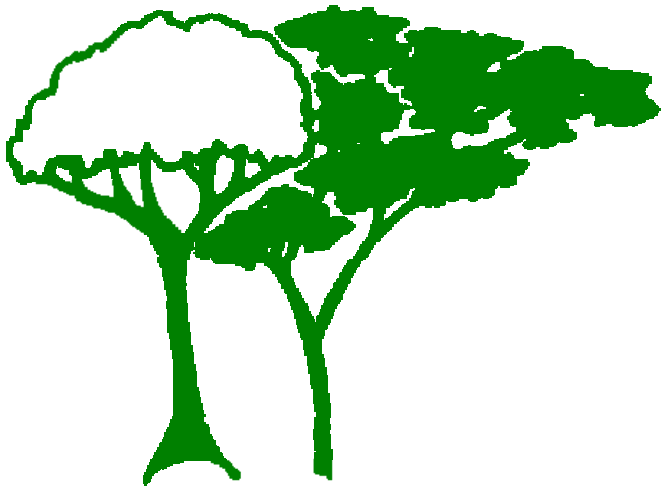
LA FORESTA PLANTACION S.A.

WHITE PAPER: TEAK PLANTATIONS



La Foresta Plantacion S.A.

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Requirements & Yields

Teak and Gmelina Plantations

Species	Gmelina arborea ("white" Teak)	Tectona grandis ("traditional" Teak)
Annual Rainfall	1,000 – 3,000 mm	1,250 – 2,500 mm
Average Temperature	24 – 35 centigrade	25 – 28 centigrade
Elevation	0 – 600 meters above msl	0 – 600 meters above msl
Dry Months / Yr	2 – 4	3 - 5
Soil Depth, minimum	1 meter	1 meter
Soil Type	Lime to lime-clay texture, flat to hilly topography, slopes < 20%, calcium > 18 cmol/L	Sandy to slightly clay, fertile, deep, well drained, neutral to slightly acidic pH, flat to hilly topography, calcium > 10meq/100ml first stratum
Limiting Conditions	Strong wind, clay, flooded or compact soils, weed competition	Strong wind, steep slopes, compacted, shallow, or heavy textured soils with high iron or low calcium content
Logistics	Within 4 hours driving of Caribbean port	Within 4 hours driving of Caribbean port
Rotation	10 -12 years	25 – 30 years
Yield (MAI)	10 to 40 m3 / hectare / year	10 to 40 m3 / hectare / year

INTRODUCTION

Teak (Tectona grandis) is one of the world's premier hardwood timbers, rightly famous for its mellow color, fine grain and durability. It occurs naturally only in India, Myanmar, the Lao People's Democratic Republic and Thailand, and it is naturalized in Java, Indonesia, where it was probably introduced some 400 to 600 years ago. In addition, it has been established throughout tropical Asia, as well as in tropical Africa (including Côte d'Ivoire, Nigeria, Sierra Leone, the United Republic of Tanzania and Togo) and Latin America and the Caribbean (Costa Rica, Colombia, Ecuador, El Salvador, Panama, Trinidad, Tobago and Venezuela). Teak has also been introduced in some islands in the Pacific region (Papua New Guinea, Fiji and the Solomon Islands) and in northern Australia at trial levels.

Although Teak logs harvested from native forests, principally in India and Myanmar, are major contributors to the global timber trade as well as to domestic markets, the supply of forest logs from these countries is becoming progressively restricted. In Thailand, harvesting of Teak, along with other native forest species, has been prohibited since 1989, while in the Lao People's Democratic Republic, supplies have been severely constrained pending a reassessment of harvest potentials. Thus in long-established and substantial markets for Teak products, such as Thailand, Singapore and China, there is major concern regarding the future supply of Teak. Plantations are an important potential source of timber to narrow the growing gap between supply and demand for Teak.

The durability and workability of Teak was recognized many centuries ago, leading to its relatively widespread distribution and cultivation throughout the tropics. Today, Teak ranks among the top five tropical hardwood species in terms of plantation area established worldwide.

Although Teak plantations date back as far as 150 years in India and Myanmar, plantation establishment has accelerated over the past 20 years. With the decreasing availability of Teak from natural forests, plantations are an increasingly important source of timber to meet the demand. In the future, plantations will probably be the most important sources of Teak. As demand for plantation-grown Teak grows, the private sector has increasingly become involved in plantations.

The lessons that can be drawn from Teak are relevant also to other tropical hardwood species such as mahogany (Swietenia Macrophylla), red cedar (Cedrela Odorata) and rosewood (Dalbergia sissoo). All of these compete in high-value niche markets and present similar environmental concerns associated with harvesting from tropical forests.

Properly done Teak plantations are socially and environmentally beneficial in addition to being very profitable.

A GLOBAL OVERVIEW

Although relatively unimportant in terms of the volume of world timber production, because of its strength and aesthetic qualities Teak is the tropical hardwood most in demand for a specific market of "luxury" applications including furniture, shipbuilding and decorative building components. Consequently it is of major importance in the forestry economies of its main producing countries.

Experiences with growing and marketing Teak are of considerable relevance to growers of other high-value hardwood species, particularly in the tropics. While some of the issues discussed here are largely unique to Teak as a species, many are relevant to other valuable hardwood species. Species such as mahogany (Swietenia macrophylla), red cedar (Cedrela odorata) and rosewood (Dalbergia sissoo) face similar challenges of competing in high-value niche markets, have longer growing cycles than many softwoods and present similar environmental concerns associated with harvesting from tropical forests.

During the past 20 years supplies of Teak from natural forests have dwindled, consequently an increased interest has developed in the establishment of Teak plantations. The transition towards greater utilization of plantation-grown Teak is not, however, being made without difficulty or controversy. Until recently, misgivings over the environmental impacts of Teak plantations - particularly controversies regarding possible soil deterioration and erosion in pure Teak plantations - rivaled those often associated with eucalyptus plantations. Further controversy has been generated in several countries by the promotion of Teak plantation investment schemes based on unlikely growth and yield projections, unrealistic pricing scenarios and dubious fund management strategies. Problems have mainly resulted from insufficient regulation and inadequate information or investor education. The long time horizons and broad range of price predictions associated with Teak plantation investment have provided opportunities for less scrupulous entrepreneurs to exaggerate figures and deceive even moderately wary investors.

Nonetheless, with Teak maintaining the status as one of the world's most valuable timbers, interest in growing and investing in the species will remain high in this economically viable solution to the production of much needed wood. Legislation and vigilance in both the commercial and the environmental spheres has been progressing to ensure that the Teak-growing industry develops in an orderly fashion.

ECOLOGY

Tectona Grandis is a large deciduous tree with a rounded crown and, under favorable conditions, a tall clean cylindrical bole of more than 25 m. The base of the tree is often buttressed (having outgrowths at the base caused by exaggerated root swelling) and sometimes fluted (having irregular involutions and

swellings in the bole). Leaves are broadly elliptical or obovate and usually 30 to 60 cm long. Over most of its range, Teak occurs in moist and dry deciduous forests below 1 000 m elevation and is one of the several species constituting mixed forest stands. It grows best in localities with annual rainfall of 1,250 to 3,750 mm, minimum temperature of 13º to 17ºC and maximum temperature of 39º to 43ºC. Hotter and wetter conditions also promote growth of the species.

Natural Teak forests mainly grow on hilly and undulating terrain with traps, basalt, granite, schist, gneiss, limestone and sandstone as underlying rocks. The best Teak forests, both natural and plantation forests, grow in well-drained deep alluvium with a PH between 6.5 and 7.5. It has been determined that high calcium content has positive effects. Teak plantations have failed completely when they have been established on low-lying, poorly drained land with clay soils (Seth and Yadav, 1959). In the natural forests of Myanmar, Teak grows mainly on hilly and undulating terrain and is one of several species constituting mixed stands.

Teak is a light-demanding species; it does not tolerate shade or suppression at any stage of its life and requires unimpeded overhead light for its proper development. Teak coppices and pollards vigorously and sometimes retains its coppicing potential even after attaining large size. Teak begins flowering and seeding at a young age, about 20 years from seedling and about ten years from coppice, and produces abundant seeds almost every year (Seth and Kaul, 1978). The hard thick pericarp of the seed prevents easy germination and a considerable portion of fresh seeds remains dormant in the first year. Teak seeds remain viable for many years.

MANAGEMENT OF NATURAL TEAK FORESTS

The earliest attempts to manage the natural forests of Teak in India and Myanmar were through the selection system: a given tract of forest was worked in a predetermined felling cycle by cutting trees that had reached a certain minimum girth, with a proviso that where Teak regeneration was absent, seed bearers were to be left standing. The number of trees to be removed in any year or over a given period was fixed (Troup, 1921).

A modified version of the selection system is still followed in some places. To induce or establish regeneration of Teak, "improvement fellings" to remove inferior wood, damaged stems and climbers are carried out under a definite felling cycle. Under selection felling, the rotation is generally 120 years with a felling cycle of about 30 years. FAO has estimated a harvesting intensity of 12 to 17 m3 per hectare per year for Myanmar's forests, using a 30-year felling cycle.

Coppicing of Teak has been used to manage natural Teak forests under different systems suited to local situations in India, Myanmar and Thailand. In particular, coppice systems have been applied to Teak forests where trees do not grow to a large size because of excessively dry or other poor site conditions. An example is the "coppice with standards system", in which 25 to 50 trees per hectare are selected as standards, on the basis of their larger diameter, and are retained as seed-bearers. The remainders are clear-felled to produce coppice shoots. The rotation varies between 30 and 60 years; in rare instances it is 80 years (Kadambi, 1972). In a modified system, "coppice with reserves", practiced in Madhya Pradesh, India, advanced-growth and pole-sized trees are retained as reserves which will provide large-size timber in the next rotation. The rotation period varies between 30 and 40 years.

Modern forestry management techniques has been greatly reducing the rotation period and increasing the amount of wood harvested.

TEAK PLANTATION ESTABLISHMENT

Teak is known to perform well in plantations under favorable conditions. In this characteristic it contrasts with some of the more commercially known and valuable tropical hardwood species. For example, many of the species that make up the timber wealth of the African tropical forests (e.g. species of the Meliaceae family, the African mahoganies Khaya ivorensis, K. anthoteca and K. grandi-folia, and Entandophragma spp.) have proved un-amenable to growing in plantations for reasons such as exceedingly slow growth, susceptibility to mortality in establishment on cleared land (being climax rather than pioneer species) or vulnerability to pests and diseases. Mahogany (Swietenia macro-phylla) is one of the few other luxury hardwoods that is extensively grown in plantations. It seems likely that there will be a significant divergence in future timber supply potential between those species amenable to plantation and those largely dependent on an established natural forest habitat.

Mixed plantations of Teak with other tree species are generally less susceptible than pure Teak plantations to soil erosion and pest and disease risks. Pure Teak plantations are susceptible to defoliating pests, particularly when under-storey growth is suppressed and site conditions are suboptimal. Teak begins flowering and seeding at a young age, about 20 years from seedling and about ten years from coppice

Teak relative to other species is easily established in plantations and because of the enduring global demand for products from Teak it has good prospects as a plantation species. These prospects are boosted by the rapidly developing trend of replacing lumber with reconstituted panels. Sliced Teak

veneers are assured of demand because of their value in enhancing the potential for composite panel substitutes in a widening variety of applications.

Apart from the introduction of Teak in Java, Indonesia, the first Teak plantation was started in 1680 in Sri Lanka. Teak planting in India began in the 1840s and increased to significant levels from 1865 onwards. Teak plantations using the "taungya" method, in which a forest crop is established in temporary association with agricultural crops, were initiated in Myanmar in 1856 and in Indonesia around 1880.

Teak was first introduced outside Asia in Nigeria in 1902, with seed first from India and subsequently from Myanmar. Teak plantations were started in eastern Ghana around 1905. A small plantation of Teak was established in Côte d'Ivoire in 1929 from plantation-grown seeds obtained from Ghana. The first Teak plantation in tropical America was established in Trinidad and Tobago in 1913 with seed from Myanmar. Planting of Teak in Honduras, Panama and Costa Rica started between 1927 and 1929.

Plantation Areas

Teak plantations constitute about 8 percent of the total plantation area in countries with climates suitable for Teak growing. In 1995, about 94 percent of global Teak plantations were in tropical Asia, with India (44 percent) and Indonesia (31 percent) accounting for the bulk of the resource. Other countries of the region with significant planted Teak resources were Thailand (7 percent), Myanmar (6 percent), Bangladesh (3.2 percent) and Sri Lanka (1.7 percent). About 4.5 percent of global Teak plantations are in tropical Africa (largely in moist West Africa, particularly in Côte d'Ivoire and Nigeria) with the remainder in tropical America (mostly in Costa Rica, Panama, Trinidad and Tobago) and the Pacific Islands. Today, Teak ranks among the top three tropical hardwood species in terms of plantation area established worldwide.

Tropical Hardwoods By Plantation Area

Species	Hectares	%
Eucalyptus spp.	9,949,588	17.7
Acacia spp.	3,904,307	7.0
Tectona grandis	2,246,559	4.0
Casuarina spp.	787,200	1.4
Dalbergia sissoo	626,020	1.1
Gmelina arborea	418,050	0.7
Terminalia spp	303,957	0.5
Swietenia macrophylla	151,214	0.3

Plantation Management

Teak can grow in a variety of soils. The quality of its growth, however, depends on the depth, structure, porosity, drainage and moisture-holding capacity of the soil. It develops best on deep, well-drained and fertile soils, especially on volcanic substrata such as igneous and metamorphic soils or on alluvial soils of various origins. The optimal soil pH is between 6.5 and 7.5. The calcium content of the soil is also an important factor as calcium deficiency in the soil results in stunted growth of Teak.

Teak plantation management regimes vary between and within countries, mainly according to site-specific conditions and prevailing markets. Typically, however, it is recommended that initial stocking rates be in the range of 1,100 to 1,600 stems per hectare to allow for early mortality rates and to provide an opportunity for selecting the better individuals during thinning operations.

Partially depending on the intensity of planting, an initial thinning should be considered as soon as the branches start to make contact with those of surrounding trees; this may occur when the plantation is around four to five years old and the intensity of removals may be as high as 50 percent of the initial stocking. A production thinning may follow at about age ten to 15, and a final production thinning at around 15 to 20 years. Again depending on market requirements and other factors, an ideal final stocking is likely to be around 200 to 300 stems per hectare, possibly producing as much as 300 cubic meters of wood.

Management practices may vary significantly, however, depending on whether Teak is grown on short or long rotations. In the past much Teak was planted with relatively wide spacing of 3 x 4 m (830 plants), 3.5 x 3.5 m or 3 x 3.5 m to test the different sites. Since then the spacing has been reduced to 3 x 3 m (1,100 plants) so as to obtain straight boles without abundant branching. Spacing of 2 x 2 m or 2 x 3 m or up to 1,600 trees per hectare has not been found to add any benefit. Spacing is modified, based on variability in site conditions. Pruning has also been intensified and is now begun after the second year. Trees are pruned up to 6 meters or two-thirds of the stem height. The objective is the production of knot- free, high-quality timber.

Two major issues that affect the performance and management of Teak plantations are the growth rates achieved and the desirability of maximizing the length of the clear bole so as to maximize the value of the log for high-quality end uses.

Modest growth rates are reported for Teak plantations. Under favorable conditions in early life, a plantation may exhibit growth rates of between 10 and 20 m3 per hectare per year. However, growth falls to the general reported level of 4 to 8 m3 per hectare per year as the plantation ages.

On the best sites in Myanmar and India, 50-year-old plantations exhibit heights of 30 m and diameter at breast height (DBH) of 60 cm. Some growth parameters for Teak grown in Malaysia are shown below:

Performance of Teak at Perlis, Malaysia

Height growth	4 m in the first year
Diameter growth	1.5-2 cm per year
DBH at 15 years	25-35 cm
Total height at 15 years	22-25 m
Clear bole at 15 years	12 m
Volume per tree at 15 years	0.50 m3

PLANTATION WOOD QUALITY

Long rotations in Teak plantations appear essential if the high potential value of the heartwood is to be realized. Studies in India found that the heartwood content of 51- to 52-year-old trees was 77 percent, whereas for eight-year-old trees it was only 30 percent. The same studies also showed a positive correlation of heartwood percentage with ring width (0.73) and with DBH (0.46), indicating that faster growth rates were associated with higher heartwood content and, by implication, higher-value timber. These results suggest that longer rotations are necessary for producing high-value logs but that faster growth rates may be beneficial to the value of the timber.

The most important form characteristic determining the value of Teak logs is the length of the clear bole, which is determined by the timing of flowering. Flowering - representing the transition from production of vegetative structures only to the production of reproductive structures - occurs in response to certain environmental signals. Flowering by the terminal shoot is then immediately followed by the initiation of the whorl of branches. Selection for late flowering seed stock has been suggested as a means of maximizing the duration of the vegetative period, also management strategies are generally employed to maximize the length of the clear bole.

It has been alleged that Teak obtained from plantations is of inferior physical quality relative to Teak obtained from the natural forest. More variability in wood quality has been observed in Teak obtained from the natural forest than in plantation Teak, and this is undesirable from the point of view of use. One misconception prevailing among Teak users is that fast-growing Teak produces only light, weak and spongy wood. However, studies conducted at the Forest Research Institute in Dehra Dun, India, do not support this view. Although plantation trees grow faster than forest trees, it has been shown that the relationship between growth rate and strength is not significant.

Studies by Sanwo based on dominant, co-dominant and subdominant trees from a 27-year-old Teak plantation in Nigeria showed that the rate of growth has no significant influence on specific gravity. Teak wood is generally stronger at the upper and lower ends and comparatively weak at intermediate heights. A study on 20-year-old Teak trees grown in plantations in wet areas in India gave similar results.

Other studies have indicated that wood density and mechanical properties are independent of growth rate or that fast-grown trees of ring-porous species have higher wood density and strength. More recently, a study on the wood properties of fast-grown plantation Teak trees of different ages revealed that there were no significant differences in wood density, modulus of rupture (MOR), modulus of elasticity (MOE) or maximum crushing stress. It was concluded that young trees (13 to 21 years of age) are not necessarily inferior in wood density and strength to older trees aged 55 and 65 years, and hence that the rotation age of fast-grown Teak wood can be reduced without affecting the timber strength. Various products such as glue-edged boards, furniture, doors and small Teakwood artifacts have been made from thinning materials, showing that even sapwood can be used to produce high-quality objects.

GENETIC VARIABILITY

Teak plants can be raised using either seeds or vegetative tissues (stumps, branch cuttings etc.). Plants raised from seeds collected at random tend to show fairly wide variability in growth, while vegetative propagation using cuttings and tissue culture ensures production of uniform planting materials of desired qualities. However, seeds are very important to maintain a broad genetic base. To obtain fairly uniform planting materials from seeds, seedling or colonel seed orchards of good-quality trees have to be raised for seed collection.

The large variation in growth conditions within the natural range of Teak suggests that there is a likelihood of substantial genetic variability. Furthermore, the long-term cultivation of Teak in regions outside its endemic area (e.g. in Java, Indonesia) suggests the possible existence of land races that are specifically adapted to the regions to in which Teak has been introduced.

To examine these questions, an international series of provenance trials was established. These trials showed that, in general, local seed sources should be preferred when Teak is established within the area of its natural distribution. Although local sources did not always give the fastest growth rates, they consistently gave good performance relative to seed lots introduced from elsewhere.

In contrast, for regions outside the natural range of Teak, local seed lots were sometimes very poor for some characters of commercial significance and were thus unsuitable for use in developing commercial-

scale plantations. Of particular interest, however, was the broad adaptation of provenances from southern India and Indonesia, which exhibited good survival, growth rates and form.

Plant stocks currently being used for the Malaysian plantation programs principally originate from local unidentified sources or from Thailand. There is no accreditation to ensure that the material comes from a reliable source of good-quality germplasm or, indeed, from the source named by the supplier. This presents a risk for plantation managers.

Most plants stocks in the Costa Rica and Panama area comes from Myanmar. The stock has exhibited very good properties for plantations in Central America.

PRODUCTIVITY AND VOLUME ESTIMATES

The productivity of Teak plantations has been studied across a broad range of countries through permanent sample plots. An important feature of all Teak yield tables is the early peak of mean annual volume increment (MAI), generally between six and 20 years. In good, properly managed sites, with rotations ranging from 20 to 25 years, Teak has a MAI of 20 to 25 cubic meters per hectare per year. Well managed plantations should produce at least 10 – 15 cubic meters per hectare per year of commercial industrial volume.

Because Teak is planted and managed for timber production, size plays a decisive role in determining harvesting, rather than the age of maximum volume production. The rotation age of plantation Teak in its natural range has varied between 50 and 90 years, while outside its range the rotation age is between 20 and 60 years.

Climatic variables explain 59 percent of the variance of the potential yield of Teak plantations. Relative humidity and annual rainfall were identified as the most important climatic factors influencing the growth of Teak. Above certain upper limits, however (70 percent and 2,000 mm per year, respectively), increases in their values result in successively less increase in the potential yield.

Teak has been the subject of comprehensive research programs in India, Indonesia, Thailand and Myanmar for at least 50 years. Some of the key outcomes from those programs with respect to plantations have been the identification of élite genetic material for wide-scale planting and the development of silvicultural practices that optimize the production of high-grade timber. In Malaysia, FRIM is currently undertaking research on the following areas to enhance Teak plantation development:

- Tree improvement, with the establishment of seed and clonal orchards to make available élite planting materials for mass multiplication.
- Tissue culture, to develop large-scale in vitro propagation techniques for the production of uniform true-to-type plants for the plantation industry.
- Genetic evaluation and fingerprinting of Teak clones using isoenzyme and molecular markers.
- Species site matching, with ongoing detailed studies.
- Optimum thinning regimes, fertilizer requirements and sound silvicultural practices, through planting trials.

ROUNDWOOD PRODUCTION AND TRADE IN TEAK

Since Teak plantation establishment is relatively recent in most countries outside its natural range, current production of mature Teak is largely restricted to the traditional large producers, Myanmar, India and Indonesia. Sri Lanka, Bangladesh, Trinidad and Tobago and a few other countries produce mature round-wood from plantations. Production of immature round-wood from plantation thinnings, mainly for utilization as posts and poles, is more widespread.

Myanmar, the only Asian producer that allows relatively unconstrained export of Teak logs, dominates the export trade in Teak logs, while China and Thailand are the two largest importers. The other substantial exporter of Teak logs has been Côte d'Ivoire, which until recently excluded Teak from its log export ban. Other exporters of Teak logs, including several African countries and some Latin American countries (such as Trinidad and Tobago and Ecuador), deal in relatively minor volumes.

Exports of Teak sawn timber are mostly from Myanmar and Indonesia, with Thailand and Côte d'Ivoire also exporting significant volumes (Table 3). A range of other countries, including Ghana, China, the United Republic of Tanzania and Ecuador, export more modest volumes. All of India's Teak production is processed within the country. India is also a significant net importer of Teak, including shipments of logs and sawn timber from Africa and Latin America.

The largest manufacturers of Teak products are Indonesia, Thailand, India and China. India produces sawn timber for construction and decorative uses, and decorative plywood almost exclusively for use in its domestic market. China and Thailand have relatively large Teak processing industries based on imported round-wood, while Indonesia processes its own plantation-grown Teak.

Much of this production is exported to Europe and North America as finished consumer items such as furniture, or as sawn timber, particularly destined for decorative uses, boat building and outdoor applications such as decking. In general, volumes of national imports (and often exports) of Teak products are poorly documented or inaccessible.

PRICING OF TEAK

Teak prices vary considerably depending upon wood quality. At the end of 2003, FOB prices for natural Teak sawlogs ranged between $420 and $1,615 per cubic meter depending upon log grade[1]. Prices for plantation Teak tend to hover in a narrower range, although variations in quality still have an effect on price. Actual market prices of plantation Teak in Costa Rica currently range between $350 to $650 per cubic meter depending on diameter and wood quality.

OTHER CONSIDERATIONS

Trade-related measures that may influence Teak growing and markets include national import tariff structures applied to Teak products, non-tariff measures such as requests for certification, and boycotts by retailers or consumer groups. The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) formalized a general trend in trade liberalization for forest products, which applies also to trade in Teak. In general, the most significant restrictions on trade in primary Teak products are those applied by potential exporting countries, particularly log export bans and export taxes on sawn timber. Nonetheless, considerable import tariffs, commonly 10 to 15 percent, are still applied in developed-country markets to some processed products, such as joinery and furniture. Such tariffs can lead to discouragingly high prices for Teak products. Probably the most significant recent change influencing global Teak trade was the removal, in 1992, of import licensing requirements for logs in India. As a consequence India is now able to import large volumes of Teak logs, particularly from Africa, to make up for the domestic shortfall caused by the country's restrictions on Teak logging.

Indiscriminate, unmanaged cutting has been the primary cause of clearance or degradation of most natural Teak forests in Thailand, the Lao People's Democratic Republic and India. In Myanmar, the use of the Myanmar Selection System, or variants of it, should continue to help avoid controversy. Nonetheless, at least one recent consumer crusade in the United States has campaigned against buying Myanmar Teak.

[1] ITTO 2003/2004

The increasing proportion of Teak coming from plantation forests may avoid some environmental controversies - but sometimes attracts others. Teak is a pioneer species and as such is generally susceptible to competition from other plant species. Clearing undergrowth and debris may assist Teak growth in the short term, but almost inevitably at the cost of longer-term site degradation. Practices that expose the soil to the elements, such as litter raking and excessive burning, may particularly exacerbate erosion and leaching problems in Teak plantations, which tend to have wide tree spacing and are prone to leaf drip. In general, most of the environmental criticisms directed at Teak plantations are the result of such inappropriate management techniques rather than irrevocable plantation characteristics. In some countries the abandonment of poor management practices has assisted in retaining site fertility.

Although not specifically targeted, Teak plantations have been included in general anti-plantation campaigns which are based on the premise that plantations, especially single-species plantations, tend to have lower levels of biodiversity than natural forests and may also be more susceptible to catastrophic damage, especially from pests and diseases but also from wind, storms and fires. In a number of countries, mixed plantations are being established to provide better soil cover and stability, to increase biodiversity and to reduce commercial risks.

Certification of forest products has potential to affect Teak products. Companies and countries supplying markets in Europe and North America, where the interest in certified forest products is highest, may find some form of certification for Teak a cost-effective option for increasing market share. That Teak is generally sold into high-value niche markets adds to the attractiveness and viability of the option. To date, the area of Teak forests with internationally recognized certification appears relatively small, as suggested by the fact that plantation forests in general have been certified, according to standards set by the Forest Stewardship Council, in only four of the 35 countries currently known to be growing Teak: Costa Rica, Indonesia, Panama and Sri Lanka.

Forest plantation activities have had a role in easing the widespread unemployment in many areas of Central America caused by a downswing in the ranching business. Forestry has created employment and trained ranch workers for new tasks as well as increasing the awareness of the local people to many environmental issues such as soil erosion and desegregation. A number of people are employed on a permanent basis in forestry management and working in the nurseries. Many more are employed as occasional workers, most of them as contractors for planting, weeding, pruning and thinning. This has created a new middle class of small family companies which, together with the economic linkage effect, support many families. Tree breeding and forest plantation are seen to be activities of importance for the area's future. Many landowners, in particular small farmers, are learning about forestry and getting tree planting material to add some long term investment and diversity to their farms. The governments have

moved to promote reforestation in these countries as they see the long term benefits in the development of this socially and environmentally friendly industry.

SUMMARY

As the sustainable supply of Teak from natural forests (now almost exclusively from Myanmar) diminishes and the demand continues to increase, the general trend in the future of Teak growing will be towards plantation-grown Teak. This suggests a justification for more private investment in plantations and enhanced knowledge regarding diverse aspects of Teak plantation establishment and silviculture, management. Research is ongoing on the effects of pruning, the effects of the site, of growing Teak in mixed plantations and the environmental impacts, sustainability and productivity of short-rotation plantations. Several countries are interested in improving financial returns from Teak plantations through the utilization of thinnings and small round-wood. To this end studies are being conducted on conversion techniques for small round-wood, techniques for reconstituting small sawn wood as larger material, and market opportunities for small-dimension timber or components.