

The importance of hardwood plantations in the tropics and sub-tropics

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SUMMARY

The importance of tropical and sub-tropical hardwoods in industrial wood production in relation to market opportunities are discussed. Forest plantation areas in 1995 are presented based on a comprehensive study made within the framework of UK/FAO Trust Fund Project. Reported gross plantation areas tended to be higher than the actual plantation resources and reduction factors were used to derive net plantation areas. Of the net area of 56.3 million hectares of forest plantations in the tropics and sub-tropics in 1995, 32.3 million hectares were hardwood species and 24.0 million hectares were softwoods. Special attention is given to the most valuable “luxury” hardwoods: teak, mahogany and rosewood. Indicative estimates of teak standing volume (industrial wood) annually available are presented showing Asia dominating production. According to five case studies, in Malaysia, the Melanesian Islands, Central America, Australia and Ghana, governments have a significant role in initiating hardwood plantation development. Recommendations are given for promoting the establishment of hardwood plantations in the tropics and sub-tropics. Demonstration plantations should be established, impediments for foreign investments should be minimised and reviews of legislation and regulations should be made, as necessary. A strategy of plantation development should be part of national forest programmes and plantation opportunities should be promoted. During the coming decades tropical hardwood plantations will produce an increasing volume of valuable timber. In the long term it is likely that the demand for tropical hardwood plantation grown industrial roundwood will exceed supply. There remains good market potential for valuable hardwood plantations, but if this potential is not realized the opportunity will be lost to substitute wood and non-wood products.

Keywords: hardwoods, plantations, *Tectona grandis*, *Swietenia* spp., *Dalbergia* spp.

INTRODUCTION

Under the UK/FAO Trust Fund Project, *Timber Production from Hardwood Plantations in the Tropics and Sub-tropics* funded by the Department for International Development of the United Kingdom (DFID), comprehensive work was undertaken in estimating hardwood plantation areas;

calculating indicative future production of teak (*Tectona grandis*) as a valuable tropical hardwood; and preparing five case studies of hardwood plantation programmes in the Central American, Asia Pacific and African regions.

An analysis of global supply and demand for industrial roundwood showed that although demand is expected to increase by about 25 % between 1994 and 2010, the supply of roundwood and fibre should more or less expand to keep pace or increase only slightly (ABARE Jaakko Pöyry 1999). Supply and demand are not, however, expected to be in balance in all regions and some classes of industrial roundwood, notably logs of high-value hardwood species from natural forests in the tropics, are expected to be in short supply due to constraints on harvesting and a shrinking resource. In some countries supplies of large diameter logs have already run out (FAO 1998b).

In 1995 tropical and sub-tropical plantations comprised 45 % of the global net forest plantation area. Hardwoods covered 32.3 million hectares, 57 % of all plantations in the tropics and sub-tropics and 25 % of the global area (Pandey 1997). It was estimated that in 1991-1995 4 million hectares were planted annually in the tropics (1.64 million hectares) and sub-tropics (2.37 million hectares) of which reforestation of harvested areas was not specifically detailed.

In an attempt to preserve the environmental functions of forests and to conserve stocks, several tropical countries have introduced logging bans, including Bangladesh, Cambodia, China, the Philippines, Thailand and Vietnam. For example, the Malaysia case study carried out for this review noted that in 1997 the country produced 35 million m³ of sawlogs, but planned to reduce this to about 27 million m³ in 2000 and in the long term to about 21 million m³/year, a level that is believed to be sustainable (Krihnapillay 1998).

The main markets for tropical hardwoods are in Europe, Japan and North America. In 1990 the European Union imported 3.2 million m³ and Japan 9.9 million m³ of tropical logs. In 1999 the figures were 2.2 and 3.5 million m³, respectively. Imports of tropical sawnwood show a similar declining trend but imports of secondary processed wood products and tropical plywood were either constant (EU) or increasing in the 1990's (Japan and USA) (FAO 2001c).

Forest plantations of a wide range of species, including the valuable "luxury" hardwoods such as teak (*Tectona grandis*), mahogany (*Swietenia* spp.) and rosewood (*Dalbergia* spp.) have been established to meet anticipated shortages of log supplies from natural forests in the future. In 1995 the estimated global net areas of these three species were 2.25, 0.62 and 0.15 million hectares, respectively (Pandey 1997). However, there is considerable uncertainty about the actual extent of these valuable hardwood plantations, and even more uncertainty about the standing volumes and thus raw material supply, and about future demand.

PLANTATION AREAS, SPECIES AND VOLUMES

The principal components of this work are summarised in FAO Working Paper, *The Global Outlook for Future Wood Supply from Plantations* (FAO 2000), in which data for the tropics and sub-tropics was based on the report, *Tropical Forest Plantation Areas 1995* (Pandey 1997). The report provided country-wise and species-wise data on areas of forest plantations in tropical and sub-tropical countries, as well as an overview and commentary on the 1990 data sets, which were updated to 1995. Different geographic boundaries, definitions and reported data were used between Global Forest Resources Assessments 1990 (FAO 1995) and 2000 (FAO 2001b). A comprehensive comparison of the different data sets between forest resources assessments between 1980-2000 were reported by Del Lungo (2001).

Data collection and analysis

Information on the area of forest plantations in tropical and sub-tropical countries for the year 1995 was obtained by several means. A questionnaire was sent to countries in 1996, to which countries sent complete or partial responses. Desk studies of available information were carried out through the FAO Forestry Department library in 1997 and 1998; Oxford Forestry Institute in 1997; and the World Bank in 1997 (for all developing countries). Personal contacts with country representatives were made by the FAO staff during the World Forestry Congress in October 1997. The data thus collected was analysed in 1997 (Pandey 1997) and was subsequently revised with new information that became available in 1998. Volume estimates for future yields from forest plantations based upon net area data were made by Leech (1998).

There were many discrepancies and uncertainties in developing country forest plantation data which did not always reflect losses due to new planting mortality, fire, pests or diseases and harvesting or report replanted areas following harvesting. In some countries area estimates were made based on seedlings raised and distributed in major nurseries rather than from actual field surveys and forest inventories.

Reported figures tended to be higher than the actual plantation resources on the ground. For this reason the 1990 plantation assessment (FAO 1995) reduced all figures by a “reduction factor” of 0.76 for tropical Africa, 0.66 for Asia-Pacific and 0.85 for tropical America, based on the average actual survival recorded in 56 plantation surveys carried out in 18 countries in the 1980s. This method gave more realistic regional and global estimates of actual plantation areas but underestimated the area figures for those countries that reported areas based on actual surveys, and may have over-estimated the figures for some countries with low, but unknown, survival rates. The same process to derive net areas from gross plantation areas was utilised in Pandey (1997).

Plantation areas

The total **gross** area of plantations in 89 tropical and sub-tropical countries was estimated in 1995 at 70.85 million hectares, of which 42.1 million hectares (59.4 %) were in the tropical and 28.8 million hectares (40.6 %) in sub-tropical countries (Table 1). Of the **net** area of 56.3 million hectares, 32.3 million hectares were hardwood plantations and 24.0 million hectares softwood plantations (Table 1).

The majority of forest plantations net area in tropical and sub-tropical developing countries were in Asia (76.3 %). Plantations in Latin America (14.1 %) and Africa (9.6 %) comprised the remainder. More than 80 % of non-industrial plantations were in Asia (Table 1).

Tropical and sub-tropical plantation areas were dominated by two genera: *Eucalyptus* and *Pinus*. *Eucalyptus* accounted for 31.9 % of the tropical hardwood plantation net area (Table 2). Other important species included *Acacia* spp., *Tectona grandis* and *Gmelina arborea*. Pandey (1997) noted, that there was a broad range (more than 100) of species utilised in plantations. The significance of minor species in tropical plantations was evidenced by the area of species classified as “Other hardwoods”, which totalled 40.8 %.

There were around 6 million hectares of Chinese softwood plantings of *Cunninghamia lanceolata*. This species was not planted on a large scale elsewhere, but the widespread Chinese plantings made it one of the world’s most extensively planted species. *Leucaena* spp. and similar multi-purpose and fodder species comprised a significant proportion of “Other hardwoods”.

Eucalyptus species were planted extensively throughout the tropics and particularly in sub-tropical regions. The countries with the largest *Eucalyptus* plantation resources were India (3.1 million hectares), Brazil (2.7 million hectares), China (670,000 hectares), South Africa (557,000 hectares) and Vietnam (483,000 hectares) and they accounted for 73 percent of the *Eucalyptus* resource (Pandey 1997).

Other species were less widely distributed. Acacias were planted mainly in Africa, Indonesia and the Indian subcontinent. Teak (*Tectona grandis*) was predominantly grown in South-East Asia (India 988,000 ha, Indonesia 695,000ha, Thailand 159,000 ha, Myanmar 139,000 ha, Bangladesh 73,000 ha, Sri Lanka 38,000 ha), parts of Central America and the Caribbean (Costa Rica 14,000 ha, Trinidad and Tobago 8,000 ha) and in Africa (Nigeria 30,000 ha, Cote d'Ivoire 29,000 ha, Sudan 15,000ha, Ghana 10,000 ha, Togo 10,000 ha, Benin 8,000), while Indonesia (91,000 ha) and Fiji (30,000 ha) had the largest introduced mahogany plantations (*Swietenia macrophylla*). About 95 percent of rosewood plantations (*Dalbergia sissoo*) are located in India (494,000 ha) and Pakistan (102,000 ha) while Nepal (21,000 ha) and Bangladesh (5,000 ha) made up an additional four percent. Small plantations of this species were found in tropical Africa, in Nigeria and Burkina Faso (Pandey 1997).

Volumes

Two recent studies projected global volumes from forest plantations. Global roundwood supply from all plantations could increase according to ABARE Jaakko Pöyry (1999) from 624 million m³ (35 % of total global roundwood availability) in 2000, to 969 million m³ (44 %) in 2020 and to 1043 million m³ (46 %) in 2040. The greatest proportional increase would be in Asia, which would double its industrial roundwood production from forest plantations. FAO's scenarios were initially more conservative but later made similar projections: 414 million m³ in 2000, 607-959 million m³ in 2020 and 867-1500 million m³ in 2050 depending on the intensity of the plantation establishment rate (FAO 2000, FAO 2001a).

Different mean annual increments for selected species used in industrial plantations have been presented; for teak 6-18 m³/ha/year (FAO 2001b) or 8-18 m³/ha/year in Central America and Caribbean and 4-6 m³/ha/year in other countries (FAO 2000); for mahogany 7-11 m³/ha/year (FAO 2001b) or 5-7.5 m³/ha/year (FAO 2000); and for rosewood 5-8 m³/ha/year (FAO 2001b) or 3-5 m³/ha/year (FAO 2000).

As an example, the indicative estimates of teak standing volume (industrial wood) annually available were derived from the data collected. The total net area of teak plantations was estimated at 2.25 million hectares in 1995 (Pandey 1997). Three scenarios of teak production were made (Leech, 1998), based on the following growth rates:

- Low, MAI 3m³/ha/yr;
- Medium, MAI 5m³/ha/yr; and
- High, MAI 8m³/ha/yr.

According to the low growth rate scenario the annual available volume increased from 6 million m³ in 2000 to 18 million m³ in 2050. In the high growth rate scenario corresponding figures were 14 and 47 million m³/year (Figure 1). Data indicated that the Asian region provided the most standing volume in each scenario (90 %). The relative contributions of Africa and Latin America varied; in the low growth rate scenario, Africa produced less than Latin America, in the medium

growth rate scenario they were the same, while in the high growth rate scenario Africa produced more than Latin America. These different contributions were caused by varying rotation lengths and varying proportions of new and re-planting rates.

Considering the medium growth rate scenario, it was predicted that most of the standing volume in teak plantations would be in insular Southeast Asia in the year 2000, with Indonesia contributing the bulk of the supply from that region. Other countries with estimated large standing volumes of teak plantation resources, in descending order of magnitude, were India, Thailand and Myanmar, followed by Costa Rica and Côte d'Ivoire outside the Asia-Pacific region. In every region, one country contributed approximately half of regional total – Indonesia in Asia; Côte d'Ivoire in Africa; and Costa Rica in Latin America.

In considering whether the expanded teak plantation programmes would meet future demands, the authors have found no reliable global estimates of future demand for valuable hardwoods as veneer, or sawlogs. Putting the estimates as detailed in Figure 1 in perspective, it has been estimated that sawnwood (including veneer) consumption, in the Asia-Pacific region alone, in the year 2010, will be about 142 million m³/year of product (FAO 1998b). The teak roundwood estimates, from forest plantations (at 60 % conversion factor) would constitute only a very small proportion of total hardwood consumption. The conclusion was that the niche market for quality plantation grown teak should remain strong.

LESSONS LEARNED FROM CASE STUDIES

The preparation of case studies discussing the development of tropical and sub-tropical hardwood plantations in a range of countries was an integral part of the UK/FAO project. Five separate case studies, examining plantation establishment in twelve countries were prepared:

- Tropical forest plantations of Malaysia (Krishnapillay 1998);
- Hardwood programmes in Fiji, Solomon Islands and Papua New Guinea (Hammond 1998);
- Teak (*Tectona grandis*) in Central America (De Camino *et al.* 1998) including Costa Rica, Panama, El Salvador, Guatemala, Nicaragua, and Honduras;
- Long rotation *Eucalyptus* plantations in New South Wales, Australia (Heathcote 1998); and
- Hardwood plantations in Ghana (Odoom 1998).

The case studies examined plantation forest establishment of varying size and by a variety of participants, most notably large-scale government planting, large-scale private sector corporate establishment, and small scale private landowner planting. Considerable diversity was found among the groups of countries selected for case studies. Nonetheless, there was a surprising degree of commonality in the issues governing establishment of plantations. At the same time there were subtle differences in the interactions between various factors and the manner in which challenges were addressed. The issues raised in the case studies can be distilled into nine key lessons. Many of these issues are well known to the forestry community, however, there are some interesting lessons to be learned by comparing the relative experiences from the case study countries. Each of these issues is discussed below.

Governments have a significant direct role to play in establishing an initial critical mass of plantations

A common theme through four of the five case studies was the major role played by governments in initiating plantation forestry in countries. Probably the most significant factor was the risk involved in initiating national plantation programmes. Heathcote (1998) noted that, in Australia, government plantation programs had often pioneered efforts to create new plantation resources where an individual grower would not have taken the initial risk.

Government in Peninsula Malaysia played a similar role. The Forestry Department was responsible for most of the initial planting trials (Krishnapillay 1998). Government recognition of impending declines in natural forest wood supplies led to plantation establishment under the Compensatory Plantation Project supported by the Asian Development Bank. That this programme was less than entirely successful, due to deficiencies in *Acacia mangium*'s suitability for sawmilling, serves to highlight the risks involved in initiating plantation programmes.

In the Melanesian Islands a major part of failures related to limitations in local private sector access to capital and difficulties in attracting international investor interest. Perceived risks relating to issues such as land tenure, economic stability and user rights appeared to outweigh the potential for high rates of return from investing in relatively low cost environments (Hammond 1998).

The exception to direct government-led plantation development is in Central America, where the private sector has played a much more important role in initiating plantation establishment, albeit with the help of significant government incentives (De Camino *et al.* 1998). The initial government incentive in Costa Rica enabled unlimited plantation expenses to be deducted from income tax. The incentive appeared to have been sufficient to encourage private landowners to experiment with teak growing.

Perceptions of political and economic stability are at the core of plantation investment decisions by the international private sector

For many developing countries, large-scale plantation development requires either direct government involvement in planting, or attracting international investment. Major obstacles identified in many developing countries were economic or political instability.

In Fiji investor confidence was negatively affected by political turmoil in the latter part of the 1980s. Political instability brought about uncertainty, which in turn impeded investment. It was noted that economic stability was important in enhancing confidence that investment conditions would not vary markedly over the long life of a plantation investment. Similarly, in the Solomon Islands disincentives to forest plantation development were caused by overall problems in the national economy affecting resource allocation and the investment process (Hammond 1998).

Heathcote (1998) emphasised the point above from a different angle: "Despite the relatively high cost environment, Australia is perceived as one of the most attractive countries for overseas plantation investment. A history of political certainty, stable exchange rates and low inflation are significant attractive features to investors."

Land tenure issues can be a major constraint on investment, and can also reflect “cultural uncertainty”

Land accessibility and security of tenure were the most widely emphasized issues across the case studies. Land security comes from having well-defined and enforceable property rights.

Customary systems of land tenure often failed to display sufficient security of tenure to encourage developed country investment. In part, this reflected the uncertainties in attempting to invest in an unfamiliar, and sometimes incomprehensible, cultural environment. Different perceptions of the nature, validity and enforceability of contractual arrangements were identified as major sources of uncertainty.

Odoom (1998) noted that any potential investor in Ghana would have to deal with the following customary land-related issues: multiplicity of interests and rights to land leading to conflicting claims to ownership, lack of reliable maps indicating land boundaries, cumbersome land disposal and documentation procedures and potential conflict concerning tenurial and management arrangements for plantations within forest reserves.

Hammond (1998) noted similar obstacles in the Melanesian Islands. Customary land ownership was not always clear, legal title to land may not have been defined, formal mapping and boundaries may be non-existent and contractual arrangements may be viewed as renegotiable by landowners.

Issues associated with native claims on customary land were becoming important in Malaysia. Krishapillay (1998) noted that in Sabah, for example, although these lands belonged to the State and were untitled, under the provision of the Land Ordinance an indigenous person could claim customary rights on them as long as he or she had been living on the land for at least three years. Such issues needed to be resolved before investors would consider investing in forest plantations.

In Ghana and in Melanesia, governments had attempted to overcome difficulties posed by customary land ownership, and cultural difficulties in negotiations, by acting as intermediaries between investors and landowners. In Papua New Guinea, partially as a protection against corruption, customary land could only be purchased by the government and then leased to a foreign investor.

In Australia communities were often sensitive to large land purchases for forestry or associated with privatization of plantations – especially by overseas investors. Forest crop ownership and management rights, purchasing the forests but not the land, both facilitated investment and reduced community unease (Heathcote 1998).

Legislative and institutional factors can create significant impediments to investment

Where plantation investment is desired, legislation may need to be adjusted to ensure it enables, rather than constrains, investment. Legislative constraints were often related to specific controls, designed to govern aspects of land-use or forestry, but were irrelevant or inappropriate for plantation development or sale of plantation-grown products. Several broad categories were noted:

- Insufficient differentiation between natural and plantation forest management practices;
- Land-use and planning regulations that specifically favoured agriculture over forestry;
- Subsidy policies that favoured other land-uses over forestry;

- Export levies and bans designed to protect natural forests, which also affected forest plantations;
- Poorly designed plantation incentive policies; and
- Absence of a coherent forest policy.

A common difficulty was that forestry legislation was designed to govern natural forest activities but, in the absence of other specific legislation, its coverage extended to planted trees and forests, and constrained desirable activities. For example, in Ghana, the Timber Resources Management Act 1998 did not explicitly exempt planted timber from the requirement of a Timber Utilization Contract (TUC) for harvesting (Odoo 1998). In Australia, some of these issues have been dealt with in a specific Timber Plantations (Harvest Guarantee) Act 1995, which sought to remove impediments to harvesting plantation timber by replacing environmental and development consents with a compliance code of practice.

In Australia, local planning regulations tended to discriminate against forestry compared to traditional land-uses (though this is contrary to the National Forest Policy Statement). Some of these inequities were exacerbated by subsidies accruing to other land-uses, for example, tariff protection on agricultural products (Heathcote 1998). Occasionally, forestry incentives may have introduced the major distortion. For example, the reforestation incentive in Panama gave tax deductibility to 100 percent of expenses, including land. This started a speculative land price spiral (De Camino *et al.* 1998).

In Papua New Guinea, Solomon Islands and, until recently, in Australia, export duties or export bans were applied to unprocessed logs from both plantations and natural forest. Part of the justification for these was environmental protection in the natural forest, part of the motivation was to encourage development of local processing, however, the direct effect was to lower the returns to forest growers, and hence the attractiveness of plantation investments.

The absence of a coherent forest policy generally left a forestry department with no clear mandate and led to weak administration. In Ghana, prior to the Fourth Republic, the forestry sector lacked an updated and clearly defined forest policy spelling out goals, objectives and strategies for development of forest resources and the future direction of the timber industry. The key issues identified that made good forest management difficult were lack of consistency in financing of forest sector operations, lack of motivation in civil service personnel, and weak legislation and law enforcement (Odoo 1998).

Cashflow problems are a major impediment

The classic problem for forestry plantation investment is the long time horizon between incurring the costs of establishment and receipt of the returns from harvest. Absence of cashflow is a disincentive for any company or individual without recourse to other income. Not surprisingly, several case studies identified lack of cashflow as a major impediment.

In Malaysia, several companies requested that they be allowed to allocate a portion of land leased for plantation establishment to the raising of agricultural cash crops. This was considered a necessary activity to cushion the long waiting period before plantation harvests (Krishnapillay 1998).

In Australia convincing landowners to participate in long rotation (up to 40 years) joint ventures was a major challenge particularly when the returns from the joint venture were not expected until each harvest. This had been easier for landowners with non-farm income to accept

as they were better able to afford to set land aside for at least ten years. In recognition of this, State Forests had introduced another joint venture agreement that made annual payments to landowners as “rent” for the first ten years of the rotation. After this time the stand was thinned and an increase in cattle grazing is possible (Heathcote 1998).

A major identified problem, once plantations were established, was if cashflows (and hence ability to finance management) became squeezed. Optimal silviculture requires that interventions be timely and effectively carried out. Often, however, there was a temptation to defer treatments, thereby affecting the quality of the timber and reducing final returns to the investor. These management issues were noted in all case studies.

Market conditions must be conducive to profitability

A perception that plantations will be profitable is the central motivation for plantation establishment. The case studies identified, however, a number of factors that acted to reduce profitability in countries.

A primary issue was pricing, particularly where stumpage rates in natural forests or from government supplies were kept artificially low. This occurred through a number of mechanisms. These included intentional under-pricing of natural forest wood, long-run concessions or quotas without appropriate price adjustment for inflation, restricting exports and thereby creating an oversupply in local markets, illegal harvesting and trade in timber and inappropriate government market behaviour and “crowding out” of the private sector.

In Ghana, Odoom (1998) described local log prices as being artificially depressed due to the 1995 suspension of the log export trade, and illegal logging, particularly by low cost chainsaw mills. Similar problems occurred in Australia where, until recently, exports of unprocessed logs were effectively banned, while governments set an artificially low rate of return on their forest production, undermining private sector investments (Heathcote 1998). In Malaysia, Papua New Guinea and the Solomon Islands, abundant supplies of cheap wood from extensive natural forests until recently provided little incentive for plantation investment (Krishnapillay 1998, Hammond 1998).

In these instances profitability has been enhanced by the payment of incentives to tree planting. Hammond (1998) argued that there were very few instances in the world where plantations have not been established without recourse to subsidies, incentives, or tax concessions, except where plantations were directly established by the government. The use of incentive payments to encourage the establishment and maintenance of tree plantations, especially by out-growers, was reported in several of the case studies.

Several Central American countries had had incentive schemes in place for several years, but had recently refined the systems, which had led to greatly increased planting rates. In Costa Rica the incentive system was specifically related to the provision of environmental services financed by a selective consumption tax on hydrocarbon fuels. It included exemption from various taxes as well as access to credit and payment of a subsidy in the first five years of the plantation's life. In Panama investment in forestry was fully deductible for income tax purposes, while import duties were waived on equipment and machinery used in plantation activities (De Camino *et al.* 1998).

Ghana had initiated a Forest Plantations Development Fund, which is intended to provide subsidies for the establishment and maintenance of plantations. Malaysia had recently offered “pioneer status” to investors in forest plantations, consisting of full exemption from corporation tax for 10 years, and an investment tax allowance on all income for 5 years. Both Papua New Guinea and the Solomon Islands offered “tax holidays” to plantation investors.

In Australia, many plantation investment schemes had been tax-driven, with the major gains realised on establishment. A subsequent lack of management meant that these neglected stands often yielded low returns and created a bad perception of plantation forestry.

Shifting from large-scale to small-scale operations

The private sector has become more involved in the establishment of forest plantations than ten or twenty years ago, and the direct role of the public sector has diminished. There is a trend towards increasing numbers of small scale farmers acting as “out-growers”, who incorporate trees into farming systems, or as small blocks, and who grow trees to supply large-scale industries. Examples in the case studies were the growing of eucalypts by farmers for pulpwood in Brazil, India or Thailand and of poplars for peeler logs for matches and plywood in India. The same trend was apparent in teak, for example in Thailand, Costa Rica, and Ghana. Labour shortages in rural areas in Peninsular Malaysia made the traditional labour-intensive crops, such as rubber, less economically attractive and led to a dramatic increase in the involvement of small farmers in the growing of teak (Krishnapillay 1998).

Odoom (1998) described the three management models used for private tree crops such as oil palm and rubber in Ghana:

- Smallholder system, where the smallholder did not own the land but is allotted it by a large company, which owns the land and which provides a guaranteed market, a loan, advice and inputs of planting material, fertiliser etc;
- Out-grower scheme, which was similar to the smallholder system, but the farmer owns, leases or share-crops the land; and
- Leaseback system, in which a farmer owned the land but does not farm it, leasing it instead to a private company.

All of these systems were being tested in Ghana for small, private teak plantations.

Local people’s participation – socio-economic issues important

In almost every country, forestry is moving to embrace, and integrate, social dimensions of forestry into the predominant economic-environmental paradigm. The importance of having support of local communities in establishing plantations will often be paramount to their success.

Throughout the tropics, many of the problems registered by plantations were related to social or environmental issues. Social conflicts were mainly due to land claims by local communities, or to the lack of sensitivity to the needs and preferences of surrounding populations. Environmental conflicts were related to poor matching of species to the conditions of soils, or susceptibility to fire pests and diseases.

In Ghana, for instance, efforts to ensure people’s participation by implementing Taungya systems (agro-forestry using block plantations with intercropping) largely failed, due to inadequate management and application of the system. Farmers wanted to utilize land for cropping or grazing as long as possible, while the Forestry Department wanted to ensure trees were established quickly and with little damage (Odoom 1998).

Involving local communities in the making of decisions helped to ensure a reasonably smooth existence for forests established with community liaison groups, such as some of the Fijian forest plantations.

Often it will be necessary to educate local communities on the benefits of tree planting. In Ghana, tree planting was not part of the culture. Consequently, development needed external motivation and technical support, as well as efforts to increase awareness and education. Often these objectives had been supported by giving free seedlings to landowners, and where extension had been properly followed up, this appeared to have worked well (Odoom 1998).

Need for continuous improvement in technical factors of production

One of the conclusions of several recent studies of plantation economics is that competitive advantage in forestry is moving away from countries that either possess or possessed large tracts of natural forests, and towards countries that can grow trees fastest. Thus, continuous improvement in the technical factors of production is likely to be important in maintaining market competitiveness for plantation grown hardwoods. Key factors of production discussed in the case studies included seeds, research, management, infrastructure, and wood properties. The following conclusions were drawn:

Seeds

One of the primary impediments to improving plantation productivity in developing countries was the availability of adequate and/or genetically-improved seeds or seeds of appropriate species. Generally, developing countries tended to favour exotic species in plantations, because these had been well researched and were known to grow quickly.

Research

Often significant research trials had been established in developing countries, but then the trials had been abandoned or lost, the results had been lost or destroyed, or the results have not been carried through to the field. For example, Krishnapillay (1998) described the 1920s as the era in Malaysia where management was generally not carried out after planting. Experience in developed countries suggested that research was crucial to maintaining competitive advantage.

Management

Most developing countries had limited experience with successful commercial forest plantation management. Hence, there were no proven technical and commercial packages and this made the concept difficult to sell to the private sector.

Infrastructure

Significant infrastructural advantages were generally conferred to developed countries, in terms of transportation, clusters of supporting industries and skilled labour. Developing countries were generally reliant on low cost economies to maintain competitiveness.

Wood properties

Converting industries from processing natural forest logs to plantation-grown logs was often a costly and difficult exercise. Generally, plantation logs were grown at shorter rotations than natural forests and logs were likely to be both smaller and have different fibre properties. Sawmills required re-tooling and upgrading before such logs could be processed.

DISCUSSION

Wood and fibre from plantation forests constitutes an increasingly important part of global supplies. FAO (2000) estimated that around 24 % of global industrial roundwood production is presently sourced from plantation forests. ABARE Jaakko Pöyry (1999) gave a higher estimate of 35 %. Given physical and political pressures on future wood supplies from natural forests, it is probable that if demand for wood continues to increase then this will need to be met by increasing production from forest plantations.

Tropical hardwood markets are likely to be negatively affected by restrictions to extraction from natural forests. Most Asian countries have already reduced production of tropical hardwood timber from natural forests. As a consequence, the opportunities for plantation-grown hardwoods, particularly “luxury” hardwood species such as teak, should be highly favourable.

There are several caveats, however, to this generalisation. Information on future demand for tropical luxury hardwoods is imprecise. ITTO estimated the roundwood equivalent of all tropical wood exports to be 55 million cubic metres in 1999, around 4 percent of global industrial roundwood production and 24 % of total timber exports (Adams and Castaño 2000). Tropical roundwood has lost markets especially in Japan but also in Europe where temperate softwoods are taking a larger market share. For example, tropical plywood has been substituted by other materials like MDF and OSB. On the other hand, the trade of secondary processed wood products of which wooden furniture comprise over half, has expanded, especially from Malaysia and Indonesia.

In Asia consumption of tropical timber products has been strongly linked to the economic situation. In Japan a steep decline occurred in the 1990's (FAO 2001c) but in China imports of tropical timber doubled from 1993 to 1999 (Adams and Castaño 2000). In USA imports of especially secondary processed wood products from the tropics have grown because of the good economic situation in the 1990's though markets in USA are smaller than in Japan or Europe. In European markets clear decline in primary product imports has occurred during the last five years (FAO 2001c).

According to FAO's analysis of high-value tropical hardwood future markets, tropical timber prospects are mainly in the maintenance of existing ‘traditional’ markets (joinery, furniture) with the possible regaining of market share lost in recent years (FAO 2001c). It is unlikely that significant ‘new’ markets will open up for tropical timbers, with the possible exception of indoor flooring and outdoor decking material.

The European tropical hardwood industry has over recent years suffered a decrease in market share. There are several reasons for this including a negative public perception of tropical timber products, change in fashion from dark to lighter coloured species, increased competition from other wood and non-wood substitute materials, reduced margins within the timber industry “squeezing” tropical timber profitability, and policy changes by exporting countries shifting export emphasis from primary products to secondary processed products (FAO 2001c).

On the other hand, the public overall perception of timber is changing and wood is generally seen by many to be a “green” material. Some evidence suggests that there is a reversal in the trend for lighter coloured species, with darker woods gaining popularity. Mounting concern over the environmental credentials of substitute materials, particularly plastics, can mean potential for increasing use of hardwoods (FAO 2001c).

Information on substitute products and their relative competitiveness and market acceptability is not readily available or well-understood in the marketplace. Particularly weak is aggregated information on consumer preferences, information (in the forestry industry) on non-wood substitutes, and understanding of the likely impacts of engineered wood products in specific market segments.

Forest growers need to be clear about the objectives and expected future markets for their produce. This should dictate choice of species, silvicultural treatments and management. A common mistake in plantation establishment is to plant species that grow quickly, but without any clear idea about the end-purpose of production. For example, Malaysia’s plantations of *Acacia mangium* under the Compensatory Plantation Programme were planned to produce “general utility timber”, and were funded by loans from the Asian Development Bank. The species proved unsuitable for sawing and, consequently, returns have been well below initial expectation (Krishnapillay 1998).

All this begs two questions: what are the appropriate responses by countries? and, what are the common features of successful hardwood plantation programmes? In general there appear to have been three distinct phases in national plantation establishment programmes.

In the *initial phase* of establishing a national plantation estate, a strong government effort presence seems almost a prerequisite to success. In many instances government forestry departments have directly initiated planting, carried on research, and installed initial processing capacity. In general, the costs and risks associated with starting a plantation-based industry appear to be unattractive to the private sector.

Given an initial direct impetus by government, a *second phase* appears to be government-assisted development. In this phase, governments move to devolve plantation establishment responsibilities to the private sector, although this phase still generally requires a level of government encouragement and nurturing through incentives.

A *final phase* is reached when a plantation industry is self-sustaining. In this phase governments have exited developmental involvement in what should be a mature industry and the private sector will invest without direct incentives.

An important question is whether, and by how much, it is possible to deviate from this model? Several experiences have shown that private sector plantation development may commence without any direct government precursor. For example, in Sabah, Malaysia, the private sector led plantation development, although planting leaned heavily on prior experience in Peninsular Malaysia (Krishnapillay 1998). Similarly, several countries in Central America appear to be successfully initiating teak plantations utilising the successful developments in Costa Rica as a catalyst (De Camino *et al.* 1998).

The type, and extent, of government involvement should be dependent on the structure envisaged for a national plantation growing industry. For example, the government strategy will vary markedly depending on whether it wishes to encourage small-scale out-grower planting, or whether it hopes to attract large-scale foreign investment.

Out-grower schemes can expand future supplies of tropical hardwoods for industry, increase the number and willingness of growers to participate in forestry and provide broad social and economic enrichment for the individuals and communities involved (Desmond and Race 2000).

The successful adoption of out-grower schemes assumes, however, that several prerequisites are fulfilled. Arrangement must be appropriate to local conditions and partners should have a reasonable likelihood of deriving benefits and possibility to the strengthening of the socio-cultural and economic development of local communities. Contributions offered (e.g. land tenure, business viability) and partnerships must be secure, production and market risks accurately calculated and shared, all partners involved should have the social and technical expertise to negotiate arrangements and they should be informed of realistic prospects and opportunities. Forestry practices must be consistent with sustainable forest management principles at local and regional levels, and they must contribute to wider community well-being (Desmond and Race 2000).

Economic, legislative and institutional issues will vary on a case-by-case basis. The key message is that governments need to create a “climate of enterprise”. This requires countries to provide a stable economic and political climate thus encouraging investment (note that this is generally beyond the control of the forestry sector); and it involves the removal of unnecessary institutional or regulatory obstacles to investment. Issues relating to security of use (i.e. that the forest grower will be able to harvest and sell wood derived from the plantation) are of particular importance.

For community-based plantation projects it is important that a cross-sectoral approach be taken, recognising that long-term forestry projects need to be integrated with means of generating short-run cashflows. The Ghanaian experience with Taungya planting illustrates a situation where afforestation objectives were allowed to override the real needs of local communities (Odoom 1998). Close community consultation, and a broad view of land-use issues as perceived by the government, is required; it is particularly important to note that forestry is not the “be-all and end-all” of land-use or in meeting people’s livelihood needs.

From a global information perspective, several informational deficiencies should be highlighted. In general, plantation inventory data remains weak in most countries, with considerable uncertainties in basic statistics such as gross or net areas and species data. The greatest lack of information appears to be in terms of translating growth rates based on experimental data to field conditions. In many countries, margins of error for estimates of plantation production remain very high, due to great uncertainty over growth rates. A related, and similarly little documented, issue is the extent of plantation mortality.

RECOMMENDATIONS

The following recommendations for promoting the establishment of hardwood plantations in the tropics and sub-tropics are based on two key principles. Firstly, the evidence collected suggests that governments need to have a central role in initiating forest plantation establishment and ensure a facilitating environment. Secondly, forestry is a long-term business. Commitment to support a national hardwood plantation programme needs to extend over many decades rather than a few years. Strategies for promoting hardwood plantation establishment should, consequently, have a long time-horizon, and accept that development of a successful plantation industry will not be instantaneous, but will be an extended and step-wise process.

- **Establishment of demonstration model plantations**

The over-riding message from the case studies is that the most important promotional tool for plantations is demonstrated success. It is recommended that governments examine opportunities

to establish small areas of plantation forests with a view to using these to promote plantation establishment. The demonstration plantations should be modelled on type of plantation scheme the government intends to promote.

The demonstration plantations should focus on quality rather than quantity. They should be based on solid research and marketing studies, and be founded on well-documented research trials. They should retain an experimental/research focus. Financial and business considerations must be well documented; a demonstration forest must be founded on sound business principles.

- **Facilitating foreign investment**

Government forest departments should extensively review potential impediments to attracting foreign investment, with a focus on possible “cultural barriers”. Strategies to minimise obstacles should be developed; forest departments or government investment agencies may have a direct facilitating role in this.

- **Regulatory review**

Government departments need to carry out periodic, detailed reviews of legislation and regulations to identify impediments and constraints to plantation establishment including sub-national and local body regulation, and customary laws or practices.

- **Forestry planning, infrastructural reviews and sector strategy development**

Strategies for the development of forest plantations should be part of an overall and integrated strategy for the forest industry development. Countries should be encouraged to prepare national forest programmes (NFPs) encompassing objectives and strategies for the development of the forestry sector as a whole. Preparation of an infrastructural review should be part of this development process and should endeavour to identify impediments to plantation development. These may include factors such as shortage of appropriate land or water, absence of adequate transport systems, distance to markets, lack of skilled labour, lack of adequate nursery facilities, lack of quality seed, absence of processing facilities, etc.

- **Direct promotion of plantation opportunities**

An important impediment to attracting foreign direct investment is a general lack of awareness of the opportunities available in many countries. Such information is often not provided and there is thus no vehicle to spark plantation investment interest in the country. Forest departments and national investment agencies should seek opportunities to directly promote forest plantation investment for foreign investors. If this is done in conjunction with the development of demonstration forests, the opportunity to promote tangible success is increased greatly.

- **Establishment of “turn-key” plantation forests**

In some countries the private sector has failed to follow a strong government lead in plantation establishment. In these instances it may be appropriate for the government to continue the establishment of large-scale plantations with a view to selling these to the private sector, as the plantations approach maturity (a “turn-key” operation). Governments may wish, at least, to examine such an option.

- **Improved forest plantation resources assessment and outlook studies for future markets**

Despite improved technology there is insufficient reliable and consistent information on purpose, ownership, species composition, age classes, annual planting rates, growth rates, rotation lengths, harvest yields and forest products outturn from forest plantations.

The lack of reliable data is a serious constraint in policy formulation and planning, and in the implementation, monitoring and reporting on forest plantations. Until the forest plantation database is improved, analysis on future global and regional scenarios may not provide realistic assessments of forest plantation potential.

In the coming decades, tropical hardwood plantations will produce an increasing volume of valuable raw material. Because the constraints prevailing in natural forest harvests are likely to increase, tropical forest plantations offer an excellent alternative to compensate and increase available resources to meet the needs of world markets. In the long term it is likely that the demand for tropical hardwood plantation grown industrial roundwood will exceed supply. Thus there is a good market potential for valuable hardwood plantations, but this potential must be realized by Governments creating the sound enabling environment and by expanding investor confidence and commitment to grow more quality hardwood. Failing this, the opportunity will be lost to substitute wood and non-wood products.

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TABLE 1 *Forest plantation areas in tropical and sub-tropical countries in 1995 and annual planting rates (1991-1995) ('000 ha)*

Region	Gross areas			Net areas			Annual planting rate
	Industrial plantations	Non-ind. plantations	Total plantations	Hardwood plantations	Softwood plantations	Total plantations	
Africa							
Tropical (37)	1,315	2,070	3,385	1,843	591	2,434	115
Sub-tropical (6)	2,482	945	3,427	1,312	2,114	3,427	173
Sub-total (43)	3,797	3,015	6,812	3,155	2,706	5,861	288
Latin America							
Tropical (25)	5,373	1,666	7,038	3,864	2,112	5,976	221
Sub-tropical (3)	2,458	467	2,925	1,051	1,874	2,925	170
Sub-total (28)	7,831	2,133	9,963	4,915	3,986	8,901	391
Asia and Pacific							
Tropical (16)	14,269	17,361	31,630	17,338	1,777	19,115	1,308
Sub-tropical (2)	18,586	3,855	22,441	6,892	15,548	22,440	2,025
Sub-total (18)	32,855	21,216	54,071	24,231	17,325	41,555	3,333
Total Tropical (78)	20,957	21,097	42,054	23,045	4,480	27,525	1,644
Total Su-btropical (11)	23,526	5,267	28,793	9,255	19,537	28,792	2,368
Grand Total (89)	44,483	26,363	70,846	32,301	24,016	56,317	4,012

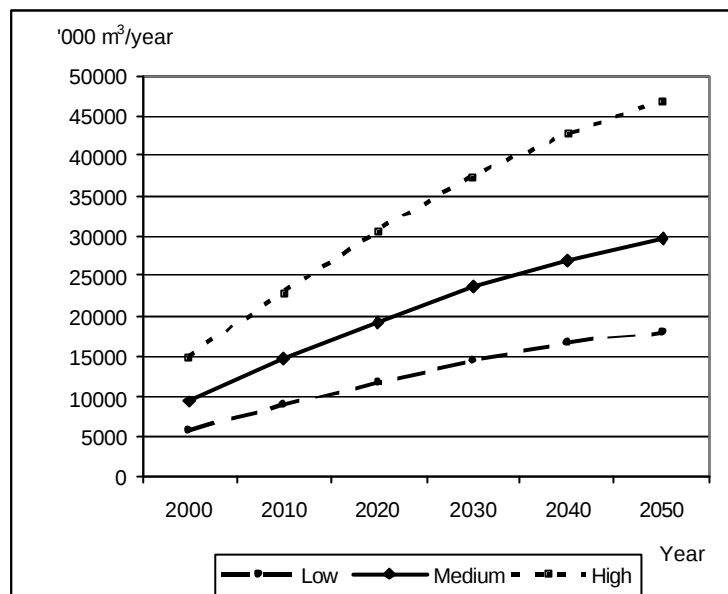
Source: Pandey (1997)

TABLE 2 *Net areas of tropical and sub-tropical plantations by species in 1995 ('000 ha)*

Species	Percentage of tropical and sub-tropical hardwood plantations	Area
<i>Acacia auriculiformis</i>	2.5	818
<i>Acacia mangium</i>	1.4	453
<i>Acacia mearnsii</i>	1.0	326
Other acacias	7.3	2,367
<i>Casuarina</i> species	3.4	1,103
<i>Dalbergia sissoo</i>	1.9	626
<i>Eucalyptus</i> species	31.9	10,305
<i>Gmelina arborea</i>	1.3	425
<i>Swietenia macrophylla</i>	0.5	151
<i>Terminalia</i> species	0.9	304
<i>Tectona grandis</i>	7.0	2,254
Other hardwoods	40.8	13,170
Total hardwoods	100	32,301
Softwoods		24,016
TOTAL		56,317

Source: Pandey (1997), extrapolated for FRA 2000 (FAO 2001b)

FIGURE 1 *Indicative estimates of teak standing volume (industrial wood) annually available ('000m³/yr) by scenarios.*



Source: Leech 1998