertainty and confusion around teak investments.

Priority Actions and Recommendations

In view of the imminent threat of losing natural teak forests, it is imperative to organize and implement a global program for the conservation, improvement, development and sustainable use of teak resources. Towards this end, the International Tropical Timber Organization (ITTO), the International Union of Forest Research Organizations (IUFRO) and the Food and Agriculture Organization of the United Nations (FAO) over the past decades have been actively involved in research and development work for the conservation and sustainable management of natural and planted teak forests.

ITTO has been supporting teak related projects with a focus on genetic resources conservation, seed production as well as sustainable management of natural and planted teak forests in Africa, Asia and Latin America. Recently, ITTO has initiated the transnational project *Enhancing Conservation and Sustainable Management of Teak Forests and Legal and Sustainable Wood Supply Chains in the Greater Mekong Sub-region* including Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. These countries of the Greater Mekong Sub-region are in various stages of introducing and implementing forest management and chain of custody certification schemes to facilitate and advance the legality of wood supply in view of the regulations put in place by industrialized countries to curb imports of timber of unknown origin onto their markets. Engaging further in the process of developing a timber legality program will serve as a formal commitment to address weaknesses in the current timber flow system, help address improvements in forest law enforcement and governance, create enabling conditions for forest investments and pave the way towards marketing legal timber.

Within its scientific structure, IUFRO maintains a special working party on the "utilization of planted teak" which aims at research and dissemination of scientific information on teak timber produced within the framework of socially and environmentally acceptable norms of sustainable forest management. IUFRO in cooperation with FAO and ITTO has published the *Global Teak Study* (Kollert and Kleine, 2017) addressing best practices and lessons learnt on the conservation of teak genetic resources and the sustainable management of teak forests in different country contexts in Africa, Asia and Latin America.

FAO has published two technical reports on teak that serve as a reference on global teak resources and markets in the aftermath of Myanmar's log export ban. FAO was instrumental in organizing three world teak conferences in Costa Rica (2011), Thailand (2013) and Ecuador (2015). The fourth world teak conference has been delayed due to the Covid 19 pandemic. It is scheduled to take place in Ghana in 2021.

Further tasks and program outputs in the field of teak investments and the promotion of responsible trade and markets of teakwood, are listed below in the form of recommendations for all relevant national and international forestry institutions and other concerned stakeholders:

Improve statistical database on teak forests. The available information and estimates on the development of natural and planted teak forests and the removals of teak roundwood are

mainly based on FAO's Teak Resources and Market Assessment 2010 (Kollert and Cherubini, 2012). This database must be improved to provide more reliable information on the development of teak resources and wood removals. Teak growing countries may consider integrating teak together with other commercial tree genera into the national reporting mechanisms and/or forestry statistics including national forest inventories, in order to monitor on a regular basis the development of teak forest resources. International forestry organizations may consider organizing a remake of the 2010 survey on teak resources and markets.

Improve the international marketability of teak. An international forestry or timber trade organization should take the mandate to develop and adopt an agreed set of log grading rules in collaboration with global buyers to reduce market constraints and to improve the marketability of teak wood products taking into consideration the quality and dimensions of logs from plantations as well as from natural forests. By the same token, public and private teak producers and processors are encouraged to pursue voluntary certification schemes (management and chain-of-custody certification) if they wish to meet environmental, social and economic standards of responsible forest management and gain better access to North American and European markets.

Provide impartial and unbiased cost-benefit analysis for potential investors. To be profitable, teak plantations require stable and predictable market conditions as well as good forest management practices with the objective to increase yields and reduce costs through suitable operational measures. In order to support the application of such a management regime impartial and unbiased cost-benefit analyses on teak investments should be made available through publications, internet portals or information leaflets. TEAKNET could take a leading role in publishing such information on-line on its website.

Improve statistical information on teak roundwood production and trade. A formalized exchange of information on the production and trade of teak would be of mutual advantage to importing and exporting countries. Reliable information on the dimensions, quality, origin and price of teak roundwood and major wood products in internationally acknowledged measuring units should be made available on a regular basis. Towards this end, the international trade of teak roundwood and sawnwood will be recorded as of January 1st, 2022 in the Harmonized System, or HS, Nomenclature 2022 Edition (HS 2022) under the new customs codes 4403.42 and 4407.23 respectively. Thereby, the assessment of the significance of the international teak trade will be considerably improved and will give policy- and decision-makers, investors and managers a better understanding of the important role that teak resources play in the provision of wood products for the national economies of many countries.

Support small-scale teak production systems for smallholder farmers. Teak-based small-scale production systems enable farmers to diversify farm production, support food security, generate income and reduce financial risk. Planted teak forests are an important alternative source of quality timber for wood industries. The potential of smallholder teak systems is hindered by limited access to good planting material, poor silvicultural management, difficult market access, and policy disincentives. These impediments must be

addressed through improved market integration and policy support which will provide farmers with incentives to adopt better silvicultural and agroforestry management, e.g. intercropping with suitable crops.

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Improving the quality of teak planting material

Key messages

- Teak is one of the most important tropical timber species adapted to different geographical regions and environmental conditions.
- A combination of genotype and growing conditions dictate the growth and quality characters of teak
- The key recommendations for improving the quality of teak planting material include:
    - ✓ Strengthen international C=collaboration and regional networks on teak such as TEAKNET with respect to conservation and use of teak genetic resources
    - ✓ Promote genetic improvement programs and international trade in documented quality planting material including clones with due consideration of associated risks of genetic depletion
    - ✓ Develop and include genetic business plans as part of local plantation programmes, entailing developing genetically superior planting materials suited for specific regions and smallscale teak productions systems

This policy brief is largely extracted from the *Global Teak Study. Analysis, Evaluation and Future Potential of Teak Resources*. IUFRO World Series 36, 2017, Vienna. ISBN 978-3-902762-77-1

Teak (*Tectona grandis*) is one of the globally most important tropical timber species adapted to different geographical regions and environmental conditions. Variation in teak can be observed in a wide range of characters such as leaf morphology, drought resistance, stem form and branch characteristics, growth increment, soil preference, the proportion of heartwood, wood structure, fibre length, strength, specific gravity, durability, wood extractives, wood colour, contents of minerals, and resistance to pests and diseases. These variations are a combination of the genetic differences (among populations and among individuals within populations) and differences in the growing environments (soils, climate, and silvicultural practices). To have a successful teak plantation providing the grower with maximum returns on the investment prudent planning and strategizing in selection of site, planting material and management needs to be adopted. Strengthening international collaboration and networks on forest genetic resources, promoting genetic improvement programs, facilitating international trade in improved and documented teak clones, developing genetic business plans, using advanced techniques in plantation management and supporting small-scale teak production systems are keys to improving the quality of planted teak sector. This policy brief provides recommendations with respect to the use of quality planting material based.

Introduction

Teak is among the most important timber trees in the world. Precious quality timer from old grown teak used to be harvested from natural forests to fetch high prices in the global timber market. The natural resources containing such qualities have dwindled and are almost no longer available. The market therefore relies mainly on plantation-grown timber, which is of significantly lower quality.

High quality of teak wood is primarily linked to its dimensions and the amount of heartwood compared to sapwood. Teak is easy to establish and trees with high percentage of heartwood and large dimension can be produced in plantations. It is easy to propagate and grow fast in its juvenile phase and is therefore a tempting choice in many areas of plantation establishment.

Current situation / Observations

Unfortunately, many existing tree plantations contain large number of poor quality trees of bad form, with little heartwood and minimal chances to develop into high-value timber products. Further, new plantations being established in hitherto new areas will face the same problems. How can that be changed?

Three basic elements are important for the success of a teak plantation to produce high quality timber providing the grower with maximum returns on the investment: 1) The site needs to be suitable for growing teak, 2) The planting material needs to be selected to match the site, and 3) The plantation needs to be managed, in particular thinned, to ensure that large

dimension logs with a high percentage of heartwood can be achieved within a reasonable timespan, which for teak usually is considered to be 20-40 years.

Teak prefers deep, well-drained soils in relatively high rainfall areas. It typically grows in areas with an annual rainfall between 1300 and 3800 mm on good fertile soils. The natural habitat in general has a dry season of at least 5 months, but the species can also grow in areas without such a pronounced dry season. One reason why tree planting, including the planting of teak, often fails is that insufficient attention is given to the 'sourcing' of the trees that are to be planted both with respect site and purpose. It is therefore of first and utmost importance to assess whether teak is the right choice of species for a given site; or whether it would be better to choose a completely different species. In particular, this is important where the soil quality and rainfall may be at the margin of what teak requires for thriving and growing fast.

Choice of the species is only the first challenge with respect to site matching. Second challenge is the *within species choice* wherein a decision has to be made with respect to the particular sources (also referred to as origins or provenance) that should be planted at the location in question. The second challenge is of utmost importance because of the huge genetic variation that exist within species affecting the growth of a particular provenance at a particular site with respect to survival, growth rate, ability to reproduce, the quality of the wood and the environmental services that may be delivered by them. Fortunately, quite a lot of knowledge is available for the right sourcing of teak to plant, but unfortunately it is not always easily accessible, not always simple to assess, and very often the best choice of planting material may not be easily available, so the final choice becomes guided by mere availability rather than quality.

Provenance variation for economically and ecologically important traits has been investigated over the last 60 years and found to be huge, but far from fully explored. Part of the genetic diversity that has been lost in natural forests may still be found in planted teak forests, many of which originate from the early introductions of the species around the world. It is therefore of fundamental importance to further investigate and characterise teak genetic variation in planted and natural populations for breeding and mass propagation. Selection and testing of planting material continues to be highly relevant as an integral part of any major planting program. Strategic plans at international, national and program level on the development and use of genetic resources ('genetic business plans') are important, whether in public-private partnerships, forestry investment schemes, or to the benefit of smallholder growers. The primary objective of such a plan should be to facilitate access to good quality planting material of well documented and reliable origin.

Teak clonal forestry has demonstrated its efficiency for establishing fast-growing industrial stands of enhanced yields, good wood quality and high commercial value. The clonal option appears to be the best way to maximize returns on investments in the shortest possible time using outstanding and site-adapted genotypes. The main risk in this context is inadequate information regarding the genetic origin of the clones that have been mass propagated and planted. The ensuing threat is an erosion of the genetic diversity in planting material deployed

for large-scale plantings, exposing them to greater risks of environmental impacts from climate change, pests and diseases.

Planted teak forests need to be managed following a well-defined operational regime to achieve the desired production goals. Most important are good site selection, initial spacing, use of genetically improved planting material, adequate soil preparation, and the timely execution of silvicultural practices.

Protection against forest fires as well as pest and disease management must be effective to avoid losses in productivity. Monitoring growth and yield dynamics is essential to facilitate adequate management responses. Sustainability (social, environmental, economical) including the provision of environmental services (e.g. watershed protection, biodiversity conservation, carbon sequestration) must be a key concern in the management of planted teak forests. The implementation of appropriate practices at every stage of development can help to achieve this goal. The recommendations here pertain specifically to the issue of using good quality planting material, including and emphasizing the potential of smallholder teak systems, which is hindered by among other things, limited access to good planting material.

Recommendations / Priority Actions

Strengthen International Collaboration and Regional Networks on Forest Genetic Resources

International collaboration and regional networks on forest genetic resources (e.g. TEAKNET, APFORGEN, SAFORGEN, LAFORGEN) should be strengthened to develop action plans for the conservation and management of teak genetic resources. Such action plans might include:

- development of geographic, operational, and reliable genetic resource databases for characterizing every teak origin and seed production stand with location maps and common descriptors;
- development of appropriate quality standards and accreditation schemes for teak planting material involving the germplasm production and delivery sector, and current schemes for control of reproductive material (e.g. the OECD scheme on forest reproductive material);
- development of user-friendly decision support tools to guide the choice of planting material for specific sites (recommendation domains), in conjunction with market information services;
- measures to ensure that these standards and tools are mainstreamed with policy makers, extension services and the private sector, including manuals, policy briefs and other capacity building and extension material;
- development of indicators that are suitable to monitor the performance of delivery pathways with regard to standards including the performance and viability of plantings;

Monitor Genetic Improvement Programs and International Trade in Clones

- Teak clone producers should be encouraged to select, identify and classify their material with a view to better monitor international trade and promote the production of a sufficient number of good quality clones of diverse genetic backgrounds that need to be reliably documented.
- In addition, the characteristics of clones that are traded on a global level should be subject to registration with an international authority. Tissue culture laboratories that have the capacity to produce good quality teak clones are to date only available in Asia and Latin America. It is expected that such facilities and know-how can be developed soon in other countries, in particular in Africa.

Implement genetic business plans as part of local plantation programmes

Initiation of local planting programmes – and in particular by smallholders but very often also by larger tree planters, often suffer from lack of knowledge, knowhow and available supply of documented good quality planting material. To overcome this it is recommended to establish a "genetic business plan". In the absence of knowledge, it is advisable to plant diverse genetic material to avoid a failure with poorly adapted genetic material. A given plantation programme is not an initial 'one time decision' - rather it should be an iterative process based on still better knowledge.

A genetic business plan should thus reveal

- what is generally known from international research,
- what is know from local experience in the area including local tests (if any),
- an overview of potential seed sources / selected clones that are available locally or internationally (relevant in terms of time frame, scale and costs),
- experience and data generated as part of the on-going activities,
- a pro-active approach to development of new seed source options (or clones) based on local (smart but low input) selection and/or more advanced coordinated effort,
- continuously adaption of the genetic business plan based on new information available locally and internationally.

The salient point is that plan includes the establishment and local production of future planting material.

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Plantation management models incorporating trees in farming systems in Ghana

Key messages

- Restoration of degraded forest landscapes in Ghana is now a major preoccupation of the government, in line with its commitment to the Bonn Challenge, AFR100 and the Paris Agreement.
- The Modified Taungya System has great potential for scaling up restoration efforts since it has proven to increase forest cover in degraded forestlands, while responding to community needs for agricultural lands. However, it requires improved governance structures to promote greater participation of local communities to secure their well-being and livelihood opportunities.
- The Public-Private Partnership model will be more successful if security of tenure and adequate funding can be assured with appropriate incentives. Land accessibility and security of tenure need to be well-defined together with enforceable property rights.
- There is urgent need for revision of the policy and regulatory frameworks to: (i) harmonize statutory and customary laws; (ii) clarify legislation in respect of tree tenure and rights, and (iii) strengthen benefit sharing arrangements to enhance scaling up of restoration efforts. This will catalyze achievement of Ghana's commitments to the Bonn Challenge, relevant targets of the Sustainable Development Goals, and other international agreements.

Executive summary

The need for restoring degraded forestlands in Ghana was realized over a century ago and has become a major preoccupation of the forestry sector lately, with the government committing to the restoration of two million hectares of degraded forest lands by 2030. Four main Forest and Landscape Restoration (FLR) approaches have been deployed, involving local communities to ensure that their well-being and livelihoods are secured. These are the Taungya system, the Modified Taungya System, Public-Private Partnership, and Community-managed forest plantations. Existing policy and regulatory frameworks, e.g., the National Land Policy, Timber Resources Management Act, Forest Plantation Development Fund Act, and the Forest & Wildlife Policy, afford enabling conditions for plantation development. Nonetheless, constraints such as land tenure and access to land outside forest reserves, land registration bottlenecks, improper issuance of land certificates, as well as inadequate capital and incentives hinder successful plantation development at scale. It is recommended that the National Land Policy should be revised to harmonize customary and statutory laws to enhance private sector and community involvement in landscape restoration. In addition, effective participation of local communities should be promoted to improve their well-being and livelihood opportunities.

Introduction

Deforestation and forest degradation have been of concern in Ghana since the 1900s, and efforts to reduce these processes date back to the period between 1900 and 1910. Recently, in response to the global call for forest landscape restoration (FLR), Ghana has pledged to restore two million hectares of degraded forest landscapes by 2030 under the Bonn Challenge and African Forest Restoration Initiative (AFR100). The restoration commitment has a strong focus on community and private sector involvement, and is made up of three broad components (Forestry Commission, 2016) that are generally aligned with the principles of FLR and aim at restoring ecological integrity and improving the well-being and livelihoods of local communities (e.g., Stanturf *et al*., 2017):

1. Forest plantations (including wood fuel/energy plantations) covering 250,000 hectares;
2. Enrichment planting within 50,000 hectares of degraded forest reserves;
3. Trees-on-farm (agri-silviculture/climate smart agriculture) covering about 1.7 million hectares.

Plantation management models tried in Ghana

Plantation activities in Ghana date back to the early 1900s; the key objective was to increase timber stock for commercial purposes. During the 1920s *Tectona grandis* (Teak) was planted,

mainly for fuelwood used in boilers to supply electricity (Oduro et al., 2012; Tufuor, 2016). In the late 1930s, the taungya system was introduced, with the primary aim of replanting degraded forest reserves with exotic tree species to provide timber in a relatively short time (Tufour, 2016). The system allowed tree seedlings to be intercropped with food crops, eventually evolving into plantation systems when the trees closed canopy.

By 1985, approximately 82,500 hectares had been established with plantations of exotic and indigenous species. Exotics included mainly Teak, Cedrela and Eucalyptus spp., while the indigenous species planted included *Mansonia altissima, Heritiera utilis, Nauclea diderrichii, Khaya ivorensis, Triplochiton scleroxylon, Terminalia superba* and *Terminalia ivorensis.*

Since 2001, the National Plantation Development Programme has deployed four management models for plantation development:

1. Partnering with farmers to establish plantations through the Modified Taungya System (MTS);
2. Directly establishing industrial plantations using contractors under a public-private partnership arrangement;
3. Releasing degraded forest reserve lands to private entities.
4. Encouraging the integration of trees in farming systems and managed by communities.

The taungya system was implemented using two different models between 1963 and 1985 (Tufour, 2016). In the first model local farmers cleared the sites and planted their food crops between tree seedlings for up to three years when the trees closed canopy. The farmers did not have any benefits from the sale of the food crops. In the second model the Forestry Department hired labour for site preparation and planting the trees and food crops. The food crops were harvested and sold to defray the cost of initial plantation establishment.

As practiced under these two models, the taungya system was unsuccessful, mainly as a result of (i) lack of silvicultural maintenance; (ii) ineffective wildfire prevention and management plans (Tufuor, 2016) and (iii) lack of farmer commitment.

Current models for plantation development

The Modified Taungya System (MTS)

The lack of success with the taungya system led to the development of a Modified Taungya System (MTS) by the Forestry Commission. This was achieved through consultation with key stakeholders, including traditional chiefs/landowners and farmers. The key elements of the modified system, which is usually practiced in areas where there is land shortage for agricultural purposes, are:

(i) properly developed criteria for equitable allocation of free and fertile land within degraded portions of forest reserves to forest fringe communities to support communities and individual farmers;
(ii) subject to land availability, prompt allocation of new planting areas to farmers as soon as intercropping is no longer possible on the previous land;
(iii) responsibility of the participating farmers/communities for the provision of labour, tending the tree crops after canopy closure to maturity and bearing part of the cost of establishment;
(iv) entitlement of the farmers/communities to 40% share of benefits from harvest of tree crops, based on an agreement signed between the Forestry Commission and each interested farming community.

Factors taken into account include the level of local participation of the community (farmer groups), establishment costs, growth rates, etc. An annual plan of work for all activities is prepared, with details of all operations to be carried out and resources required. Other factors include nursery production (seedlings, stumps, etc for planting).

Benefits and challenges of the current MTS

The system is beneficial in that it leads to an increase in forest cover (Figure 1). It also minimizes the scarcity of agricultural lands in the fringe communities since free and fertile lands within degraded portions of forest reserves are allocated to farmers. Food production is increased and the standard of living in fringe communities improved.

Figure 1: Mixed stand of indigenous species plantation established under the Modified Taungya System in the Eastern Region of Ghana. (Photo: E. Foli)

In addition, plantation establishment cost is minimized because farmers are responsible for tending the tree crop to maturity. Benefit sharing for respective stakeholders is based on proportions stipulated in the agreement and backed by law.

The main challenges with the MTS are (i) inadequate funding to cover activities; (ii) delays in signing benefit sharing agreements with stakeholders; (iii) multiplicity of commitments amongst forestry staff to effectively supervise activities; and (iv) inadequate education of the farmers to enable them fulfill their obligations under the agreement.

Public-Private-Partnership model for plantation development

In this model, the Forestry Commission (FC) allocates degraded forest areas to the private sector for plantation development. The FC contributes through project document preparation, bears the costs of survey and demarcation, registration of agreements and fire education within fringe communities. The investor is entitled to 80% of the plantation proceeds and benefits, while the FC, landowners and forest fringe communities share the remaining 20%. A 50-year land lease and the benefit-sharing agreement are executed and registered at the Lands Commission.

An example is the FC /Timber industry partnership to establish 5,000 hectares of plantations in six degraded forest reserves. So far, a total of 3,131.60 hectares have been planted by the Forestry Research Institute of Ghana, which has been contracted to establish and manage these as model industrial plantations (Figure 2). Mostly, native species have been planted, but proven exotics such as Teak, Cedrela and Gmelina have also been planted to satisfy the future needs of the timber industry.

Figure 2: A nursery for supplying planting material under the FC/Industry Public-Private-Partnership plantation model in Mankrang Forest Reserve in Ghana. (Photo: E. Foli).

Similar to other efforts, community engagement has been key to ensure successful establishment of these plantations and provide jobs for local communities.

Community-managed plantations

Since 2015, two key projects have been initiated, funded by the World Bank and African Development Bank (AfDB) under the Forest Investment Programme (Foli, 2018). These are:

1) Enhancing Natural Forest and Agroforest Landscapes (ENFAL), and
2) Engaging Local Community Involvement in REDD$^+$ and Enhancing Carbon Stocks (ELCIR$^+$)

The ENFAL Project aims at restoring ~40,000 hectares in enrichment planting, while the ELCIR$^+$ Project aims to establish 5,000 hectares of tree plantations, 16,000 ha climate-smart cocoa-agroforestry, and 1,200 ha in fuel woodlots.

The aim is to reduce greenhouse gas emissions (REDD+), reduce poverty, conserve biodiversity, and improve forest and cocoa management practices of farmers in the selected landscapes. Under these projects, approx. 24,925 hectares of native species have been established, involving about 159 forest fringe communities.

The projects have successfully enhanced landscape-level tree growing in the cocoa landscape (Figure 3), including agroforest corridors, with active community involvement to increase tree cover in degraded forest reserves. In addition, about 5,564 families have been supported with the supply of 1.6 million seedlings of native species to plant on their farms and farm boundaries.

Approx. 28,571 hectares of a mosaic cocoa landscape have been established with native tree species on farms outside forest reserves. Also, about 8,543 hectares of native species have been established through enrichment planting in degraded forest reserves.

Figure 3: Integrating trees in farming systems. One-year old *Terminalia superba* tree in a cocoa farm in the Western Region of Ghana (Photo: E. Foli).

Enabling conditions for plantation development in Ghana

Ghana's efforts are supported by several policy and regulatory frameworks, e.g:

(a) the National Land Policy (1999) provides guidance and direction on land ownership, security of tenure, land use, etc.;
(b) the Timber Resources Management (Amendment) Act, 2002 (Act 617) prevents government from allocating Timber Utilization Contracts for private forest plantations;
(c) the Forest Plantation Development Fund Act, 2000 (Act 583), provides financial support for plantation development;
(d) Ghana Forest and Wildlife Policy, 2012, supports the implementation of the National Forest Plantation Strategy.

Also, the government's commitment to a green economy and its endorsement of several international agreements including REDD+, FLEGT, the Bonn Challenge and the SDGs create an enabling environment for FLR efforts.

Constraints to plantation development

It is noteworthy that 85% of Ghana's total commitment to FLR is expected to be established in deforested agricultural landscapes. Much of this will be on customary land, with a focus on community and private sector involvement.

The key constraints to the achievement of the targets are land tenure and access to land. Multiple issuance of land certificates, land registration bottlenecks; inadequate capital and lack of incentives worsen the problem. Consequently, restoration efforts so far tend to be confined to degraded forest reserves.

Conclusion and recommendations for action

Ghana is committed to meeting the commitment of restoring two million hectares of deforested and degraded landscapes by 2030. While teak constitutes more than 70% of species planted, some indigenous species are increasingly been used. Since 2002, approximately 238,450 ha of tree plantations have been successfully established, comprising 48,049 ha by the private sector and 190,450 ha by the public sector. Under the Forest Investment Programme (FIP), which engages local communities on forest landscape restoration, 24,925 ha of native species have been established in degraded forest reserves, involving 159 forest fringe communities. Approximately 8,543 ha of degraded forest reserves have also been restored through enrichment planting. In addition, 28,571 ha of mosaic cocoa landscape have been planted with native species in farms outside forest reserves. This is a notable achievement.

Land access and tree tenure security remain critical constraints. The National Land Policy requires some revision to harmonize customary and statutory laws to enhance effective private sector and community engagement. Also, legislation in respect of tree tenure and rights will have to be clarified speedily in order to enhance FLR activities in areas outside forest reserves. Land accessibility and security of tenure need to be well-defined together with enforceable property rights.

Success and scaling up of restoration efforts will depend on improvement in governance by enhancing participatory forest management and monitoring, providing access to adequate capital and incentives, and diversifying livelihood options related to the MTS.

Ensuring effective enforcement and compliance with forest legislation will be the key to strengthening the various models of plantation development to achieve Ghana's commitment to the Bonn Challenge, AFR100, REDD+, the Sustainable Development Goals (SDGs), and other international agreements to which Ghana is signatory.

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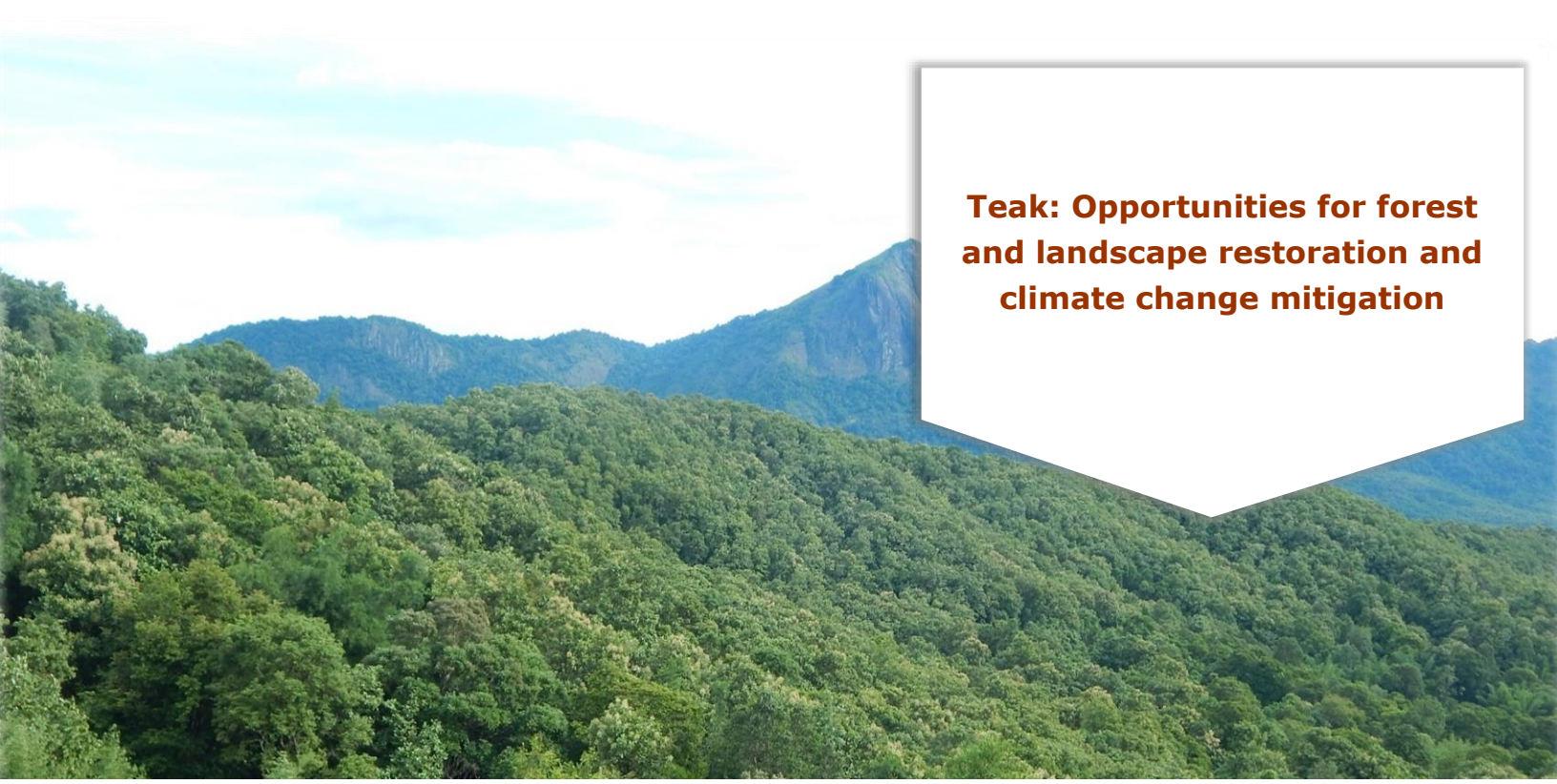

Teak: Opportunities for forest and landscape restoration and climate change mitigation

Key messages

1. Nearly half of the world forests have been either converted to other landuses or under threat of degradation posing serious challenge to ecosystem services, livelihood options and climate change adaptation. Hence, reversing forest land degradation and restoring forest landscape is an imperative task for humankind

2. Global conventions on climate action, biodiversity conservation and desertification endorses forest and land restoration as a viable option for resilience and well - being of millions of people across the globe

3. Teak with its adaptability to a wide range of edaphic and climatic factors, longer-life cycle, sand premium prices becomes an ideal species in such restoration efforts.

4. Rising teak wood demand along with technological improvements in major teak importing countries presents positive market conditions to absorb surges in production from new areas added through restoration efforts

5. Bridging gaps in teak resource management, establishing supply chains and developing an enabling environment remains key challenges in taking up large scale teak based forest and land restoration projects in new areas

6. Key recommendations for promoting teak-based forest and landscape restoration programs include:

- Assessment of landscape degradation and restoration opportunities
- Developing an enabling environment
- Strengthening Institutional settings
- Sorting out governance issues
- Providing supporting technologies and approaches
- Capacity development and extension
- Resource mobilization
- Building investor confidence and mobilizing private-sector investments
- Addressing research gaps and information dissemination

Executive summary

Global restoration commitments such as the Bonn Challenge, UN Decade on Ecosystem Restoration, New York Declaration on Forests, Convention on Biological Diversity and various other international, regional and national initiatives represent a unique opportunity for investment into timberland and forest plantations. With its high adaptability, wood quality, potential to replace energy intensive materials, unique ability to fetch premium prices in the timber markets and a global information network (eg. TEAKNET), teak has the potential to become a pioneering species in meeting restoration goals in a tangible time frame and an economically viable manner. However, the enabling environment will play an essential role essential role for teak based restoration efforts to succeed and contribute to the achievement of global impact.

Introduction

Global estimates suggest that one-third of the original forest cover has been diverted for other uses and an additional 20% is facing degradation (IUCN and WRI,2014). Such conversions and degradations decline the capacity of forests to provide goods and services and poses serious obstacles to the elimination of poverty, hunger and reversing biodiversity loss along with our ability to adapt to the impacts of climate change. The loss of precious forests also increases the competition for scarce resources, (food, water and energy security) leading to possible conflicts between users that threaten the livelihoods, resilience and well - being of millions of people across the globe. Reversing forest and land degradation and restoring forest landscape is therefore an imperative task for humankind. In this context. The concept of forest and landscape restoration (FLR) should be construed as an active process that brings people together to identify, negotiate and implement practices that restore an agreed optimal balance of the ecological, social and economic benefits of forests and trees within a broader pattern of land uses.

Current situation and observations on planted teak

IUCN estimates that achieving the Bonn Challenge require restoring 350 million hectares of degraded and deforested lands by 2030 and would generate at least US $84 billion in material benefits, net of costs, annually, providing direct, additional income opportunities to rural communities. Teak with a natural habitat in South and South East Asia have proven to be a versatile plantation in different climatic and edaphological conditions. Currently grown in over 70 countries, teak forms an ideal species for both landscape and mosaic restoration of degraded sites and could tap a good portion of the huge economic potential projected under the Bonn Challenge. From the humid tropical conditions in Asia and America to the dry ecosystems of Africa, teak has proven to rehabilitate soils, diversify crop production, improve microclimate and increase incomes. Teak based agroforestry systems, provide an ideal option for biodiversity conservation and income. Recent estimates indicate that planted teak is the only emerging valuable hardwood forest resource covering an area of 4.35 - 6.89 million ha globally. Along with its spatial expansion, substantial progress has also been made in the strategies and techniques of establishment, management and development vis – a – vis site selection, planting material, soil management, post planting operations, harvesting and timber utilization. Though raised on a plantation scale and in agroforestry systems on a commercial basis, the species has not been considered for large scale land restoration efforts.

Emerging opportunities for teak in Forest and Landscape restoration

Globally, 1.5 billion ha would be available for mosaic restoration, in which indigenous trees and teak could be used with other land uses (eg. agroforestry, smallholder agriculture and settlements) (Laestadius et al., 2011). By planting teak, degraded lands could be restored to productive use, reduce pressure on forests from development uses, provide communities with secure incomes and thereby reduce smaller-scale pressures that drive continued degradation

Economic case for teak: Conversion of large tracts of native teak forests in India and Thailand to protected reserves and export ban of native teak logs from Myanmar had triggered a sharp increase in the teak prices from US $ 750 per cm^3 in 2013 to US $ 2000 per cm^3 in 2014. In recent years, the rising global demand of teak wood on account of increasing incomes and domestic demand in major client countries such as China and India have raised the mean global annual teak trade to more than 1 million m^3. Since 2000, the global trade in teak logs of the major importing countries (India and China) has more than doubled in terms of volume and more than quadrupled in terms of value. At present, the global annual teak wood trade is valued at US $ 487 million (about 3 per cent of the total timber trade value). One increasingly important consideration influencing trade in plantation-grown teak is forest management certification and legality issues. The timber markets of North America and Europe have responded legislatively through the Lacey Act (USA) and the European Union Timber Regulations (EUTR) and other markets are expected to follow suit soon. Technological improvements along with good artisanal manufacturing procedures in major teak importing countries offers an ideal condition to absorb further surges in teak wood production in the future.

Teak as a climate mitigation option: Emissions of carbon dioxide, the most potent greenhouse gas, threatens the life on earth in an omnipotent manner. Storing the atmospheric carbon in terrestrial sinks is increasingly being realized as one of the viable options to mitigate the ill effects of climate change. Options include reversing forest losses and restoring landscape for increased carbon absorption or sequestration. The standard forest management and agroforestry practices applied in the context of FLR can contribute to the process of carbon sequestration. Achieving the Bonn Challenge alone would sequester 47 GtCO2e (at an approximate rate of 1 GtCO2e per year), generating US $ 5 billion in annual net benefits and reducing the current "emissions reduction gap" by between 11% to 17%.

To convert such estimations to reality, species with relatively higher productivity, longer-life cycle, stem density with options for longer rotation would be the most effective. Teak is a species satisfying all these criteria along with producing sustainable wood that can be considered as one of the most climate friendly alternative substituting several energy intensive materials such as steel, concrete, aluminium and plastic. Teak planted soils also hold significant amounts of carbon similar to natural forests, and various management approaches such as adding organic manure, reducing carbon losses by implementing conservation measures and establishing windbreaks to counter wind erosion will improve carbon sequestration potential of teak based FLR efforts. By increasing productivity of landscapes, enhancing the resilience of forest ecosystems and landscapes, and reducing the vulnerability of forest dependent communities, such FLR efforts would also contribute to social and ecosystem adaptation.

Emerging landscape options for Teak: Successful restoration initiatives using teak would require community-based landscape planning and decision-making, effective intersectoral cooperation and coordination among government agencies at the local, subnational and national levels. Priority areas for FLR using teak include unproductive or abandoned agricultural land, deforested areas and degraded forests. Table illustrates the general landuse categories for teak based FLR

Land use	Land subtype	Description
Forest land	1. Degraded forests 2. Barren lands	Land where forest is, or is planned to become, the dominant land use. Teak tress can be planted along with other species to raise a mixed forest with teak as the dominant species. **Suitable for wide-scale restoration**
Agricultural land	1. Permanent management 2. Intermittent management	Establishment and management of teak on active agricultural land through planting to enhance income, increase soil fertility, enhance water retention, etc. **Suitable for mosaic restoration**
Protective land and buffers	Protective land and buffer	Teak tress can be planted along with other species to raise a mixed forest with teak as the dominant species. **Suitable for watershed protection and erosion control**

Priority Actions and Recommendations

FLR is neither a top-down nor a bottom-up approach and works in both directions. The promoters of FLR will have to give careful consideration to the intermediate levels that exist between policy-makers and decentralized management levels. The attempt to cover a very broad range of forest-related activities under the FLR concept might imply a certain risk of dilution and a loss in clarity, hence a concentrated single species approach would be more effective. There is no blueprint for successful forest landscape restoration, since each situation will develop from local circumstances.

Critical issues to be addressed in teak-based restoration efforts are

1. Assessment of landscape degradation and restoration opportunities:

The first step should be to decide on the most appropriate assessment methodologies (e.g. Restoration Opportunities Assessment Methodology - IUCN), to identify degraded lands and the opportunities for successful restoration. The ecological conditions, social-cultural dynamics and other enabling factors are to be assessed in the landscape for successful interventions with teak. If a private venture is planned, the cost- benefit and risk assessment have to be evaluated to build investor confidence.

2. Enabling environment

Analyze the policies, laws and regulations across different sectors and determine their adequacy, complementarity and conflicts. If inadequacies are noticed, consider drafting, revision or harmonization of laws, policies and sectoral programs. The program should strive to strengthen local institutions to better manage conflicts over land use and tenure and improve policies for integrated management (e.g. agroforestry).

3. Institutional setting

Identify relevant land-use sectors and stakeholders for teak based FLR. The designed activity should be in tune with national strategies (eg. climate-change, biodiversity, rural development, etc) and if executed properly, teak based FLR can be an effective package to generate and share a range of benefits such as biodiversity, food security, climate mitigation, livelihoods and poverty alleviation to different sectors and stakeholders. Identify and leverage existing partnerships.

4. Governance issues

Assess land-tenure issues and try to secure tenure, especially for local stakeholders, as a key issue to allow investments in FLR. The barriers to people's participation should be identified. The decision-making processes in the region should be analyzed and engagement of all relevant stakeholder groups should be facilitated for a successful teak based FLR programs.

5. Technologies and approaches

Carry out stocktaking of existing technologies and approaches for sustainable land use (reforestation, afforestation, agroforestry, climate-smart agriculture etc.). It is advisable to

build on successful experiences and approaches already carried out. The gaps in teak plantation management should be identified and steps taken to rectify them.

6. Capacity development and extension

Identify capacity-development needs at the individual and organizational level and propose relevant strategies to meet these needs. Building capacity-development programs for relevant stakeholders to undertake planning, implementation and evaluation of FLR efforts would be one such step. Develop networks and knowledge platforms at national and regional levels between practitioners and extension services in order to ensure a free flow of information.

7. Resource mobilization

Estimate the resources already available through existing national or subnational programs and elaborate national action plans or strategies as the basis for building trust with donors in terms of national commitment to propose teak-based restoration interventions. If the activity is planned in the public sector, special care should be taken to integrate FLR into state budgets and public investment funds. In cases where public funding would be limiting, devise coordinated approaches to inform or sensitize potential donors and support the development of new plantations. Mobilize innovative sources of funding through mechanisms such as climate finance instruments, environmental services and develop incentive packages that include economic and non-economic benefits. Design, adapt and implement national and local financing mechanisms, in particular by promoting the development of financial instruments at the local level (e.g. local development funds, microfinance instruments, credit lines in local private banks), with positive incentives for local stakeholders to promote sustainable FLR investments in teak. Use these financing instruments to implement public incentive schemes (e.g. payments for ecosystem services) and couple these schemes with investments in sustainable value chains to ensure a long-term, self-sustaining financing strategy.

8. Private-sector investment

Increase engagement with the private sector, especially with pioneer private-impact funds and other innovative initiatives. Dialogue between the private sector and other stakeholders should be facilitated to decrease transaction costs for private-sector investments. Develop bankable restoration projects and raise the awareness of the private sector about teak-based FLR opportunities in key value chains. Favorable conditions for public–private partnerships must be fostered and risk-mitigation mechanisms promoted to engage FLR investors at scale.

9. Information dissemination and research needs

Regular access to relevant information with practical knowledge and experiences targeting varied audiences should be ensured through different channels and teak information networks such as TEAKNET. Research projects for developing innovative local solutions should be promoted.

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