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EDITORIAL

A major portion of space in this issue, has been allocated to an article by the late Dr. Apichart Kaosa-ard: A Synthesis report on Site, Technology and Productivity of Teak Plantations. It was compiled from reports presented at the Regional Seminar on "Site, Technology and Productivity of teak Plantations" which was jointly organized by Chiang Mai University, FORSPA and Teaknet and held from 26-29 January, 1999 in Chiang Mai, Thailand. It is significant in that it touches upon every aspect of teak plantations and covers all the regions in which teak plantations have been established. Dr. Apichart prepared the paper for the Third Regional Seminar on Teak, which was jointly organized by Gadjah Mada University, Perum Perhutani and Teaknet, and hosted by Indonesia from 31 July - 5 August, 2000 in Yogyakarta, but never had the opportunity to present it at the seminar, because of a tragic ailment that resulted in his demise four months later. This article is probably his last contribution to Teaknet, its members and readers. Its inclusion is a tribute to him, and to the many teak experts and scientists who had provided invaluable information through their seminar papers.

Forest fire protection had been a major issue in Southeast Asia since several decades, and the outbreak of recent severe forest fires has caused a great deal of concern. Since it has been well acknowledge that many valuable lessons can be learnt from past experiences, Teaknet has included an article with a rear-ward view of the strange relationship between teak and forest fire, which greatly influences the decisions for fire management in a country with natural teak bearing forests.

SPECIAL REPORT

Site, Technology and Productivity of Teak Plantations: a Synthesis Report

by Dr. Apichart Kaosa-ard

Introduction

Teak (*Tectona grandis* Linn. f) is one of the most valuable forest tree species of the South and Southeast Asian regions; with only a few countries i.e. India, Myanmar, Thailand and Laos being its natural habitats. The species has long been domesticated, e.g. in Java, Indonesia, for over 500 years (Kaosa-ard 1986), and planted as exotic species in Sri Lanka in 1680 (Ball *et al.* 1999). Thereafter, teak plantations had been widely established throughout the tropical and subtropical regions.

To review the existing states and management of teak forests and plantations for sustained production and market opportunity, a pioneer teak working group, i.e. the Teak Sub-Commission was formed under the FAO Asia and the Pacific Forestry Commission in the 1950s. The current information and status of this species, e.g. ecology and distribution, forest and plantation area, timber production, utilization and marketing, plantation technology and growth potential etc., both within and outside its natural habitat was presented, reviewed and published (FAO 1956, FAO 1957). After the termination of the Teak Sub-Commission, attempts had been made to develop formal teak working groups. These include the Species Improvement Network (SPINs) for teak, the Teak Network for Asia and the Pacific (TEAKNET), IUFRO initiatives, Teak 2000 etc.

The regional seminar on Site, Technology and Productivity of Teak Plantations" was held in Chiang Mai, Thailand, on 26-29 January, 1999, as a part of the TEAKNET activities. The objectives were:

- To review the current state of technologies and practices for establishing and managing teak plantations in the region;
- To review the information on productivity of teak plantations under different conditions and management regimes and to assess the linkages of site, technology and productivity; and
- To identify the main issues of improving management of teak plantations and to develop a framework for collaborative studies and technology improvement.

There were over 100 participants representing various government and private sectors

profitable in many countries, e.g. Bangladesh (Haque 1999), India (Chundamannil 1999 and Subramanian *et al.* 1999), Sri Lanka (Weerawardane 1999) Myanmar (Anon 1999), Malaysia (Krishnapillay and Razak 1999) and China (Jiayu and Kunnan 1999). With the productivity of 3 m^3/ha/year at a 50-year rotation, the average rate of return of investment is over 15%. A cash flow study conducted in Kerala, India, for example, shows that the total cost of teak plantation establishment and management for 58 years is 3,117 US$ per ha and the net benefit from investment is 54,663 US$ per ha (Chundamannil 1999). Under different site classes and plantation productivity, i.e. low, medium and high, the rate of return from the investment are 11.7, 31.3 and 46.4% respectively. (Chundamannil 1999 and Subramanian *et al.* 1999). Internal rate of return (IRR), net present value (NPV) and benefit cost ratio (BCR) of teak plantation investment under different productivity regimes is shown in table 3.

The high profit in teak plantation investment is due largely to (1) the exclusion of land costs from the analysis, (2) the high price of timber obtained from thinning of the old stand and final harvesting and (3) marketabily of timber from the early thinning. When the rotation age of the plantation is taken into account, it recommended that on the average site the most profitable rotation age should be about 40 years (Haque 1999).

Table 3: Internal rate of return (IIRR), net present value (NPV) and benefit cost ration (BCR) of the teak plantations in Kerala, India

Yield m^3/ha/year		Rate of Return	Net Present Value NPV (US$/ha)		Benefit Cost Ration BCR (%)	
		IRR (%)	6%	12%	6%	12%
Low	0.97	11.7	988	-24	2.9	1.0
Medium	2.85	31.3	4,494	941	7.5	3.2
High	5.64	46.4	9,059	2,118	10.9	5.1

Source: Chundamannil (1999) and Subramanian et al. (1999)

Conclusion

In 1995, the total area of teak plantations, within and outside of the teak natural habitat, was recorded as being 2.3 million ha, or about 8% of all forest plantations in the tropics. At 50 years rotation, the average productivity (MAI) of teak plantations is from 2 to 20 m^3/ha/year depending on site conditions. The average MAI of 5 m^3/ha/year is accepted and the total production of teak timber in years 2030 and 2050 are estimated at 24 and 30 million m^3/year respectively. To improve productivity, only good sites should be selected as attempts to improve site quality on marginal or degraded land by fertilizer or irrigation, gave no information on the long-term responses of plantations to such practices. Productivity can be improved substantially through tree improvement programmes, as genetic gain obtained from simple and advanced breeding can improve productivity by 10 and 25% respectively i.e. productivity of plantation grown from seed of first generation seed orchard is 10% higher than that grown from unimproved seed. If teak is being introduced as an exotic species, the best performance provenance(s) or seed source(s) should be used. Insects, especially stem borers and defoliators are still the main problem in teak plantations and chemical and biological treatments should be conducted carefully to minimize their residual effects on the environment. Investment in teak plantations has proven to be still profitable at a 50-year rotation, though the rate of return varies from 8 to 45% depending largely on site productivity, rotation age and market opportunity for small logs from early thinning.

Teak and Forest Fire

General background

Basic concepts regarding forest fire prevention were initiated in Myanmar together with the advent of scientific forest management. It was generally accepted that fire prevention was very important and that valuable benefits could be accrued from this vital function.

A Forester by the name of Mr. Slade with his article "Too much Fire Protection in Burma" (Indian Forester May, 1896) touched off a series of debates that raged fiercely around the pros and cons of fire protection. The benefits derived from the protection of plantations in their early years was beyond doubt; Mr. Slade's argument was against the marked tendency to advocate extensive fire protected areas and fire protection of "all teak forests". He pointed out that forest fires in Burma were mere surface fires, which slowly advanced and consumed dry leaves covering the ground; that as a rule fierce fires were quite exceptional; and figuratively, that a fire once started, might burn for weeks and travel from one end of the country to the other.

He reasoned that annual fires were so constant and regular, and had become natural to teak transforming it into a fire hardy species. He also rationalized that as most other vegetation suffered more severely in their younger stages than teak, the annual fires could be considered as an agent favouring the growth of teak at the expense of vigourous, but fire tender, competitors; concluding that natural regeneration of teak over large areas without the prior assistance of fire was impossible.

Mr. Slade recommended that the general extension of fire protection over thousands of acres should not be undertaken; that existing fire lines be curtailed to exclude old plantations; that effective protection be prescribed for small defined areas with fairly good stocks of young teak seedlings and that the total area of protection be limited by the amount of supervision available. He held on to the view that

A recent surface burn in a moist deciduous forest, being inspected by Dr. Johann Goldammer, of the Global Fire Monitoring Centre/FIREGLOBE

annually recurring surface fires should be considered as friends and not enemies, except during the occurrence of fire with exceptionally high intensity, and that fire was one of the forester's most useful agents so long as it remained his servant and not his master.

Two schools of thought

Mr. Slades article stirred up a great deal of controversy and the forestry administration, together with the body of practising foresters, was split into two schools of thought. One was in favour of the general expansion of fire protection to large forested areas, while the other was for exclusion of natural forests and mature plantations, and the inclusion of only young plantations and areas on which fairly good stocks of young teak seedlings were significantly present.

The dispute among foresters regarding the effect of forest fires remains to this day. Some pointed out that most of the forest associations in Myanmar could adapt to fire and the intensity of the annual fires did not result in complete destruction of forests or loss of forest land. They even argued that, in some forest types like the mixed deciduous and Indaing (dry dipterocarp) forest types, fire may be of great assistance in establishing new regeneration and seed germination. It is also a well known fact that the rootstock of teak seedlings are not seriously affected by fire, and are capable of shooting coppice repeatedly until they reach the stage when they can no longer be burned back, thus the argument that fire favours teak against its adversaries.

The other group debates that frequent burning causes considerable consequences on site quality, composition of the forest and tree form; that the loss of species variety and biomass may lead to soil depletion, erosion and sedimentation, bringing about social and economic hardship to the people; and that fire also causes the loss of some wildlife and effects their habitat.

Current forest fire arrangement

Financial constraints, inadequate budgetary approbation and limitations in supervision finally tipped the balance in favour of protection only for young plantations and, to a lesser extent, areas with a fairly good stock of young natural regeneration. Natural forests and mature plantations are generally excluded from fire protection schemes. When funds are spread too thinly over many areas only a bad job of protection can be expected.

Many foresters hold on to the idea that it may be better to have annual fires with light intensity in a forest, than to successfully protect it for a few years and later see it destroyed by an outbreak of very serious fire highly intensified by the burning of fuel accumulated during those years of successful protection.

It had already been proven beyond a doubt, that fire protection in the dryer types of forests was beneficial, but it still needs to be proven, that such operations are financially justifiable.

At this stage it may still be

The aftermath of a severe fire in a dryer and more open type of forest

A severely burnt young teak tree (taken, 21-2-1999)

The same tree one year later; not dead, but with permanent scars which will definitely reduce the quality of the timber (taken, 21-1-2000)

absolutely absurd to advocate fire protection over extensive areas of natural teak bearing forests, in addition to the current fire protection programmes. However, it may be more than worthwhile to consider affordable fire protection schemes for areas of manageable extent, in order of priority depending upon their need for protection. Past experiences, of which one is brought back to mind, indicate that such efforts had paid handsome dividends in the past.

Past experiences

The following is an abstract from the article "Note on the effect of 70 years treatment under selection system and fire protection in the Kangyi Reserve" by U Kyaw Zan, B.F.S, which appeared in volume3, of the March, 1953 issue of the Burmese Forester Magazine.

The article describes the area of study as the Kangyi Reserve, one of the plain reserves of the Zigon Forest Division, 4894 acres in total extent and divided into 30 compartments each of 148 to 187 acres. Prior to reservation in 1870, it was said to be an open forest abounding in decrepit and malformed trees many of which were teak.

It describes how the reserve had been managed for 70 years during the periods of three working plans and a part of the fourth from 1870 to 1941. In the first plan (1870-1891) the reserve was worked under the plan prepared by Dr. Brandis for all forests, with the system being teak selection. Fire protection was effected from 1876 to 1891.

In the second plan (1892-1922) the selection system had been applied more or less in the primitive form, and teak alone was favoured at the expense of all other species. Heavy improvement felling had created conditions ideal for the development of teak and young reproduction of teak appeared. Further, subsidiary operations in favour of teak had resulted in an enormous increase of this species. To augment the existing teak stock, 500 acres of abandoned Taungya areas had been planted with teak and broadcast sowing and dibbling in of teak seed over a total area of 200 acres were made to fill up the blanks. Fire protection which had been introduced in 1876 was extended to 1920 over a continuous period of 45 years with the objective of encouraging young teak for early establishment in plantations and in the natural forests. During the felling cycle, teak trees of and above the exploitable girth size were systematically girdled to remove the mature and over mature trees. The effect of all these works had been the definite improvement of the forest in that its stock of valuable teak was more than double in a short span of 30 years. Also, young *Xylia Kerri* trees came up in abundance under continued fire protection.

The third plan (1923-24 to 1932-33) was said to have been written in great detail. The selection system was improved to favour not only teak but also *Xylia Kerri* and other commercially important species. From the result of complete enumeration of all trees (down to 3' gbh) teak had been found to be by far the commonest with a high stocking of 9.8 per acre and a relative density of 25.5%. In the improvement felling, species of little or no value were removed in

the interest of the more valuable ones and the condition of the forest had been changed greatly, though its irregularity was maintained. Trees were found vigorous and healthy with marked increase in growth increment. Stem analysis revealed that it took only 73 years for teak to attain 80" gbh. Trees of the younger age classes also became more prominent and to provide frequent treatment to the young crops existing in both plantations and natural forests, the felling cycle was even reduced from 30 years to 10 years under the plan. Fire protection, temporarily abandoned in 1921, was resumed in 1924 till the end of the cycle. Steady decomposition of leaf mould set in, increasing the soil fertility. Stocking of teak and *Xylia Kerri* had greatly increased but the others showed no discernible improvement. It was reported that the forest under that plan had built up its wealth with amazing rapidity and an important point was made that "if fire protection could raise the productive capacity of soil for a particular type of forest, the case of Kangyi reserve was an outstanding example"

For the fourth plan (1933-34 to 1947-48) no immediate revision of the previous plan could be under taken due to internal disturbances in that particular district where the Kangyi Reserve was located. Operations were carried out under the draft plan before the main plan appeared in 1939. Method of treatment under this plan was the same improved selection system more in line with the prevailing condition. Teak, *Xylia Kerri* and a few other valuable species were favoured as usual. One of the main objects of management was to further encourage teak in the young age classes to get a better proportion in the growing stock. To induce the natural reproduction of teak, some controlled burning had been made, but with no appreciable result, apparently due to the various strata which had been formed overhead. This is clear evidence that with or without fire, teak being a light demander, cannot reproduce itself naturally under shade.

Under various silvicultural treatments, the reserve was packed with beautiful stands of teak, *Xylia Kerri* and a few valuable species though reproduction of teak was strikingly absent in the latter stage. Trees were found to be sound, straight and vigorous, as dominant stems attained good heights. Other species of economic value were said to have come up well to make a congenial mixture in the crop, more akin to the natural than the artificial one. Fertility of the soil had increased with marked improvement in production. Financial return had far exceeded the forecast. The reserve was therefore described as a magnificent forest of exceptional value and the actual results of scientific management under selection system and fire protection.

Conclusion

In the light of the increasing opening of the forests through severe forest fires and excessive cutting, it may be wise to consider forest fire protection for those natural forests which have undergone various stages of changes and degradation. It may also be advisable to focus on areas in which, fierce fires, which in the past had been quite exceptional in Mr. Slade's own words, are now occurring more often than not, and where fires of high intensity are beginning to get out of hand and cannot be considered as a forester's friend but his foe.

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