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TECHNOLOGY SCENARIOS IN THE ASIA-PACIFIC FORESTRY SECTOR

Study contributed by

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EXECUTIVE SUMMARY

According to recent assessments, the Asia-Pacific Region requires more wood than it can sustainably produce; this situation will become more marked in future. This raises the question of how the sector in the Region will react. The impending food shortage during the 1960s resulted in impressive developments in agriculture with the advances of the Green Revolution. Will we see similar advances and technological change in forestry?

Significant changes have been made during the recent past. Rubberwood, formerly viewed as a waste product, is today a valuable raw material. The wood processing industry has developed reconstituted wood panels, thus reducing its dependence on large diameter timber. The private sector has assumed an increasing role in plantation management and farmers have entered into agreements with the processing industry for supplying wood.

This review provides an overview of the current forestry and wood processing practices to assess what forestry in the Region might look like in the year 2010. It reviews technologies and practices that are presently available and the constraints that have obstructed a faster adoption and adaptation of available knowledge and research results. Following the review of technological changes in individual forestry sectors it provides an outlook of potential developments.

Besides the widening supply and demand gap, forestry has also been affected by environmental concerns and the discussion about certification schemes have raised the awareness of the need for sustainable forestry management. Globalization of production and trade have enabled a free flow of capital investments affecting forest resources and industries in other parts of the world. Particularly the ASEAN and Northeast Asian economies have experienced unprecedented growth and industrialisation with impacts on the rural landscape and labour availability. Market liberalisation in the former centrally planned economies has stimulated the interest of private sector in growing trees.

The present study is divided into five parts covering the sub-sectors of natural forest management, plantation management, agroforestry, non-timber forest product (NTFP) use and management and wood processing.

NTFPs and agroforestry have been the least affected by technological changes. Economic growth has created non-land based employment opportunities which has led to labour shortages in the agricultural sector. Farmers are looking for means to increase production in the short-term. The development of agroforestry technologies has not responded to this need. Diverse agroforestry systems will remain in existence in many countries but where farmers intend to produce wood in respond to increasing demand, they will switch to more simple systems.

With few exceptions, NTFPs have suffered from a lack of incentives for resource management and downstream processing. Conflicts over resource ownership have fuelled over-exploitation and increased the risk of investing in any processing industry based on naturally occurring products. To establish a viable industry means investments in plantations, which explains the current expansion of rattan plantations in Malaysia. For most people, NTFP collection and processing are not remunerative. Furthermore, people view NTFP collection as a backward

activity and many products themselves as primitive or old-fashioned, and replace them with more “western” products. Investments in new technologies are therefore unattractive.

Natural forest management has been affected by over-exploitation of accessible lowland forests, considerable logging damage and, more recently, mounting environmental pressures to improve operational standards. Natural forest management is currently limited to timber harvesting operations with only little attention paid to enrichment planting and liberation thinning.

The expansion of harvesting activities to more mountainous environments has led to the introduction of skyline cable systems and helicopter logging. However, both systems have been introduced only recently. Their impact will be limited in the near to medium-term future. Research into reduced-impact logging has been stimulated by the move towards sustainable forest management, timber certification and the reduction of carbon emissions. The impacts of reduced-impact logging and its cost-effectiveness are still under investigation. Rapid adoption will not be possible because of substantial training requirements.

In general, those stakeholders responsible for forest management, generally concessionaires, have not opted yet for specialised forest management. Logging has hardly changed over the last thirty years. Some companies will upgrade their equipment and practices. In response to timber certification, reduced-impact harvesting will improve the logging practices. The rate of adoption will depend on pressures by governments and opportunities for acquiring concessions overseas.

With the involvement of the private sector in plantation management the objective of reforestation has shifted from protecting the environment towards producing wood for downstream industries. The integration of wood fibre production with processing facilities has stimulated the use of improved planting stock and higher expenditures for fire protection and research.

The plantation sector in the Region will assume increasing importance with rising raw material demands. A review of past experiences shows some success, particularly in simple plantation forestry but numerous examples also demonstrate a significant extent of poor results. Notwithstanding earlier problems, the interest in plantation establishment by the private sector will grow, fuelled by the need to feed the growing capacities of pulp and paper mills as well as supported by government incentives. Land use conflicts between private companies and the rural population will decrease. Farmers will increasingly get involved in growing trees in most countries of the Region.

In contrast to natural forest management, the plantation sector will continue its transformation from less to more intensive management. In the medium-term future most interest will focus on monocultures of species for which high quality planting stock is available. This trend will continue as long as there are no major setbacks (e.g., pest and disease infestations). Labour shortages will affect the degree of mechanisation operations. Tree felling and bunching will be performed by light feller bunchers and log extraction by light rubber-tired skidders and forwarders in large-scale plantations. Improvements in the road network will allow for the use of mobile chippers.

Collaboration between wood producers and processors will draw farmers into small-scale plantation management but will affect the development of complex plantations only to a limited extent. Maintaining naturally regenerating hardwoods in plantations would be a first step towards more complexity. This will also determine the use of dipterocarps for enriching logged-over forests, which may also be coupled with the intensive management of NTFPs such as rattan.

The wood processing industry is undergoing a structural change with a gradual shift from using large to smaller diameter trees. The most dramatic developments in the wood processing industry have been in the reconstituted wood-panel industry, particularly in medium density fibreboard (MDF) production. Special grades and properties, including moisture resistance, fire retardance and exterior grades will fuel growth rates in the future. The expected growth in ready-to-assemble furniture will increase the awareness of the special characteristics and advantages of wood-based panels.

The decreasing supply of large diameter logs will also affect the plywood industry, which over the years developed technologies for peeling high density hardwoods smaller diameter logs. Depending on the success of marketing strategies for alternative boards, it can be assumed that the tropical plywood sector will shrink faster than expected, at least in relative terms.

Vertical and horizontal integration of productive units will provide opportunities for increasing efficiency of wood use. Currently there are no incentive structures for reducing wood waste during harvesting operations in natural forests, or for transporting the waste to processing mills. The most logical way to overcome high extraction and transportation cost of wood waste is to pre-process timber at the logging site and the use of mobile chippers is predicted to increase. Non-wood fibres will play some role in production processes. However because of their drawbacks they will not replace wood as the most significant raw material in most countries.

INTRODUCTION

The Asia-Pacific Region is experiencing significant social and economic changes which affect forestry in various ways. The Region's forest resources are of crucial importance to the global forestry sector. They provide raw material for globally, and perhaps more important, regionally increasing wood consumption. Forestry provides employment for millions of people and the natural forests harbour resources which more than 100 million people depend on for their daily subsistence and income generation. At the same time, the Region's forests are recognized as a critical component of the planet's natural heritage and environment.

The Region is extremely diverse: the countries' populations are confronted by an endless number of issues - reaching from forest conversion, urbanization, pollution, economic growth, industrialization, increased market orientation, impact of global trade, etc. - and have very different capacities to respond to such issues. As far as Southeast Asia is concerned, until very recently the general conception has been one of abundant resources, sparse populations, and the necessity of "taming" the wilderness, by opening up the frontier to development. High population growth rates were viewed as essential for national development. Supporting population increase belongs to the past, yet it still has a marked impact on forest conversion and wood consumption.

The changes that affect the future perspective of forest resources and forestry have not only been brought about from within the Region. For example, World Bank lending in the forestry sector has shifted from lending for industrial forestry to greater emphasis on social forestry and environmental issues (Cassells and Rietbergen, 1995). Global attitudes about forests, forestry and forest products have changed in unprecedented ways (Whaley, 1995). Environmental issues such as biodiversity erosion and anticipated global warming have stimulated the discussion on sustainable forest management not only in the Region but world-wide.

To date there has been no apparent diminution of the overall global wood supply and consumption of wood has continued to increase over the last several decades. In the absence of interventions to increase forest productivity or to promote end-use efficiency, wood consumption has already exceeded the sustainable supply capacity of the Region's forests. This may even be more so the case because available consumption figures give no indication of the damage caused to standing trees by current harvesting activities. Concerns over the widening supply and demand gap have been raised before but recently there is a more general agreement that the forestry sector will be significantly affected by the shortage of raw materials. This raises the question of how the sector in the Region will react, and what the role of advances and technological changes are in shaping forestry during the first decade of the next century.

Significant changes have already been made during the recent past. Rubberwood, formerly viewed as a waste product, is today a valuable raw material fuelling a multi-million dollar industry. Technological advances have been made by manufacturers of boards and reconstituted wood panels to accommodate smaller-sized timber. The private sector has assumed an increasing role in plantation management and the use of higher quality planting stock is becoming more widespread. In addition, the forestry sector has been strongly influenced by patterns of globalization of fibre production, consumption and trade. Today, other

forestry sectors are influenced by the same developments. The recent strengthening of trade between Asian and Latin American economies will improve the access of the Region's multi-national corporations to raw material supplies overseas as conservation measures and more stringent forest policies are imposed in their own countries.

The evidence of rapid economic growth of the ASEAN countries suggests that industrialization in countries such as Malaysia, Thailand and Indonesia is leading to substantial changes in rural areas. Labour shortages have led to formerly agricultural land being left idle. While this has not led to a general reversal of forest conversion trends (in fact, some countries are still planning to convert forests to other land uses) it opens opportunities for reforestation and investments in forest plantations which, in general, require lower labour inputs than agriculture. Furthermore, as economic growth proceeds, society's perception of the benefits of retaining forests rises, while the perceived benefits of clearing the forests diminish (Byron and Ruiz Pérez, 1996).

Purpose of the Study

The contemporary developments raise many issues concerning forests and forestry. Questions have been asked whether we are running out of wood and which technological changes are needed in the forestry sector to bring about productivity increases and improvement in end-use efficiency. As Sayer and Byron (1996) rightly remark, technological change neither occurs randomly nor haphazardly. Instead it is usually a rational response to real or perceived constraints and opportunities. However, only very little is known about how forest managers, industries and farmers have reacted and even less about how they might react in the next decade.

This review is designed to provide an overview of the current forestry and wood processing practices to assess what forestry in the Region might look like in the year 2010. It provides an account of technologies and practices currently available, their extent of application, where possible, and the constraints that have obstructed a faster adoption and adaptation of available knowledge and research results. Following the review of technological changes in individual forestry sectors it will provide an outlook of potential developments.

There are two main reasons for assessing technological changes in the forestry sector. First, no up-to-date assessment exists. Second, the information that is available usually addresses only individual sub-sectors without providing a more comprehensive outlook. Since individual sub-sectors influence each other there is a need for a more comprehensive approach. The review and assessment outlined in the report do not provide definite answers to all the questions that policy makers, industries and managers may have. In fact, some speculation may be viewed as contested or controversial. The report therefore serves a third purpose, i.e. to stimulate the discussion on which way forestry is heading and what to do about correcting its direction, if any correction is deemed necessary.

A brief glance at the issue of technological change reveals that the number of aspects that might be a addressed are infinite. Products to consider range from timber to non-timber forest products including the potential of forests to provide eco-tourism benefits. Wood is produced in agroforestry systems by farmers, harvested by major corporations in the natural forest and derived from the growing plantation sector. Wood processing spans the areas of solid wood

products to reconstituted wood panels and pulp and paper. The recognition of the multiple local to global benefits of forests accounts for the diversity of reforestation objectives ranging from watershed conservation, to job creation, subsistence support and fuelling growing industrial demands.

Structure of the Report

The present study is divided into five parts covering the sub-sectors of natural forest management, plantation management, agroforestry, use and management of NTFPs and wood processing. For each of the sub-sectors technological changes and their impacts on productivity and use efficiency are reviewed. The accessibility of information has shaped the report in that some aspects receive more attention not because they are viewed as more important but because the availability of information allowed for a more in-depth analysis. Furthermore, there is a country bias in that information from some countries (such as Malaysia and Indonesia) was more easily available than from others. Keeping these limitations in mind the review attempts to answer the following questions.

Natural Forest Management

How will natural forest management be affected by the introduction of timber certification and the growing pressures to raise timber harvesting standards? To what extent will better forest management be achieved? Which technologies exist to reduce the impacts of logging practices and what is their rate of adoption? Which factors explain adoption rates? How will silvicultural treatments and logging intensities develop? To what extent will natural forests fulfil the demand of the processing industries and will the geographical distribution of wood production shift? Will eco-tourism provide an impetus for sustainable forest management?

Plantation Management

How will the shift from public to private ownership in plantations affect their management? Will plantations become more complex or will their management rely on intensively managed monocultures? What will be the impacts of tree breeding, biotechnology, pest and disease management and silvicultural treatments on productivity? How will harvesting operations change? What will be the main objectives of plantations, which industries will they supply? What is the role of small-scale investors and farmers in plantation establishment?

Agroforestry

Have new technologies changed agroforestry systems over time? Which systems have been widely adopted by farmers, which have been the most successful innovations and which factors have determined adoption? Will agroforestry systems become more complex? What is the farmer's main objective in adopting agroforestry? What will be the impacts of rural transformation on agroforestry technologies and aerial extent of agroforestry? How much will agroforestry systems differ from simple small-scale plantations or is there, in fact, a need to differentiate between those two systems?

Non-Timber Forest Products Use and Management

How has the demand for NTFPs and technological changes affected their management and availability? How will their commercial role change and what will be their role in supporting the subsistence economy of the rural population? Will the natural forest remain the main source of NTFPs or will domestication replace naturally occurring raw materials?

Wood Processing

Has wood processing changed during the last decades? In which way? How has the reduced availability of large diameter trees affected the industry? Has the raw material supply diversified? What has been the development regarding recovery rates and the use of logging waste? Are wood products substituted by alternative products such as steel and cement? What has triggered technological changes in the industries?

While the five topics are treated as separate entities, they are very interrelated and affect each other just like other sectors of the economies affect forestry. It is particularly obvious that the recent expansion of forest plantations and the developments in the wood processing sector are a response to real and perceived supply constraints from the natural forest. The supply of NTFPs depends very much on timber harvesting and agroforestry systems. Also, as will become apparent, there are no widely accepted definitions that allow for drawing a clear boundary between agroforestry and plantations. In fact, some agroforestry systems are so rich in species composition that they resemble a natural forest.

The final section of the review gives an account of the reasons for technological change in forestry in the Asia-Pacific Region. Providing an outlook for each of the five sub-sectors it discusses the factors that will most likely influence further technology changes. Before summarizing the main findings it also provides an overview of the limitations that have not allowed for a more in-depth analysis of certain issues as well as a comparisons between countries. The review should therefore be viewed as preliminary with updates to be made once additional information is available.

Limitations of the Study

Looking into the future for technology partly involves assessing the past and the present. However, as other authors have observed, existing data as well as forecasts, for several aspects, are rather sketchy and in many cases not available at all (Nilsson, 1996). In addition, perceptions and information are, at times, conflicting and frequently represent authors' disciplinary biases. This makes a quantitative assessments and predictions difficult and quite unreliable.

The issues to be considered are numerous, ranging from the aspirations of rural people, to policy changes in the forestry sector as well as other sectors of the regional and global economies. Price changes and adjustments of various raw materials have profound effects on the forestry sector.

Any outlook study must also consider the heterogeneity of the Region's countries. The Asia-Pacific Region comprises some countries endowed with substantial forest resources. Papua New Guinea's, Brunei's and Cambodia's forest cover is above 70 percent, while that of Bangladesh, Pakistan and Singapore is below 10 percent. On a per capita basis forests reach from less than 0.1 ha to about 9 ha. Deforestation rates differ substantially just as the importance of forestry in the overall economy of individual countries. The countries of Northeast Asia are highly developed (as are Australia and New Zealand) while some of the South and Southeast Asian economies belong to the group of least developed countries. Economic as well as population growth rates are equally diverse.

In a sense this diversity prohibits the provision of a consistent picture of past and future developments. In fact, no two countries are alike, of which plantation developments in Australia and New Zealand are appropriate examples. Malaysia's and Thailand's economies have both experienced unprecedented economic growth over the last ten years. Wood products import and export as well as fuelwood use, however, differ considerably.

The diversity is compounded by the unreliability or unavailability of information in the forestry sector. Many new technologies have been described or are currently being tested. The use of skyline systems or clonal planting stock may serve as examples. However, the extent of their application is not know. With few exceptions even less is known about their impacts, including the impact of research on productivity and efficiency. This is not to say that it was possible to canvas all the existing information during the course of this study. More relevant documentation exists than what has been reviewed, but at the time it was not available.

Some readers may find that certain technologies did not receive any attention. Post-harvesting technologies and changes in transport operations have not been mentioned. Regarding the latter, it can be assumed that the expansion of road networks and the need to continuously feed manufactures with raw material will shift transport from water and rail to trucks. Advances in remote sensing, geographic information systems (GIS), and global positioning systems (GPS) technologies have also not been considered, even though progress has been impressive over the last decade. However, the scarcity of data and poor training support will render them inappropriate in the near to medium-term future for the purpose of improving forest management, as long as they cannot provide useful information on tree heights and species (Le Van Diem, 1995). However, they are likely to play an increasing role in national

forest surveys, monitoring (such as logging progress) and map updating, and land use planning, and the case of GIS, management of geographically referenced data obtained through traditional on the ground survey methods. The cloud penetrating abilities of radar will also provide data for areas that have never been satisfactorily mapped and improve natural resource inventories.

The review also suffers from more in-depth comparisons among countries. This is mainly due to the skewed availability of information. For example, concerning reduced-impact logging in natural forests most information comes from the Sabah. There are few similar efforts towards improving timber harvesting in other countries, but they have just not received the same publicity. The review of other sub-sectors suffers from the same problems, and it is hoped that an updated version of this document can be more comprehensive and fill gaps.

NATURAL FOREST MANAGEMENT

The last ten years have witnessed an unprecedented concern over the fate of the world's forests. The recognition that forests provide more than just timber has particularly affected the discussion on natural forest management. While the environmental services provided by forests have shaped forest policies and management, and with it the use of the forest resources, in the densely populated countries of Europe for centuries, forest management in the less populated regions of the northern hemisphere and the tropics has developed more slowly. Today there is a general agreement that a transition from timber exploitation to sustainable multiple use forest management is crucial. The following discussion draws on examples from the Asia-Pacific Region, at the same time recognizing that some problems encountered and some of the changes that have taken place are similar in other regions. Furthermore, it should be emphasized that while changes in forest management will take place they will not be sufficient to guarantee a reversal of current deforestation trends. Though logging has been identified as one cause of deforestation it should be emphasized that the major cause is planned and spontaneous conversion to other uses, particularly agriculture. On the other hand, degraded forests criss-crossed by logging roads are frequently entry point for migrants in search on agricultural land.

The world's attention has only recently been drawn to deforestation of tropical forests because of the heightened awareness of its global externalities. This development and the reactions of governments, non-governmental organizations (NGOs), forest managers and the general public, do not mean that up to about ten years ago nothing has happened. Quite on the contrary, international aid as well as national projects and programmes for protecting tropical forests have steadily increased over recent decades. The Food and Agriculture Organization of the United Nations (FAO), the European Union (EU), the International Tropical Timber Organization (ITTO), the International Union for the Conservation of Nature (IUCN), the Asian Development Bank (ADB) and the World Bank have all assisted governments of tropical countries to introduce necessary changes. However, the billions of dollars spent on forestry activities still do not enable us to answer some of the most basic questions concerning global forest resources and their functions (Nilsson, 1996). This is echoed by Bach and Gram (1996, p. 168) who note "there are still no visible signs of significant positive effects in tropical forestry". The main reason for the failure to reduce deforestation and forest degradation is the narrow traditional forestry sector focus. It has in the past neglected other

economic sectors that affect forests. In general terms, this criticism is justified but ignores that developments have varied among countries and that some changes occurred.

The international discussion on natural forest management has received its most recent impetus by the 1992 United Nations Conference on Environment and Development (UNCED) which emphasized the need for sustainable management guidelines, criteria and indicators for temperate, boreal and tropical forests alike. A review on timber certification is used in the following discussion as an entry point for assessing the current state of the art in tropical forest management and the changes that can be expected.

Over-Exploitation of Natural Forests?

Over the last couple of decades a numerous official reports have been produced in which the management of the Region's forests is described as sustainable. It is ironic, that at the same time the forestry sector has undergone many changes and adjustments. For example, the export of unprocessed logs has been banned in Indonesia, the Philippines and India. In the Philippines, logging has been banned in old-growth forests and shifted to residual forests. The most dramatic developments could be observed in Thailand with the declaration of a "logging ban" in 1989. The ban, together with the growing economy and raw material needs for the furniture and secondary processing industries make today Thailand the top importer of tropical sawnwood. Similarly, the Philippines, once a major exporter, imported tropical sawnwood with a value of USD 100 million in 1993 (Johnson, 1996). The general growth in consumption explains the increases in imports partially. Deforestation and unsustainable timber harvesting are the other two reasons for increasing timber imports in countries such as Thailand and the Philippines. In Peninsular Malaysia and Indonesia, the move to develop and support domestic wood processing has led to export restrictions, first for logs but later also for sawnwood.

While the shift from net export to net import indicates that timber production has not been as sustainable as claimed, other trends in the forestry sector cannot be used for interpretative purposes in the same way. For example, the increase in domestic processing does not correlate with shrinking supplies but with the desire to produce higher value products for export. Rather it is the conventional cutting practices and damage to advanced regeneration typical of most logging activities in the Region, that explain the much slower than expected regrowth. In other words, damage to residual trees, seedlings, soils and streams is often so extensive (see below) that it "hampers the attainment of the silvicultural objectives associated with harvesting operations" (Dykstra and Heinrich, 1996, p 11).

The international debate on the environmental and social impacts of logging operations led some environmental pressures groups (esp. in Europe and North America) to demand a ban on the import and use of tropical timber. Timber producing countries contended that this proposed measure was a trade restriction, but that did not stop some municipalities in European countries (e.g., Germany and the Netherlands) from banning the use of tropical timber. Economists were fast in pointing out that if timber production would cease, tropical forest would be viewed by many governments as a resource of only little value, available for conversion to more productive uses. As a result, today many governments, trade groups and NGOs look for alternatives to tropical timber boycotts. The option that has received substantial attention is forest or timber certification (Upton and Bass, 1995).

Forest Certification

The debate of what actually constitutes certification is ongoing and in some countries considerable confusion still surrounds the issue (Wadsworth and Boateng, 1995). Generally, certification involves the assessment of forest management practices and systems against performance indicators of ecological, social and economic standards. While there are numerous unresolved issues regarding acceptable standards for ecological and economic aspects, the incorporation of social criteria and indicators has received strong criticism by forest certifiers "as being the least well developed, the most difficult to assess in the field and the most ambiguous to interpret" (Wollenberg and Colfer, 1996, p. 9). The lack of generally accepted international principles and criteria to assess forest management, the lack of a widely accepted accreditation process for forest certifiers, and the emergence of many parallel systems, are noted by Baharuddin (1995, p. 23) as additional problems. Certification continues to be, both from its conceptual and operational perspectives, a learning process for many stakeholder groups involved (Upton and Bass, 1995). Despite the remaining problems, the reluctance by many governments to consider certification as a useful tool is waning. For example, the Sarawak Timber Association urged the federal authorities to speed up the formation of the proposed National Timber Certification Centre (Anon, 1997).

The twin objectives of certification are (Upton and Bass, 1995):

- to provide a market incentive for improving forest management; and
- to improve market access and share for the products from sustainably managed forests.

From a technological perspective the first objective is of major interest because it addresses practical issues of forest management and timber harvesting operations. This issue has received only little attention in the literature, whereas the objective of improving market access and share has been dealt with in more detail.

It is perhaps not surprising that of the various stakeholders potentially affected by certification, forest industry, forest product trade and retailers are more in favour of the initiative than others. The views are particularly positive from such organizations close to the "green" consumer, and new entrants into the market who want to create a niche for specialized products (Upton and Bass, 1995). The number of comprehensive studies concerning the implications of certification is rather limited. Thus, it is difficult to assess the market potential for certified forest products. Moreover, it is not only the environmental concerns which is changing consumer behaviour in some countries. As Upton and Bass (1995, p. 41) notes, "the current fashion for lighter coloured furniture has contributed to an increased demand for temperate hardwoods, compared to their generally darker tropical counterparts". Earthy colours and materials from American hardwood are forecast to have a great appeal to the Asian consumers, particularly to the rapidly growing middle class of the ASEAN countries. Rubberwood benefits from this trend too. This has led some observers to question whether the consumer is, in fact, willing to pay a premium for "green" forest products. As Telfer (1996, p. 182) notes, "consumers appear to want sustainably sourced products at competitive prices".

In his critique of timber certification Kiekens (1995) points out that as a percentage of timber production, the global demand for certified timber is negligible. Supply and demand patterns,

Kiekens continues (p. 27), "indicate that trade in certified timber would be likely to have only a marginal role in world timber trade". From a slightly different angle, this perception is echoed by Wadsworth and Boateng (1995) in their "Study on Markets and Market Segments for Certified Timber and Timber Products". They conclude that, for example, according to timber agents, by the year 2000 there will be no market for certified products in Germany. Also, there is only little interest in some major importing countries such as Japan and Korea (Varangis et al., 1995). In the latter, most companies view tropical timber as unreliable in the long-term and redirect their attention towards raw material sources that are less affected by the intense environmental lobby. Similarly, France, Spain, Portugal, Ireland and Italy show little interest in timber certification. China, a major importer with a fast growing market, has not indicated any interest. The same holds for other major importers or consumption areas such as India, Thailand, the Middle East and Latin America. In line with other analysts Bourke (1996) concludes therefore that only a minor share of products traded world-wide will be affected by certification.

Other problems yet unsolved are potential trade distorting effects, the costs of certification and the increased use of substitute materials such as metal frames, PVC or concrete in the US and Europe. In China, wooden structures are replaced on a large-scale by cement structures and metal ware. Perhaps most importantly, developments in the production of reconstituted wood panels reduce the need to rely on larger diameter logs from natural forests or plantations.

As discussed earlier, the objective of certification is to provide a market incentive for improving forest management. This, as Upton and Bass (1995) continued is a "sticky issue". The question is whether such an objective can be reached or whether certification can only reward those forest operations that are already sustainable. This raises the issue of the quality of current natural forest management.

Natural Forest Management Today

As Poore et al. (1989) points out, most of the world's tropical rain forest is managed in an unsustainable way. Reeve (1994, cited in Upton and Bass, 1995, p. 160) claims that at least 99 percent of trade is unsustainable, though a detailed study of specific areas suggests a lower figure. According to Leslie (1994) the proportion of tropical forests under "sustainable" management may be in the order of around 5 percent. In addition, in some countries re-logging, i.e. the premature re-entry into stands that were previously logged, occurs within five to ten years after the first harvest (Gillis, 1988, cited in Ascher, 1993). It is impossible to say how accurate such claims and assessments are because of the lack of reliable information. Most claims are countered by contradictive statements. For example, a 1990 ITTO-report on forest management in Sarawak cites over-cutting of the hill dipterocarp forest as a major impediment to sustainability. Mok (1992, p. 32) calls ITTO's conclusion "illogical, irrational and unfair as it presumes that Sarawak will continue to harvest timber at the present rate without any regard for sustainable forest management or the people's welfare". Whitmore (1994) praises the highly developed system of tropical forest management in Malaysia, while Appanah and Weinland (1993) complain that sustainable forest management has neither been achieved nor given a chance. What these examples highlight is the absence of a common definition of sustainability. Basically, two issues need to be considered. The first is the quality of harvesting operations itself. The second deals with the volume of timber harvested, i.e. the harvesting intensity.

Harvesting Operations and Intensities

One of the hindrances to sustainable forest management practices has been the destructive form of logging. Logging operations in most, though not all, countries in the Region are performed by concessionaires. They are responsible for the silvicultural treatments, whereas forestry departments supervise operations and enforce regulations set out under the various forest policies. However, the reality of logging operations is often a long way from the tight frameworks for forest management (Upton and Bass, 1995). As Arentz (1992, p. 7) notes, "policing harvesting operations is difficult or impossible due to both an inadequate number of trained personnel to enforce harvesting regulations, and of trainers with the necessary expertise and experience to conduct the training courses required". The most common problem is that the majority of the people working in the forest are not aware of the requirements of good forest practice. This explains why "far too many harvesting operations are carried out without the benefit of any kind of formal, written plan" (Dykstra and Heinrich, 1996, p. 11).

For a number of reasons, many timber harvesting operators do not treat natural forests as a renewable resource. Johnson and Cabarle (1993) summarized fourteen studies on damage to residual trees following selective harvesting in Malaysia, Indonesia and the Philippines. Conducted over more than twenty years, the studies shows that not very much changed during the relevant time span and that between 40 to 60 percent of the residual stand was damaged. In a recent study in Sabah, damage recorded in conventional logging areas was approximately 66 percent (Pinard and Putz, 1996). Therefore, operations have not changed to any significant extent. If anything, damage during log extraction has increased due to the use of larger and more powerful machines and cutting in environmentally more sensitive areas (e.g., steeper terrain).

Most logging is still performed with ground skidding equipment though the need to develop more appropriate harvesting systems for logging hill forests is gaining recognition. The switch to less damaging practices is obviously desirable considering that skid trails usually cover up to 40 percent of the area. Dykstra and Heinrich (1996) refer to studies that found up to 80 percent of a selectively logged area covered by skid trails, though it is both unnecessary and uneconomical to drive skidders to every log to be extracted. While the continued use of crawler tractors has been criticized repeatedly, they have certain advantages over tracked and wheeled skidders, and are likely to remain the most common type of skidding machine, particularly in steep terrain with large trees and high precipitation (Dykstra and Heinrich, 1996)1. Damaged caused during felling and skidding operations is compounded by poorly designed and maintained transport infrastructure.

The commercialization of lesser known species has led to a general increase in harvesting intensities. In Malaysia, for example, the volume of timber harvested has increased from an average of 24m^3/ha over the period of 1971-78 to 45m^3/ha in the years 1979-90 (Ahluwalia,

[1] It is recognized that the discussion in this review is biased towards the large-scale timber harvesting operations in Malaysia and Indonesia. Small-scale harvesting systems in several other countries are far less mechanized. For example, in India, Sri Lanka and Myanmar elephant logging with its much lower damage to soils is still common. Similarly, mobile sawmills have inherent advantages regarding environmental impacts. On the other hand, since they are more mobile, small-scale timber operators are far more difficult to control and the impacts of their operations on the residual stand may be just as high as in mechanized operations.

1995). Frequently it is much higher. In Sabah, Pinard and Putz (1996) recorded an average of 154 m^3/ha and 104 m^3/ha in conventional and reduced-impact logging areas, respectively. Another striking feature, which is criticized, is the amount of waste material left in the forest. It is not uncommon, to find more than 50 percent of the wood of the main stems of tropical trees felled for harvest to remain unutilized (Schmincke, 1995). This is not only wasteful in itself but increases the fire danger in logged forests. The large-scale fires in Kalimantan in 1982-83 indicate that this is not merely a hypothetical issue. Only little progress has been made in reducing the amount of waste produced or in utilizing it. The industry has until today expressed no interest in using wood waste because of high transportation.

The discussion above has focused exclusively on timber harvesting; but this is not to say that harvesting is identical with silvicultural treatment. The reasons for neglecting silvicultural treatments, such as enrichment planting, poison girdling and liberation thinning, in the discussion are threefold. First, research results from Malaysia cast doubt on the need for enrichment planting (Ng, 1996). Second, while most forest departments advocate silvicultural treatments, the costs of such measures are prohibitively high after poorly performed harvesting operations (Adhar, 1996) and due to unfavourable climatic conditions (Ng, 1996). Third, the most promising silvicultural treatments are selective logging operations which focus on the retention of a viable stand and regeneration for future harvesting instead of maximizing log output. As Stocker (1991, cited by Arentz, 1992) suggests the only silvicultural action necessary for sustainable management may be adequate harvesting control. Compared to the expensive post-harvest silvicultural treatments it is a more viable option (Taumas, 1996). It may be insufficient but as long as the impact on residual stands and soils is not reduced, any silvicultural treatment that follows logging operations can be considered as window dressing since it cannot sustain forest productivity.

Constraints to Improving Forest Management

In their publication on natural forest management, Johnson and Cabarle (1993) cite eleven studies whose authors with few exceptions note that tropical forests can be managed sustainably. Most of them are convinced that it is technically feasible but also highlight that it may be unprofitable and will never be brought about if major improvements are not implemented.

In recent years, researchers have made considerable progress in testing and refining environmentally sound harvesting practices in many parts of the world. While it is still too early to assess whether such practices can ultimately make natural forest management sustainable, the prerequisite for better management exists. The crucial issue is the lack of the political will to make the required changes, to enforce the already existing regulations and to provide incentives for forest operators to adopt better forest management. Certification may be one vehicle that will speed up the adoption of reduced-impact logging practices but it is not a “miracle cure”.

The recently published FAO Model Code of Forest Harvesting Practice (Dykstra and Heinrich, 1996) sets out guiding principles and recommended practices for better forest management. It addresses seven critical elements of harvesting: harvest planning, forest road engineering, cutting, extraction, landing operations, transport operations, and harvesting assessment. There is no need to recapitulate the recommendations of each element. The main

point raised is that better management means, in many cases, paying more attention to planning. In Pinard's (1994, p. 11) words, the "harvesting plan is pivotal to reducing logging damage". Currently, most practices are inefficient because planning is poor. As a result damage is unacceptably high and resources are wasted. For example, a 1991 report on tractor logging in the hill forests of Sarawak showed that tractor drivers spent at least 70 percent of an operating day building skid roads and wandering through the forests in search of felled logs (Aulerich, 1995). This is unnecessary and costly, which explains why adaptations to the current harvesting practices do not automatically have to incur higher costs.

One major impediment to better forest management is the lack, in most cases, of any form of vocational training for forest workers (Strehlke, 1993). Training for forest workers is usually provided on the job (Tiki, 1994), with the result that people only repeat what they see and that skill development is lacking. Personnel at the management and supervisory level are also affected by weak training programmes, and Salleh and Ng (1994) lament that a whole generation of foresters has emerged with no experience in natural forest management. Particularly, practical aspects receive far too little attention. To improve forest management and to reduce the cost of adopting ecologically sound operations thus requires adequate training, particularly on such subjects as harvest planning, technology and practical silviculture. Initial staff training incurs substantial costs. Positive research results on reduced-impact logging in the 1970s in Sarawak were not adopted because no one company was prepared to cover the training costs (Palmer, 1996). In Sabah, tree fellers and skidder operators have been trained by foreign specialist which incurs extremely high costs.

Increased costs are still viewed as the main constraint to adopting better forest management. As Johnson and Sarre (1995, p. 3) correctly point out "low impact logging needs to be paid for, and needs to pay its way". Where timber extraction causes massive externalities, economic benefits of reduced impacts will cover costs. But as Putz (1994) reports, reduced impact logging may also be attractive in strictly financial terms. Short-term financial benefits derive from more efficient planning and reduced transport costs, and long term financial benefits accrue because forests recover more quickly (Pinard and Putz, 1996). Jonsson and Lindgren (1990, cited in Baharuddin, 1995) also suggest that better planning may reduce rather than increase operating costs. Preliminary estimates for Sarawak reveal that the introduction of reduced-impact logging would result in net savings to the contractor of about USD 17 (ITTO, 1996a). Operations utilizing comprehensive harvest planning can cost 20 to 45 percent less than operations for which only minimal plans were done (Dykstra and Heinrich, 1992). However, there is also a concern of significant income forgone with a reduction in yields. On the other hand, Cedergren *et al.* (1994) show that reducing impacts in harvesting operations does not automatically result in lower yields. This only applies where the annual allowable cut is inconsistent with sustainable forest management. As Waggener and Lane (1996) note, serious questions are raised in the Region regarding the appropriateness of current and/or recent harvesting levels. Where such levels are still based on the exploitation of natural forest stocks they will have to be reduced in order to reach sustainable yields in intensively managed forests. But this applies regardless of whether harvesting operations are conventional or designed to reduce impacts.

While most results currently under discussion come from research projects, and may not be easily replicated under standard situation, it should be remembered that better harvesting practices can mean lower costs. Experiences from the Philippines (Ludwig, 1994) and Malaysia (Rashid and Ibrahim, 1994) indicate that skyline cable yarding systems compare

favourably, ecologically as well as economically, with conventional yarding systems. However, high investment costs render the environmentally sound extraction systems such as skylines and helicopters financially unattractive for areas that can be logged using conventional systems. For example, helicopter logging in Sarawak has shown that costs are between 85 to 110 percent higher than the use of tractors (Downing, 1995). The comparison is, however, unfair because helicopters are cost-effective in areas that cannot be logged by more conventional means (Blakeney, 1994). In Sarawak, for example, helicopters logging is executed only in areas inaccessible to more conventional extraction methods (Chua, 1996). Nonetheless, in Indonesia, shortage of capital has already resulted in a slowdown of investment in new equipment, lowering productivity (Kuswanda, 1995) and the shift to reduced-impact logging.

Eco-tourism

Eco-tourism is being portrayed as a vehicle for providing environmental, socio-economic and cultural benefits at both local and national levels (Brandon, 1996). It presents a means by which forests can be used to provide income while conserving the natural resource that the eco-tourism industry ultimately relies on. The demand for eco-tourism is steadily increasing and Ong (1996, pers. comm.) predicted that the increasing importance of eco-tourism as a revenue generator in Sabah will also affect natural forest management in the future. Brandon's (1996) review of the key issues provides an excellent overview of the opportunities and limitations of eco-tourism. It does not address natural forest management per se. Yet, it provides valuable insights for assessing the likely impacts of eco-tourism on forest management.

There are only few well documented cases were eco-tourism has provided substantial social and economic benefits (Brandon, 1996) without causing ecological damage. In fact, it appears that those natural sites described for their outstanding tourism potentials such as the Himalayas, the marine environments of many Southeast Asian countries and the highlands of Thailand are more degraded today than ten to twenty years ago. Mass tourism frequently took over and transformed a formerly natural landscape into an environment more suited to the average holiday maker.

In theory, eco-tourism provides an economic incentive to protect natural resources (Laarman and Durst, 1993). In practice, conflicting interests and short-term benefits result in the environmental impacts incompatible with eco-tourism. Because of these problems, various countries within the Region including Thailand, Brunei, the Philippines, Australia and New Zealand have passed national eco-tourism policies and guidelines.

Natural forest, particularly lowland rainforests, have numerous inherent characteristics that leave them at a disadvantage in comparison with other sites. First, as Theophile (1995, p. 25) describes, "most eco-tourists still want a vacation. Balancing luxury with adventure is the trick for tour operators, wildlife park managers, and inn keepers". Most forested areas that are of interest offer only very few amenities that, at least, the "soft" eco-tourist is looking forward too. Second, most forest sites, of great interest because of their high biodiversity, have a limited appeal because of their remoteness and difficulties of access. Third, the likelihood of viewing wildlife is rather low. Fourth, the climatic conditions are far less attractive in lowland rainforests than in more mountainous or marine environments. And fifth, eco-tourism should

not be mixed up with ethno-tourism. Though parts of the Northern Thai highlands are very scenic and offers diverse natural ecosystems, the most interesting component of any trekking trip is a visit to a hill tribe village (Chudintra, 1993). Thus, it is not per se the natural environment that tourists are interested in. Their first priority may be experiencing cultural diversity.

Hence, it is obvious that many forests of the Region don't make for very attractive tourist locations. The picture is not necessarily bleak everywhere; but "the overall effect of small-scale success is inconsequential in the face of current environmental degradation and economic development needs. Eco-tourism is not a panacea for forest managers struggling to balance economic and environmental concerns in the United States or overseas" (Theophile, 1995, p. 27).

Outlook

The recent developments in natural forest management and developments that can be expected over the next fifteen years cannot be viewed in isolation from what is happening in other forestry sectors. Forest plantations are increasingly supplying raw materials for the industry. The wood processing industry has seen dramatic changes over the last two decades. Solid wood products are being replaced by plywood and reconstituted wood panels such as medium density fibre boards (MDF) and oriented strand boards (OSB) (Adams, 1995). This shows that the processing industry has already reacted to perceived and actual changes in wood supply. For instance, the Malaysian timber industry is faced by a shortage of about 8 million m^3 in the coming decade (Shaharuddin, 1996). The reliance on large diameter wood will decrease even further in the future. Log production will shift considerably out of the natural forest with more raw material being supplied by forest plantations and the estate sector. As an example, in 1992 in Indonesia, 68.7 percent of the total log production (41.9 million m^3) was from natural forests. Two years later, this figure was reduced to barely 62 percent (total production was 35.23 million m^3). Current projections are that by 1998 it will be reduced to less than 55 percent out of a total production of 39.23 million m^3 (Adhar, 1996).

Since UNCED the service functions of forests have received more attention in deliberations on the use of the Region's forest resources. There has been a shift, albeit slow, from focusing on the developmental, where forest production and industrialization were viewed as an engine to general economic development, to the environmental roles of forests. Recently passed legislation in a number of countries underscore this shift. As described by Durst (1995), the under-valuation in the traditional economic analysis and the low financial profitability of forestry investments relative to investment alternatives encourage over-exploitation and forest conversion to more profitable land uses with higher short-term benefits[2]. Accordingly, the key challenge is how to make sustainable forest management more profitable than unsustainable practices and competing land use (Sizer, 1994).

[2] The development of methodologies for the valuation of forest resources is still ongoing. Valuing various forest benefits poses a number of problems, particularly in areas for which there are virtually no reliable data available such as remote tropical forest areas. Also, our knowledge of complex human-environment interactions is still inadequate to forecast and quantify likely impacts (see e.g., Enters, 1996). Finally, and perhaps most important, ethical concerns have been raised regarding the appropriateness of calculating monetary benefits for many of the values that forests provide.

Despite these developments and mounting environmental pressure in the main producer countries, only a few forest managers have decided to improve performance (Upton and Bass, 1995). The explanation for this poor response lies in the business nature of current forest management. As discussed above, natural forest management consists mainly of timber harvesting, which is in most cases conducted by private companies. As profit maximizers these firms would be following the recent debate on sustainable forest management closely before deciding how to adapt. Being diverse, they will thus make different decisions. Their reactions will depend on:

- their dependence on marketing their products in countries interested in certified products;
- pressures applied by their respective national governments as well as restrictions imposed by government departments on their overseas concessions;
- the capacities and interest to invest in new timber harvesting equipment, training and wood processing technologies;
- their perceptions about resource supply;
- alternative - outside the forestry sector - investment opportunities; and
- opportunities to move their operations overseas.

As a result, three possible scenarios emerge, which have quite different impacts on what happens to the forests of the Region.

First, those companies not interested or unable to upgrade existing technologies and practices will phase out timber harvesting operations and downstream processing. This will be companies that operate with outdated and inefficient equipment. Their departure from the scene has positive effects where inefficient processing factories are closed down and their concessions are taken over by companies with better management records or state operators. In Indonesia, the government has reduced the number of timber licenses from 500 to 350 over the last three years. It can be assumed that these companies knew beforehand that the licenses would not be extended. They were not interested in upgrading their practices and equipment. While this is not the place to speculate how many additional companies will be phased out it can be assumed that the number will rise.

The second group of companies is seriously pursuing a path towards better forest management. Some companies are interested in increasing the market share for their products overseas or have recently invested in downstream processing facilities. Some are actively searching for ways to reduce the impact of timber harvesting operations such as Innoprise Corporation in Sabah. Innoprise is a particularly interesting case because it receives funds from New England Electric Systems (Massachusetts, USA) to implement reduced-impact logging guidelines. The harvesting guidelines include the following specifications (Pinard, 1994): buffer zones for streams and roads, a formal harvesting plan, pre-felling climber cutting, skid trail planning, tree marking for directional felling, tree felling, skidding, log landings and post-harvest operations. The guidelines are similar to the codes of harvesting practices that have been developed by FAO (Dykstra and Heinrich, 1996) as well as locally in some countries such as Fiji (Ministry of Forests, 1990).

Currently, the area treated by better forest management is still very small. In Indonesia, for example, only six of the 350 forest concessions have been identified as sustainably managed (Ngu, 1996). What is encouraging is that some companies are seriously considering to adapt. For example, Ong (1996, pers. comm.) predicts the present enthusiasm for skyline systems to

translate into an increasing use of such systems in Sabah in the near future. However, the available information regarding the application of better management technologies currently comes predominantly from pilot projects. For example, Innoprise Corporation Sendirian Berhad is implementing reduced-impact logging guidelines on only 1,400 ha of its 1 million ha concession (Pinard et al., 1995).

Better management in many cases means better planning and not necessarily huge investments in new systems and machinery. As discussed, some studies even note the cost effectiveness of reduced-impact logging though it is not always clear which actors involved in timber harvesting operations benefit and who has to bear any additional costs. It can be safely assumed that better forest management, i.e. less destructive harvesting, will become more widespread as long as operators have the incentives to follow commonly accepted guidelines. Furthermore, land use conflicts need to be solved and the degree of control and enforcement increased. In Sabah, one professional forester is employed per 93,000 ha of commercial forest reserve (Sabah Forestry Department, 1989, cited in Pinard et al., 1995). In other countries, foresters are responsible for even larger forest areas. This persistent lack of enforcement capacity will substantially affect the current move towards better forest management.

Malaysia and Indonesia have worked towards what can be regarded as creating necessary conditions for sustainable forest management for quite some time. The main risk, with a potential for backlash, is that independent certifiers may assess operations or systems as being "unsustainable" even though concerned operators can prove that they have followed the various guidelines and regulations imposed on them.

The last group of companies - as examples indicate it overlaps partially with the previous group - will follow a very different strategy (for details see EIA, 1996). Convinced that they will face a supply shortage and declining profits in the near future, they are looking for alternative investments in the forestry sector. This is not a new development and for many years companies, have heavily invested in operations in countries such as Myanmar, Papua New Guinea, Vanuatu and the Solomon Islands. But as recent evidence from Cambodia (World Bank *et al.*, 1996, Global Witness, 1996), Surinam (Sizer and Rice, 1995) and Guyana (Colchester, 1994) indicates the interest in logging concessions as far away as Latin America and Africa (e.g., Gabon and even Zimbabwe) is rapidly growing. While some operators are expanding in the region to tap formerly "under-utilized" resources (e.g., Cambodia, Vietnam and Laos) the majority is looking for opportunities in other regions where the cost of acquiring timber concessions is comparatively low, and where forestry departments are not only inadequately staffed and under-funded but also politically marginalized (Colchester, 1994). Some of the approved and/or proposed new concession areas cover vast areas. For example, the area that three Asian companies applied for in Suriname covers almost 3.5 million ha (Sizer and Rice, 1995). This is almost one third of the total Production Forests in Malaysia (10.67 million ha). The concession area under consideration or recently being granted in Cambodia is more than 4.2 million ha (World Bank *et al.*, 1996, Global Witness, 1996). The move to Latin America is not confined to investments in the forestry sector. Investments in other sectors of the economy are expanding too with large companies in the Region looking for opportunities to boost trade links and raw material exports.

While the information on overseas investment in logging concessions is scanty at best and not always reliable, it is obvious that they will affect natural forest management and the wood processing industries especially in Malaysia and Indonesia. In particular, it will reduce the

pressure on the natural forests in some countries while increasing it in those countries selected for further investment. As experience in Myanmar (Enters, 1992) and Cambodia (Global Witness, 1996) showed, logging activities are very destructive when concessionaires view their business as risky. The tendency in those cases is to maximize short-term profits. It can therefore be assumed that wherever the capacity to enforce regulations is low, natural forests will suffer further. An example of highly destructive operations by foreign concessionaires is Papua New Guinea, where monitoring is ineffective, approval of plans is nothing more than a formality (1994), and the requirements of the laws are blatantly neglected (DEC, 1995, cited in McCallum and Sekhran, 1996).

Summary

The pressures to introduce better forest management practices are increasing in the Region. The international debate on sustainable development and resource use have contributed significantly to raising the awareness in many countries of the Region that not all is well in the forests. Countries such as Malaysia and Indonesia, the two main timber producers, have reacted by amending existing policies not only in response to international pressures but also because it has become apparent that supply will decrease in the medium-term. Some actions have been rather drastic such as the revocation of logging licenses in Indonesia. While partially critical of the international initiative of certification, Malaysia as well as Indonesia have foreseen its significance and put in place the necessary agencies to undertake certification themselves. Indonesia is the main producer developing a national system for timber certification (Varangis *et al.*, 1995). These developments are paralleled by research on reduced-impact logging practices and efforts to transfer the new knowledge to the forest. How soon that will be, is difficult if not impossible to answer. Recently Malaysia and Indonesia opted to jointly establish a set of criteria and indicators for sustainable forest management at the regional level. The technologies for managing natural forests in an environmentally sound manner are available. Most of the proposed changes do not necessarily entail high capital investments. As many authors have pointed out, the focus should be on better planning. This requires a commitment to training, a long-term investment. It is unreasonable to expect practices to change in the near future even if pressure on timber harvesting operators is increased.

As a result, three parallel developments, as discussed above, can be expected. The first two will have a positive effect on natural forest management in the Region while the third will have mixed blessings.

- The number of concessionaires in the main producer countries has already been reduced and will decrease further (see e.g., Anon, 1996a) though new players will enter the scene. Those who do not view natural forest management as a profitable venture will find alternative investment opportunities.
- Those concessionaires who continue to operate will slowly adapt their practices and follow national codes of forest harvesting practice or similar guidelines. The impact of certification and the willingness to pay higher prices by consumers concerned about the future of the tropical forests will determine adoption rates, and whether changes will be voluntary, or mandatory.
- As private companies in the forestry sector are profit maximizers they are looking for alternative opportunities where they can use their experience. This explains the interest in obtaining concessions in other countries.

If one accepts that timber certification is not expected to provide significant commercial benefits to producer countries in the Region in the near future, then the conclusion is that not much will change over the next decade and the available technologies will be adopted only slowly. Certification might provide significant rents to individual firms that develop market niche strategies (Varangis *et al*., 1995). Since no more than 20 percent of the tropical timber market in Europe and the US will be affected by certification, the number of players who can benefit from financial incentives is rather small and will remain small over the next decade.

As a result the chances for sustainable or, at least better management, are not too good. While technologies for change exist and research as well as development projects have provided relevant results and insights, the tropical forest area affected by destructive practices is at the moment growing, though not necessarily in the Region. Incentives for plantation management and for further increasing wood processing facilities outweigh incentives for sustainable forest management. Coupled with the general decrease in available supplies this means that,

- The percentage of timber supply from the natural forests will decrease while the supply from plantations (forestry and estate crops such as rubber) will increase. Any forecasts should be treated carefully but the successful implementation of plantation programmes may reduce the dependence on natural forests as a raw material resource to about 50 percent by the year 2010 in countries such as Indonesia, whereas in other countries the shift to plantations as a raw material source will be considerably slower.
- Better forest management practices will be adopted slowly in the forests of the Region. However, limited enforcement capacity, inadequate training and the lack of political will to provide incentive means that the area affected will remain small. It would be unrealistic to expect any major changes by the year 2000. Even in 2010 it can be assumed that no more than 20 percent of tropical forest management will be sustainable.

A more rapid change is not happening because large corporations involved in timber harvesting and processing do not feel pressured enough to change. The result is, that today the top logging nations in the Amazon basin are from Malaysia, Indonesia, Taiwan, China and South Korea, that environmental groups warn of a "forest chainsaw massacre" (Anon, 1996b), and that foreign companies are warned of "a very rough time" by the Environment Minister of Brazil (Anon, 1996c, p. 12). In fact, the criticism of relocating logging operations to other continents has reached such an extent that the term "transnational predators" has been coined (ITTO, 1996b).

PLANTATION MANAGEMENT

The importance of the plantation sector in the Region is increasing as the demand for raw materials is rising and the supply from the natural forests is dwindling. The Region accounts for about 80 percent of the new plantations established in the tropics between 1981 and 1990 (Cossalter, 1993). During the same period, plantations grew in South Asia from 4.96 million to 19.76 million ha, in Continental South East Asia from 1.8 million to 3.2 million ha, and in Insular South East Asia from 4.34 million to 9.16 million ha. In the Pacific Islands, it more than doubled from 88,000 to 189,200 ha (FAO, 1995). China's plantation resources stand at about 32 million ha (Waggener and Lane, 1996), New Zealand's at 1.47 million ha (Brown, 1996), and

Australia's at about 1.1 million ha (ABARE, 1996). Excluding Japan and the Korean Peninsula, the plantations cover an area of roughly 67 million ha.

The figures presented above should be viewed as a rough estimate at best. Pandey (1995) concludes that survival rates in many plantations are rather disappointing. His estimates for plants surviving are between 63 and 77 percent. This indicates that the total area might be 25 to 35 percent less. On the other hand the figures are outdated and it can be safely assumed that the plantation area has grown significantly since the assessment. Furthermore, many small plantations have not been included in the FAO survey such as 300,000 ha in Bangladesh. 90 percent of the fuelwood in Pakistan comes from farms (Hulscher, 1995) which are also excluded from the statistics.

The plantation area would receive another boost if crops such as rubber, oil palm and coconut were included. Rubber alone covers about 9 million ha in Asia, with 3.04 million ha in Indonesia, 1.83 million ha in Malaysia, and 1.78 million ha in Thailand (Hong, 1995). As the discussion in the chapter on wood processing will indicate, there is no reason to distinguish between forestry plantations and some estate crops. Furthermore, from an environmental point of view there is no difference between an intensively managed rubber plantation and an intensively managed eucalyptus, acacia or pine plantation. In fact, some of the small holdings offer considerable biodiversity and other non-timber forest products and services.

Diversity of the Plantation Sector

The plantation sector has been beset with difficulties (Ng, 1996) and continues to be a contentious and troubled area in relations between lowlands and uplands in some countries. Principal conflicts arise from struggles over resources, especially land, and labour relations. Particularly in Thailand, commercial eucalyptus plantations have been described as incompatible both with forest conservation and with village livelihood (Lohmann, 1990). Many villagers have protested against plantation schemes by destroying nurseries and forest equipment in the late 1980s and early 1990s (Anon, 1989, Puntasen *et al.*, 1992). In Indonesia, plantation development has been criticized for replacing natural, albeit degraded, forests (WALHI, 1992). In both countries, plantation establishment has experienced setbacks because of social problems in the past; problems that appear to have decreased in recent years. The controversies regarding the choice of exotics such as eucalypts and acacias, however, ultimately did not lead to a shift towards the use of indigenous species. In Thailand, *Eucalyptus camaldulensis* is today the most popular species planted by both the private and public sector (Kijkar, 1995).

The objectives for establishing plantations among the countries of the Region are very diverse, and have changed over time. The objective of the first plantations was predominantly timber production, with initial efforts reaching back to the last century (e.g., Bryant, 1994). Most initiatives appear to have responded to a perceived crisis. Pine plantations in Peninsular Malaysia were created in the 1960s to support the pulp and paper industry. It was followed by a larger project based on *Acacia mangium* in the 1980s, to compensate for a decline in supply from natural forests (Ng, 1996). Plantations in other countries were established in order to rehabilitate degraded lands, to assist in rural development, and/or to increase fuelwood supplies. Tree planting programmes became major development tasks for governments in many countries in the Region, with much efforts dedicated to identifying and developing tree species for particular purposes. However, from the early 1980s onwards, the trend has gone slowly towards

multi-purpose species, designed for soil improvement, provision of fuelwood and for the wood industry. In fact, many plantation projects had hidden agendas. To the rural population, it was not always obvious why "their lands" had to be used for a product (such as fuelwood) which, according to their perception, was freely available in the natural, forest. To a certain agree this confusion still persists today, though plantation management has become more sophisticated and purpose, i.e. product, oriented. This is particularly the case of the large scale private plantations which started to emerge in 1983/84 (AFTSC, 1996). Since then, private corporations in the Regions have made substantial investments in hardwood plantations to supply downstream processing industries, particularly the pulp and paper and reconstituted wood panel industries.

The plantation sector is diverse in terms of ownership, scale, species planted and production purpose. The diversity explains why it is difficult to present a coherent picture of what happened in the sector and what will most likely happen. As Kanowski (1995, p. 483) explains, "plantation forestry is an evolving concept but is most often interpreted as the relatively intensive management of monocultures for the production of a relatively narrow range of products".

Plantation ownership

Up until about 15 years ago, in most countries of the Region it was the state that initiated large-scale reforestation or afforestation programmes in order to build up new sources of raw material and to rehabilitate degraded areas. The success of these plantations was rather limited and many suffered from multiple problems including low quality planting stock, weak links to markets and social problems. Some plantation projects ultimately had to be terminated when external financial support came to an end (Cossalter, 1996). Since then, many technical lessons have been learned, and the establishment of industrial plantations has mushroomed (Bass, 1992).

Several other factors beside the technical advances explain the enormous growth of plantations and with it a shift from state to private management. In the former centrally planned economies, fundamental changes have taken place in rural areas with regard to land management systems. In China, for example, collective land management was replaced by a family contract system (Ruiz Pérez *et al*., 1996). This change has significantly facilitated reforestation in parts of China, more efficient resource management and the development of processing facilities (for wood and NTFPs). Similarly, the government in Vietnam gives 50 years renewable use rights over degraded areas to individual farmers in an attempt to stimulate private investment in reforestation (Van, 1996). While the transition to a market economy explains an increase in tree growing in countries such as Vietnam and China, in other parts of the Region it is industrial growth that has triggered a transformation of the rural areas. Off-farm employment opportunities become increasingly available which results in a decreasing pressure on the land locally. Labour shortages in parts of Indonesia, Malaysia and Thailand have resulted in land left idle, a rise in land prices and a change in land use. Coupled with an attractive market-driven demand for wood, small-holder timber plantations and private tree growing have sprouted up in the Philippines (Garrity and Mercado, 1994), Nepal (Malla, 1992), Laos (Roder *et al.*, 1995), India (Saxena, 1994; Ghosh, 1994), and Thailand.

The growing interest in small-holder wood production and farm forestry does not mean that the deforestation trend has been reversed on a broad front. In addition, in certain cases it has also resulted locally in overproduction of a particular product and farmers were unable to realize the anticipated profits. For example, supply of small sized eucalyptus timber outstripped demand in

parts of India (Saxena, 1994). A positive side effect, however, was an increasing investment in wood-based industries that today provide for a competitive market (Sharma, 1995). Also, poplars, the leading species in north India for the wood panel and packaging industries did not suffer the same fate as eucalyptus, due to its multiple end uses. Further, its replacement values are so high that long distance overland transport is possible (Ghosh, 1994).

Private involvement does not suffer from many of the inherent problems of social forestry interventions described by Dove (1995). On the other hand, as recent studies from Laos (Roder *et al*., 1995) and India (Saxena, 1994) indicate, it is predominantly absentee landowners and large farmers, with the support of substantial non-crop incomes, who can take advantage of the demand for wood. The picture is not uniform because resource poor farmers also replace annuals with perennials in order to concentrate on improving their income through wage labour (Saxena, 1994). In some cases, close collaboration between the wood processing industry and small-scale suppliers has boosted reforestation.

The emergence of many small-scale land owners in the plantation sector is paralleled by massive corporate investments in wood production. Both players have reduced the role of the state in the sector. Plantation establishment is coupled particularly with the production facilities for pulp and paper in Indonesia (Gales, 1996, Wong, 1992). Faced by prospects of further diminishing supplies from the natural forests, the reconstituted wood panel industry has also opted for plantation management. This includes plantations of fast-growing tree species, and further involvement in producing rubber. The impact of private corporation involvement will be a significant increase in plantation area, the mechanization of silvicultural and harvesting operations and increased productivity due to the intensification of management and the use of improved planting stock.

Plantation Species

While there is a wide variety of species used in plantation management, the most common species are pines, acacias, eucalypts, teak (Pandey, 1995) and poplar. *Tectona grandis* has the longest history as a plantation species followed by pine. *Pinus radiata* is the main species used in Australia and New Zealand. Teak production for the sawnwood industry is on the upswing. It is currently strongly promoted in Malaysia for producing quality timber on a 15 year rotation (Anon, 1996d). Species with more country specific importance include *Robinia pseudoacacia*, *Gmelina arborea*, *Melia azaderach*, *Casuarina equisetifolia*, *Calliandra* spp., *Paraserianthes falcataria*, *Dalbergia sissoo*, *Swietenia macrophylla* and *Leucaena leucocephala.* More than 1 million ha are planted with *P. elliottii*, *P. taeda* and *P. caribaea* (Pan, 1991) and poplars cover more than 2.4 million ha in China (Wang, 1991).

Over the last two decades eucalypts and acacias (particularly *A. mangium* and *A. auriculiformis*) have made inroads into plantation establishment. Eucalypts have been very important in plantations in southern China with a total area of more than half a million ha (Hong, 1991). *Eucalyptus camaldulensis* has become the main plantation species next to teak in Thailand (Bhumibhamon, 1992) and is of major importance in India (Pandey, 1995). In Malaysia and Indonesia, industrial plantation development has focused on *A. mangium* (Haines, 1994). The advantages of eucalypts and acacias are that they grow very well on poor soils and, particularly, that high quality seeds are easily available. The scarcity of good quality seed has sometimes

hampered advances of other species such as *Pinus caribaea* and *Araucaria* in Malaysia (Ahmad and Ang, 1993).

The majority of industrial plantations relies on exotic species as they are more attractive from a profitability perspective, with a broad knowledge base. Most existing plantations can be described as simple, in terms of purpose, composition, structure and management (Kanowski, 1995). There has been a recent swing of interest to indigenous species, such as in China (Hong, 1991). However, to what extent this interest has translated into significant changes in area is currently unknown. While Kanowski (1995) forecasts that most plantations will become more complex, the near future will be dominated by more simplicity than complexity.

Plantation management practices

The silvicultural interventions necessary in plantations depend foremost on the main production objective (e.g., conservation, fuelwood, fibre, or sawlog production). Where wood production is the main objective, intensive silvicultural treatments are probably justified (Whitmore, 1994). For the production of high quality sawlogs they are definitely necessary, as examples from northern softwood plantations indicate. Management practices are so diverse that no clear picture emerges. Therefore, the brief description that follows relies heavily on information for only one species, i.e. *A. mangium*.

In Malaysia, potted seedlings in polyethylene bags are used, as the bags are relatively cheap, not bulky and have no adverse effects on the seedlings (Thang, 1994). The same technology is also used in Indonesia (Gales, 1996). Where road conditions are adequate for transport during the wet season, centralized nurseries are used. Where infrastructure is poor, seedlings are raised in simple nurseries. As Kanowski and Savill (1992) remarked many early plantation failures are attributable to poor nursery techniques. Generally, it appears that nursery practices have improved immensely (Fryer, pers. comm., 1996), though poor nursery practices have limited the success of reforestation efforts in Vietnam (Poynton, 1996). The impact of improved nursery technologies is, however, not know in quantitative terms as most plantations are still very young. It has emerged, however, that survival rates are substantially higher.

Three types of site preparation are in use. Where land is covered by grasses or light brush, it is mechanically cleared by bulldozers in flat or slightly undulating terrain. Manual clearing takes place in steeper terrain and where the clearing of residual secondary vegetation is required. The slashed vegetation is usually burned though burning as part of site preparation has been illegal since 1995 in Indonesia (Gales, 1996). Chemical treatments are involved in areas affected by *Imperata cylindrica*. Most site preparation are designed to disturb topsoil minimally, which is quite different from site preparation for estate crops.

Planting begins with the onset of the rainy season and may be accompanied by fertilizer applications, particularly if inexpensive fertilizer is available. The usual practice (for *A. mangium*) is to plant nursery-grown seedlings (Srivastava, 1993). Stand tending includes weeding, cleaning and thinning as well as pruning. Disc harrow weeding between planting rows followed by hand weeding as well as herbicide applications are common (Wong, 1992). The importance of weeding has not been fully realized, with operators following different schedules and techniques (Srivastava, 1993). Thinning and pruning are necessary for the production of sawlogs but not for fibre production (Lee and Mohammad, 1992).

Single species plantations have suffered heavy losses due to fires, the major cause of extensive damages (Srivastava, 1993). In Sabah alone, at least 6,000 ha of forest plantations were affected by fires during the 1980s (Lee and Mohammad, 1992). In Sumatra, on the other hand, fire danger is usually low and losses to fire are within an acceptable range (Wong, 1992). To protect against fires, large plantation projects have prepared guidelines and equipment, constructed fire breaks (the reason why *A. mangium* was originally introduced to Sabah), fire access roads and watch towers, and established good relationships with local communities (Gales, 1996).

The reduction in species diversity, tree age and genetic variation provides favourable conditions for the spread of insect pests and diseases (Hutacharern, 1993) and increase the risk for substantial damage (Gales, 1996). For example, in 1984 a leaf fungus disease wiped out plantations of *Eucalyptus camaldulensis* in Malaysia (Ng, 1996), and large areas have also been damaged by disease and insect attacks in Vietnam (Poynton, 1996). For *A. mangium,* damage caused by pests has not been serious to date (Lee and Mohammad, 1992; CIFOR, undated), and there are no reports of any serious disease outbreak (Lee, 1993), though the incidence of heartrot has resulted in a drastic, temporary slowdown of plantation establishment in Peninsular Malaysia. Pesticide applications are rare and strategies in controlling pests are moving towards Integrated Pest Management (IPM) (Gales, 1996). However, the most common option for pest and disease management remains sanitation or the withdrawal of certain species from planting programmes (Day *et al.*, 1994), which indicates that insect and disease management are still in its infancy.

While limited to almost exclusively one species and industrial plantations, the brief introduction to current management practices provides a couple of interesting insights. First, until recently plantation management did not change dramatically. Some technologies of plantation management in the temperate region have been adopted and this development is rapidly increasing with private sector involvement. Silvicultural treatments are of limited significance when wood is produced for its fibres. Second, there have not been any major problems with pests and diseases. However, as the example of heartrot disease in *A. mangium* shows, any outbreak can lead to the immediate moratorium on the use of individual species. This highlights, as Srivastava (1993) stressed that serious gaps on many aspects of *A. mangium* remain and need more research. If this is the case for *A. mangium*, then it certainly is also true for other species of which far less is known.

Harvesting of Plantations

A wide variety of harvesting systems exists for the plantations in the region. While there is very little documentation available, harvesting techniques range from essentially manual to completely mechanized (Kanowski and Savill, 1992). They are slowly evolving from the use of animals and simple, often second hand, machinery to complex and integrated systems. Most machinery has been adapted either from the estate natural forest management sectors. A very simple systems is described by Derus and Hameed (1994) in which rubber trees are pushed over by crawler tractors, subsequently crosscut by chainsaw and then loaded onto small trucks by a modified backhoe tractor.

Harvesting of plantations started 1981 in Sabah, using tractors and a skyline based systems (Lee and Mohammad, 1992). Most systems in use are still adapted in response to high labour costs,

the need to keep soil disturbance at a minimum, expected infrastructural improvements and frequently poor weather conditions.

Carle (1996) predicted substantial changes to more mechanized systems with tree felling and bunching performed by light feller bunchers and log extraction by light rubber-tired skidders and forwarders. This equipment is used in temperate plantations and can be expected to have a significant impact on the industrial plantation sector within the Region too. The first companies in Malaysia and Indonesia have fully mechanized operations. In at least one place, this even includes a mobile wood chipper which allows for a substantial reduction in waste left behind. On the other hand, where labour costs remain low handsaw and animal-based systems will remain competitive, such as in the southern Philippines (Jurvélius, 1997). In India, Myanmar, Sri Lanka and Thailand, elephants will remain attractive, particular when their operations can be combined with machines (FAO, 1995).

Tree Improvement

Poor quality planting stock material was a major constraint to performance of earlier plantations (Bass, 1992). The consequences of choosing sub-optimal or outright wrong materials as well as species span from poor performance, reduced plantation health, and even disasters (Ng, 1996). Next to taking into account the political economy (Kanowski and Savill, 1992) and social factors (Smits, 1996) as the determinants of the nature and success of plantations, it is now widely understood that the production of high quality planting stock of improved trees has a tremendous impact on growth and yield, and ultimately profitability.

Significant advances in species selection, tree breeding research and programmes have been made in almost all countries. However, in most plantations the use of sexually propagated seedlings is still common. The plantation areas that have benefited from research in tissue culture and rooted cuttings are still small. There are some notable exceptions. The forest industry in New Zealand extensively utilizes genetically improved *Pinus radiata* and since 1985 improved stock has been used in virtually all plantings (Carson and Carson, 1995). Significant productivity increases have also been reported for state-owned plantations of the same species in Australia (Ferguson, 1995). In China, tissue cultured hybrid trees and cuttings are used commercially (Turnbull, pers. comm., 1996). In Thailand, demand for planting stock of high genetic quality increased dramatically in 1994, when the world price for pulp and paper doubled (Kijkar, 1995). In some countries, private companies are offering improved planting stock, predominantly asexually propagated clonal material. In India, for example, ITC Bhadrachalam Paperboards Ltd. sells eucalypt clones that have demonstrated superior growth rates, disease resistance and stem qualities to tree growers (Lal, 1995). Other private companies also provide improved planting material though the impact of such enterprises is rather mixed with some companies taking advantages of inexperienced tree growers. Tree seeds are widely traded and, although information and controls concerning their origin and genetic quality have improved, uncertainties remain in many cases (Kanowski and Savill, 1992).

Breeding programmes and the establishment of tree seed centres have raised the awareness of the importance of quality planting stock but translation into actual practice is low due to limited availability of planting stock and weak extension services (AFTSC, 1996). Self-critically the AFTSC also notes that it needed to be more responsive to the current needs and realities (AFTSC, 1994), which partially explains the limited impact of this and other research projects.

In his review on tree improvement, Haines (1994) concludes that most plantings are still conducted with material subjected to little, if any, improvement. Awang and Bhumibhamon (1993) also report that gains achieved in agriculture and horticulture from using improved seeds have not been obtained by forestry in most counties of the Asia-Pacific Region. In Vietnam, for example, the use of poor quality seeds and seedlings is a major constraint to reforestation efforts (Poynton, 1996). Kishwan (1995) also laments the dearth of good quality material throughout India. Also, most improvement programmes have focused on a limited number of species with sophisticated breeding programmes unlikely to be warranted for most non-industrial species. Hence, for many multi-purpose species that farmers plant on a variety of sites and for diverse reasons, there is no improved stock available, though increasing resources are being allocated to provide better-performing germplasm to farmers (Simons, 1996).

Generally, tree improvement aims at producing trees with better features at each new generation, including

- higher resistance to pests, diseases, droughts, frost and even herbicides, to reduce mortality and for more efficient silvicultural treatment;
- quality enhancement and product uniformity to reduce costs in harvesting, transport and wood processing; and
- productivity, to improve growth and yield.

To what extent these objectives have been reached in the field is difficult to judge. The breeding for certain traits is still in its infancies. The main development direction is heading at the moment towards the production of clonal planting stock with improved growth and yield characteristics.

It is often not clear whether improvements are related to more sophisticated silvicultural practices or due to superior planting stock. For example, in New Zealand, the mean annual increment for a 35 year rotation for *Pinus radiata* in state-owned plantations rose from 18m^3/ha to 26m^3/ha over the 1960 to 1984 period. Ferguson (1995) concludes that the shift in productivity owed "its origins to continuing research in silviculture and genetics, especially in tree breeding and establishment techniques" (p. 467). The effect of either changes in silvicultural techniques or planting stock cannot be assessed from those data. Lal (1995) on the other hand pointed out that the productivity of some selected eucalypt clones is 20-25 m^3/ha/yr under rainfed conditions compared to only 5-6 m^3/ha/yr in plantations raised from ordinary seed sources at 7 years rotation. This represents a four-fold increase, indicates the potential of using selected species and clones, and explains the tree growers' interest in seedlings that are over ten times more expensive than seedlings of unimproved seeds. In Vietnam, farmers abandoned the local source of *Eucalyptus camaldulensis* when the five-fold more productive provenance Petford of the same species became available. This shift occurred in only a short period of time even though Petford seedlings were three times more expensive (Cossalter, 1996), another indication of tree growers' interest in superior planting stock. Hybrids, such as the one of *A. mangium* and *A. auriculiformis*, sometimes grow faster than either of their parents, have better stem forms, higher wood density and may be more disease resistant (Gales, 1996). On the other hand, major setbacks such as the clone-specific calamities of poplars have also been experienced (Haines, 1994). In general, spectacular gains due to tree improvement are not common, yet Productivity increases of 15 to 20 percent should be considered as normal (Cossalter, 1996).

Even those increases can usually only be achieved if stand management is intensified at the same time.

Biotechnology in tree improvement is still in its infancy. As Griffin (1996) summarizes, there is still much to learn about the expression of transferred genes over the life of a tree crop, the costs of enabling technology and genelicences are high, and the process of satisfying government regulators and the public that the technology presents no substantial environmental risks has hardly been initiated.

The main impetus in tree breeding and the production of superior planting stock will come in the near future from the commercial sector whose role in the plantation sector has progressed considerably over the last decade. As Schmidheiny (1992, cited in Bass, 1992) points out, corporations can provide the stability and resources required for tropical plantation investment more sustainably than governments. Most corporations are directly linked to the downstream processing sector which requires a continuous flow of high quality and uniform raw materials. Public research in tree improvement in most countries of the region is greatly under-resourced (Haines, 1994) because it is not a high priority of the state. For private plantation corporations it is of high priority, and they will increasingly invest in optimizing their plantation activities, including efforts in tree improvement. Most of the work will be limited to few species. As a result it is rather unlikely that in the near future plantations, particularly large-scale plantations - in the Region will become more complex.

Outlook

As the discussion indicates, the plantation sector in the Region has experienced substantial growth in the last 15 years. The expansion of industrial wood processing capacities together with dwindling supplies from the natural forests point towards further growth. The speed of this expansion will depend on the nature of state interventions, price stability for wood products, collaboration between small-scale producers and the processing industry, and the impact of research on planting stock quality, plantation establishment and management, and the processing of raw materials.

As described by Saxena (1994), tree growing by small-holders has flourished despite state interventions and competition with subsidized supplies of wood from government sources. Not withstanding those constraints, there is growing evidence from India to suggest that planting of trees for commercial ends has increased since the early 1980s. Similar situations have emerged in other countries though they are far from homogeneous. The transition to market economies in some of the Region's countries has also triggered interest in plantations and the growth of downstream processing industries. In other countries corporate players are increasing the areas under fast-growing trees while governments continue to announce ever increasing targets for further plantation development.

Sayer and Byron (1996, p. 4) predicted that "it seems almost certain that the share of the world's wood production that comes from plantations will increase and that a large part of this increase will occur in the tropics." For this to happen means that the plantation area and productivity have to increase substantially. The questions that remain to be answered concern the limits to the growth of both.

Economic growth and agrarian change are pointing towards a decreasing competition between forestry and agriculture. The rural areas of the fastest growing economies are facing labour shortages with subsequent impacts on agricultural production. This explains partially the interest in extensification and tree growing by small-holders. At the same time agricultural production intensifies on a smaller share of the total land area, as food demands by a growing population increases. Vast areas of degraded lands are also available for reforestation though, for obvious reasons, most private investors shun those risky locations. Confrontations between rural communities and corporations involved in plantation establishment appear to have decreased. While conclusive evidence is not available, it seems that land use conflicts will not hinder a further expansion of the plantation sector.

The second major aspect discussed by Sayer and Byron (1996, p. 5) is "the serious, and still unresolved, issues of sustainability of second and subsequent rotations in low potential areas in the humid tropics and the associated problems of pathogens". Tree breeding programmes, species site matching, more sophisticated silvicultural treatments as well as fire protection, less soil damaging harvesting techniques and increased inputs can ensure that losses can be maintained at a minimal level. Ng's (1996) review of more than 25 years of forestry research in Malaysia showed that not all is well, and there will always be setbacks particularly in what Kanowski (1995) called simple plantation forests. The seriousness of such setbacks will determine the progress towards more complexity.

Changes will also depend on the real and perceived environmental and social impact of plantations, export capacities of other regions (e.g., US hardwood lumber exports to Asia have more than doubled in the last ten years) and consumer demands. The increased use of rubber cannot only be explained by the availability of an inexpensive resource and research success in processing rubber wood but also by the demand for light coloured wood and the perceived environmental soundness of using rubber as a raw material instead of wood from natural forests.

One advantage of plantations is the uniformity of their outputs. Weinland and Yahya (1994) have proposed to maintain naturally regenerating hardwood in plantations of *A. mangium*. This would be a first step towards more complexity and will more acceptable once wood processing is capable of different specifications and qualities. This will also determine the use of dipterocarps in plantations. As Smits (1996) reported a number of dipterocarps have an extremely favourable average growth of more than 2 cm diameter increment per year. Once the anatomy of indigenous species is better understood and becomes more acceptable to the processing industry (an industry already experimenting with oil palm for panel production), it is likely that logged-over degraded forests will not have to automatically make way for single species plantations. The management of secondary forests is receiving more attention in the American tropics (CIFOR, undated) and they are managed intensively by small-holders in countries such as Costa Rica. The provision of appropriate incentives may stimulate more interest in secondary forest management or restorative management of severely logged-over forests within this Region too. This development will not only be beneficial from an environmental perspective but may also be coupled with the intensive management of NTFPs such as rattan.

Summary

In their recent report Waggener and Lane (1996) conclude that forests are increasingly seen as promoting many national and international objectives, including soil conservation, protection of habitats, watershed maintenance, and related conservation and environmental purposes. They view the establishment of forest plantations more frequently related to these environmental objectives than to strict product or utilitarian objectives. This report concludes that the driving force for plantation establishment by farmers, small-holders and corporate players is instead of a commercial nature. The dwindling supply of raw material from natural forests, rising consumer demands, as well as increasing capacities in the wood processing sector are predominantly responsible for the current growth of the plantation sector. Other factors are the industrialization of the Region's economies, agrarian changes and a market orientation in former centrally planned economies.

Currently plantation forestry in the Region can be described as the intensive management of monocultures for the production of a relatively narrow range of products and species. Main species are and will, in the foreseeable future, be pines, teak, poplars, acacias and eucalypts. Major losses due to pests and diseases as well as fires have not been reported but there have been a number of setbacks. The sector was originally dominated by state involvement. This has changed over the last fifteen years.

With the adoption and adaptation of practices used by producers in the temperate regions, the plantation sector will become modernized and more mechanized. High quality planting material and soil conserving site preparation will increase growth and yields which have hitherto been rather disappointing (see e.g., Pandey, 1995). While single species plantation management will intensify there are opportunities for a slow shift from simple to more complex systems. In order to capitalize on these opportunities more research should be geared towards the management of degraded or secondary forests. Furthermore, state intervention and government support needs to provide the appropriate incentives to motivate investors to consider alternative options to monocultural plantations, particularly in those areas where they replace logged-over forests.

AGROFORESTRY[3]

In short, agroforestry is the use of trees in farming systems. Over the last two decades, it has received increasing attention from policy makers, foresters, researchers and representatives of, in its broadest sense, development projects and NGOs, mainly as a development strategy for rural areas affected by deforestation and land degradation. Thus, agroforestry has been promoted as a means to sustainable upland management and to reduce negative externalities (land and watershed rehabilitation, eradication of grasslands, biodiversity conservation, stabilization of shifting cultivation), to increase soil fertility and agricultural production (soil and water conservation, sloping lands technologies, crop diversification, fodder production, shelter belts), and to satisfy subsistence needs and generate income (fuelwood blocks, small-scale plantations for industrial purposes)[4].

[3] Most information reviewed in the "Agroforestry" section is based on the recently published second edition of Asia-Pacific Agroforestry Profiles (APAN and FAO/RAP, 1996).

[4] While various approaches of agroforestry may have existed for centuries, efforts to mainstream agroforestry are fairly recent. "Conventional wisdom" is yet to develop about many aspects - indeed, there is even some controversy about much that is presented in this section. The views of the author have nevertheless been produced as originally prepared - they should serve to stimulate dialogue and should not be interpreted as reflecting the views of FORSPA, FAO or the FAO Regional Office in Bangkok (Editor).

While it is acknowledged that agroforestry systems have existed and evolved for centuries, foresters originally viewed agroforestry as a new system for using cheap rural labour for establishing plantations (e.g., see Bryant, 1994). The aim of most early agroforestry systems such as taungya, was to eventually increase the area under forest and not to increase agricultural production. With the failure of most taungya-based approaches the definition of agroforestry has been substantially widened. Today, the spectrum reaches from diverse systems such as home gardens, to trees in agricultural fields, alley cropping, plantations of commercial crops (e.g., coffee, tea, coconut, rubber), orchards, woodlots and even shifting cultivation. Depending on the mixture of production systems researchers furthermore distinguish between agrosilvicultural, silvipastoral and agrosilvopastoral systems. With few exception, the increase in diversity does not mean that new technologies have been developed or adopted. Rather, more systems are described today as agroforestry.

For the purpose of the following discussion, a difference is made between traditional agroforestry systems which have slowly developed over time in response to opportunities, constraints and needs, and systems that have been promoted by outside agencies within the framework of development interventions. This is not to say that there is a clear distinction between the systems. All systems should rather be viewed as being somewhere on a continuum between these two extremes. Many of the former, such as trees in fields in Thailand, improved fallow systems in shifting cultivation areas in India and the Philippines, the diverse rubber gardens and damar forests in Sumatra, or the home gardens throughout the Region have only been recently recognized as "agroforestry systems", even though they can make up to more than 14 percent of the total land area as is the case in Sri Lanka. The latter including alley cropping, fuelwood blocks and taungya have been developed more recently.

Traditional systems have gone through many rounds of adaptations. They are still evolving and on the increase where land use pressure is low. Many technologies are developed locally and crop mixtures are adjusted in response to demand and supply. Labour input is not necessarily low but demand is rather flexible. While these systems have many environmental benefits, the farmers' primary objective is not conservation but rather stable and diversified production. Lately, as reported for Pakistan, an overriding common motive is also to generate cash (Hatch and Naughton, 1994).

The prime purpose of the second group of agroforestry systems on the other hand was, and in many cases still is, land rehabilitation and environmental conservation. For example, the Integrated Social Forestry Programme in the Philippines aims to "transform farmers into agents of forest conservation". While there are some local success stories, adoption rates on the whole have been low or unsustainable. There are many reasons for the disappointing results, as will be discussed below.

Performance of Agroforestry Projects

Many extended agroforestry systems were based on supply-driven research, a common problem in forestry research (Nair *et al.*, 1995). Only recently has research shifted from experimental plots to on-farm research after it has become clear that many of the encouraging results could not be replicated by farmers. Technologies developed were extended to very diverse environments

with subsequent failures. The importance of participatory research is acknowledged today, though it is still not common.

There have been only very few innovations in agroforestry. Some of the technologies that have emerged over the last few years are adaptations or refinements of existing agroforestry systems. Alley cropping has received substantial attention in the literature. It has been promoted by development projects and government departments for the last two decades, mainly for soil and water conservation purposes. Alley cropping has never been widely adopted because it has not been developed in response to farmers' problems. It substantially decreases soil erosion and increases water infiltration thus reducing runoff. However, benefits in terms of crop yield increases are frequently not attractive enough to farmers. From their perspective, the costs often outweigh the benefits. That is why recently the research focus has shifted to improved fallow technologies. In a strict sense improved fallowing is also not an innovation. It is already practised in various locations. However, it is doubtful that it will be widely adopted, since the general development is directed towards either more intensive cash cropping of annuals, or more extensive management of perennials.

The supply-driven or top-down research approach is also evident in extension (Enters and Hagmann, 1996). Extension workers still see themselves as teachers educating the ignorant instead of acting as facilitators in the change process. Extension messages are contradictory and there is little co-ordination among projects, programmes and government departments. In other cases, an extension service is absent, which is the case in many remote areas. Agroforestry education and training are inadequate and focus on introducing "officially developed" agroforestry technologies. While changes are evident in research, extension and training, their impact in the field will only become evident in the long-term.

The implementation of agroforestry projects is also a top-down process though bottom-up approaches are receiving more attention. Farmers are often told what to do and when to carry out an activity. This includes many of the silvicultural treatments and intermediate as well as the final harvests. This is very discouraging for farmers who prefer to make their own decisions.

Forestry and agroforestry policies have experienced many changes over the last few years. It has been recognized by now that land security has a significant effect on how farmers decide on long-term investments. However, in some countries forestry regulations and heavy taxation are still an impediment to tree planting (e.g. Saxena, 1994, for the situation in India). Even when tenure and tree rights have been changed in the farmers' favour, farmers do not always believe that these revisions are long-lasting. Subsequently they hesitate to get involved in an unknown venture particularly if permits are required for literally every activity and transaction.

Credit facilities are frequently unavailable to farmers, likewise insurance and price support mechanisms. Marketing constraints exist where physical infrastructure is poor, severely curtailing the production of cash crops within agroforestry systems. Another obstacle is a lack of quality seeds and seedlings, or conflicting delivery schedules with the farmers activities.

The above are some explanations for the poor performance of many agroforestry projects. However, merely tackling these individual barriers will not make agroforestry projects more viable. Instead a major change in approach is required. Therefore, introduced agroforestry has to be as responsive to people's needs as the traditional systems, particularly to arising opportunities, and should not be based on outdated perceptions. As described by Malla (1992) in

Nepal, forestry policies are still designed to assist rural people in the production of fodder when in many areas, due to labour shortages, the number of livestock has actually decreased. Agricultural crop production has been affected in the same way and farmers have responded by planting trees on their private lands.

The growth of the agricultural population in the countries of the Region is much lower than the growth in the urban areas. In China and Thailand, it is only 0.3 percent and in Indonesia even negative. Thus, in combination with the increasing opportunities for off-farm employment, agricultural land will be left idle or, alternatively, becomes available for less intensive forms of land use. The views that all rural inhabitants are farmers and that their activities are subsistence-based are outdated. These new developments will substantially affect the rural landscape in the next decades. As can be seen already, previously cultivated marginal upland areas are being abandoned in Thailand. Some are turned into commercial small-scale tree farms. Even urban investors are planting high value trees, particularly orchards. If economic growth rates can be maintained in the countries of Southeast Asia then we will definitely see more land use conversion from agricultural to tree-based systems though it is doubtful whether these will be agroforestry systems. Instead it can be expected that on the better soils agricultural production will intensify while trees will occupy poorer sites.

A brief review of the more successful agroforestry projects helps to understand what the most likely developments in agroforestry or small-scale plantations will be.

Subsidies and incentives schemes have frequently boosted adoption rates. However, as soon as such scheme ceased many farmers abandoned their agroforestry plots. Similarly, adoption rates were high where communities received benefits in terms of infrastructural amenities or where farmers attempted to avoid reprisals from government departments (Enters, 1995). A heavy handed top-down approach which sometimes includes the use of threats and force has also lead to an increased use of introduced agroforestry practices (Lee, 1995). Whether such examples should fall into the “successful” category is questionable but they help explain what is happening in the landscape.

Insecure land tenure has helped to explain low adoption rates of soil conservation and agroforestry practices. In fact, many farmers plant trees on land that, in a strictly legal sense, is not theirs, to strengthen their claims (Wiersum, 1994). This strategy is often adapted by projects (e.g., in the Philippines) in which farmers receive limited land security as long as they plant trees on a certain percentage of the land received from a forest department. The long-term sustainability of such approaches is threatened in those cases where there is no market for tree products. Once farmers feel that they have secure ownership they may switch back to agricultural crops.

Outlook

Historically, small farmers have been the “most obvious” clients of agroforestry research, extension and projects. A review of developments in some Asia-Pacific countries indicates that in the future this will change. Market liberalization and progressive tenurial land arrangements in former centrally planned economies have a major impact on the rural areas. They provides off-farm employment in the urban areas and stimulate the development of rural industries. It creates markets for forest and tree products which led to the establishment of 2 million ha of

Paulownia plantations in China and an increase in small-scale pulpwood production in Vietnam for export to Japan and Taiwan. In Thailand, farmers responded to the increasing demand for short-fibre pulp by planting trees even though the Forest Plantation Act of 1992 discourages investments in forest plantations. In India, the plywood sector has created a demand for poplar to which the private sector has responded. Arrangements between private companies and farmers have stimulated tree growing in India, Thailand and the Philippines, where the Paper Industries Corporation of the Philippines (PICOP) has a long history of co-operation with farmers (Kato, 1996).

Wood processing technologies have changed too. Rubberwood can now be used by the plywood and the medium density fibreboard sector (see section on wood processing). In India, ammonium fumigation techniques enhance the appearance of eucalyptus wood. The provision of quality seeds and seedlings as well as clonal material is still the exception for the small-scale user but as the example of the Western India Match Company (WIMCO) and ITC Bhadrachalam indicate, private companies have started to provide tree growers with high-quality planting stock (Tandon, 1991; Saxena, 1994; Lal, 1995).

However, it is not technological innovations that explain the increase of private plantations but rather the availability of land that was formerly used for agricultural purposes, market liberalization which has increased the demand for wood as well as non-timber forest products, changes in land security (e.g., in Vietnam) as well as a closer co-operation between rural tree growers and industries.

Due to further population growth and economic development, the demand for wood and wood products will increase in the future. Due to industrial development, the agricultural labour force will decrease. The combination of these two processes means that more wood will be produced in the rural areas outside the reserved forests. However, it is questionable whether the small farmer, particularly the resource poor, will benefit. As examples in India, Laos and Thailand indicate, it will be rather the people who are able to obtain credit or who have the necessary capital who venture into growing trees.

Summary

There will always be a place for traditional agroforestry systems in subsistence economies. Home gardens can be expected to prevail in those areas where rural economies are slowly changing from land-based to industrial activities. They will be maintained as remnants of former practices as long as land prices remain low. In accessible areas, private forestry will be in direct conflict with agricultural systems. Depending on marketing opportunities and prices, farmers will intensify agricultural production and produce for the market as is the case in upland areas where off-season vegetable and fruit production is lucrative. In certain areas (e.g., in Thailand) even urban residents get involved in establishing fruit orchards. Systems such as alley cropping or improved fallows will not be adopted widely. In this sense, the development of “new” technologies with their focus on supporting agriculture will not be successful.

Continuing demand for wood by the wood fibre using industries will contrastingly stimulate farmers to grow trees. Small-scale tree growing enterprises will boom in places which can

offer alternative employment opportunities, fair marketing agreements between tree growers and the industry, and sufficient support structures in terms of extension and regulations.

As examples throughout the Region indicate, there is a great potential for agroforestry. However, this forecast needs to be qualified. First, agroforestry will not be a system for land and forest rehabilitation as long as farmers do not receive land security. Second, the resource poor rural population will benefit only marginally from an expansion of agroforestry activities. And third, agroforestry will not be the species diverse and extensively managed home gardens or "kebuns" but will rather be intensively managed small-scale plantations with the objective of producing only one or two products.

NON-TIMBER FOREST PRODUCTS USE AND MANAGEMENT

Relative to forest management for the production of timber, non-timber forest products (NTFPs) and environmental services received only scant attention by forest departments until recently. Interest in NTFPs grew slowly during the 1980s, in response to calls for using forests sustainably for the benefit of the wider society and particularly the rural population. NTFPs include plants used for food, beverages, forage, fuel, medicine, fibres and biochemicals; animals, birds and fish for food, fur and feathers; as well as their products such as honey, lac and silk (Wickens, 1994). Today's interest in NTFPs is based on the argument that in order to conserve the world's tropical forests we have to find new products, develop markets and improve marketing systems for NTFPs, so that the forests will become far too valuable to destroy (Byron and Ruiz-Pérez, 1996). Shiva (1995a, p. 333) called NTFPs the "potential pillars of sustainable forestry". The current and potential value of NTFPs for local communities is being utilized in integrated conservation and development projects (ICDPs). An underlying assumption is that communities will conserve and protect forest resources if they receive tangible benefits from sustainable forest utilization (RECOFTC, 1995). While this assumption still needs to be tested, currently local people appear to have only very limited rights to forests, despite the recognized importance of NTFPs for income generation and food security (Lynch, 1995).

NTFP Research

More than twenty years ago, Robbins and Matthews (1974) predicted a widespread revival of interest in naturally occurring raw materials, including many NTFPs, though they cautioned that the magnitude of such revival could only be speculated. They furthermore suggested that a broader, long-term examination of the economic opportunities of NTFPs would indeed be desirable. Today, there is no dearth of research results on NTFPs. However, most studies in the NTFP sector have been descriptive, product oriented, generally not systematic, and focused on biological issues. The social science dimension has been neglected (Nair, 1995). The status and potential of many NTFPs is still not fully understood and appreciated (Gupta, 1994), there is a lack of actual production records for the majority of products and reliable data on the value of NTFPs used domestically do not exist (Silitonga, 1994). In addition, information on how to manage forests to yield a variety of products is insufficient (Wickens, 1994). Though fuelwood has received increasing attention since the onset of "the second energy crisis", only little is known about the contribution of fuelwood to national economies, employment and income generation, and how and from where fuelwood is coming to the market (Hulsebosch, 1994). Just as limited is the knowledge on use efficiencies and adoption of improved cook stoves.

Most studies are of a disciplinary nature and characterized by disciplinary biases. Research is carried out on a case-study basis, lacking evolutionary perspectives, which hinders the identification of common threads and the anticipation of trends (Ruiz Pérez, 1995). This begs perhaps the question whether we should expect any common threads and trends. In terms of natural forest endowment, climate, history, population, forest policies and economic development, the countries of the Region are just as heterogeneous as NTFPs themselves. Even within countries the conditions are so diverse that certain products are over-exploited in one area while neglected in others. It could be argued that NTFPs and their uses are so diverse that any trend and development can be predicted.

Employment and Income Generation

While policy-makers have tended to overestimate the employment benefits associated with timber harvests (Gillis, 1992), the significance of employment and income generation in the NTFPs sector was underestimated and remains to a large extent obscure even today. To many forest managers NTFPs are still what they used to be called until recently: minor forest products. The example of India indicates that this view is highly distorted. NTFPs contribute about 50 percent of forest revenue and 70 percent of income through export (Campbell, 1992, cited in Sekar *et al.*, 1996). They also contribute 10 to 40 percent of income to the 50 million tribal households in India (Shiva, 1993, cited in Sekar *et al*., 1996), while about 200-300 million villagers depend on NTFPs to varying degrees (Shiva, 1995b). In Indonesia, the rattan industry alone provides employment for 200,000 people (Haury and Saragih, 1995). More than 320,000 people are involved in NTFP production in Vietnam (Tien, 1994) and in Bangladesh NTFPs provide employment for nearly 300,000 people (Basit, 1995). In India, 1.6 million person-years are generated in the NTFP sector (Gupta, 1994). In Malaysia, rattan collection has been estimated to contribute 14.8 percent of the economic activity of residents in the swamp forests (Kumari, 1995). These figures are impressive in themselves but are dwarfed by the number of forest dependent people and obscure the magnitude of the contribution of forest based activities to total income of many rural households, which case studies in Sri Lanka (Gunatilake *et al.*, 1993), Indonesia (De Foresta and Michon, 1995) and India (Hegde *et al.*, 1996) have shown to be between 50 and 75 percent.

Diminishing Resource

Despite the continuing dependence of many rural people and industries on NTFPs, most products are overexploited. Destructive harvesting is rather common (Peters, 1996), thus casting some doubt on the possibility of promoting the use of NTFPs in ICDPs. The fragility of extractive economies in general and the unsustainable use of NTFPs in particular have been pointed out, amongst many others, by Peluso (1991), Homma (1992), Hall and Bawa (1993), Gupta (1994), Wickens (1994), Ros-Tonen *et al.* (1995) and Antolin (1995). While the diminishing natural resource can be partially explained by forest conversion and destructive timber harvesting methods, the reasons for over-exploitation in remaining natural forests are very complex.

In the past a number of social and environmental constraints held over-harvesting of NTFPs in check (Peluso, 1991). Where population numbers are low, accessibility restricted and

subsistence use predominates, most products are still used sustainably and traditional restrictions and regulations are heeded. Today, however, even remote areas are accessible, resulting in the breakdown of traditional controls. As a result, very aggressive collection behaviour develops for commercially important NTFPs such as wild honey, mushrooms, rattan, bird nests and gaharu. The traditional collectors suffer most from the run on available supplies. They are usually not organized. Furthermore, the existence of monopsonies in marketing NTFPs leads to inefficiency in marketing and very low returns on labour to collectors. Market expansion for many products has led at the same time to greater competition among collectors and traders. As Basha (1996) pointed out for bamboo, the traditional NTFP sector is less harmful to the resource than the newer commercial sector. While other studies generally confirm this finding, the issue is far more complex, particularly because first there is no clear distinction between subsistence and commercial use. Second, the NTFP sector is very dynamic. As a result products recently classified as belonging to the traditional sector belong, today, to a very organized commercial sector. Even the opposite is possible when NTFPs are replaced by industrial substitutes such as plastic, and hence lose their importance altogether.

Dynamics of NTFP Use

Homma (1992) has described the dynamics of NTFPs use for Amazonia. They apply also to the situation in the Asia-Pacific Region. Most NTFPs are characterized by limited quantities, seasonal availability, quality control problems, and inelastic supply. This constrains the commercial development for many products and confines their sustainable use mainly to the subsistence sector where there is no incentive to harvest more of a product than can be utilized by a household or a community (Warner, 1995). If commercial interest develops and marketing opportunities appear, exploitation intensifies (Nair, 1995) and harvest rates exceed regeneration rates, particularly in accessible areas. If returns to collectors remain low, raw material shortages are common. This development has been described for rattan (larger diameter stems of manau and batang) in Kalimantan where 80 to 85 percent of the rattan harvested come from the natural forest (Haury and Saragih, 1995). A price increase of nearly 100 percent raised the profitability of rattan collection, which enabled collectors to explore more remote areas and ended the shortage experienced in Java.

In response to labour shortages, further declining supplies and strong demand of an expanding market, domestication replaces products collected from the natural forest. It is frequently triggered by unmet demands of markets with potential (Ruiz Pérez, 1995). This explains the recent development of large scale rattan plantations in Malaysia (Poh, 1994), where the government is promoting the rattan industry for export. Other products which have been domesticated are rubber, oil palm, many tropical fruits, cocoa, coffee, tea, cardamom, cinnamon, cashew and pepper. Domestication and plantation establishment reduce production costs and increase productivity. They succeed where technologies are available, prices remain high and substitutes do not exist. If natural products can be replaced by industrial substitutes, domestication is of no or only short term significance. A prime example of industrial substitution is medicine. In Malaysia, for example, local people prefer modern over traditional medicine as the former is regarded as more effective and readily available in the rural areas (Lim and Ismail, 1994). Also, with the emergence of a growing middle class and growing domestic economies in the Region, markets shift from being supply-driven to demand-driven with higher quality expectations and requirements (FAO, 1995a). The example of the traditional umbrella and wooden clog industries in Indonesia, highlights that producers of wooden handicrafts can be

affected quite rapidly by changing demands and the availability of synthetic substitutes (Hadi, 1991).

NTFPs in the Rural Economy: Who Benefits?

While the differences between the use and management of NTFPs on one hand and timber and natural forest management on the other cannot be denied, there are also some striking similarities. Both products are characterized by over-exploitation, affected by government regulations and their weak enforcement, and a trend towards domestication or plantation management. The biggest difference lies in the composition of stakeholders. While natural forest management in the Region is performed by government departments and capital intensive industries, the NTFPs sector is predominantly dominated by the rural poor and labour intensive small-scale industries. As will be shown below, they are not the only stakeholders determining the future of NTFPs. However, political, social and economic changes in the Region are very rapid. This very much affects people's aspirations and decisions. NTFP activities are in many situations perceived as a sponge, and their use is transitional, giving way to other enterprises and products as the economy improves (FAO, 1995a). Village life can be expected to look quite different offering constraints and opportunities for the development of NTFP collection, processing and marketing.

The benefits of current exploitation of NTFPs for commercial purposes are unequally spread among participants (Ros-Tonen *et al.*, 1995). Low returns to labour usually accrue to collectors though there are always exceptions (Richardson, 1995). The NTFP sector has been described as a low wage trap in India (Nair, 1995) and according to Bandaratillake (1995), it is associated with a suppressive caste system in Sri Lanka. Where alternative income generating opportunities are unavailable, products are collected and sold even when prices are depressed (Warner, 1995). Studies on timber and other forest products in China suggest that farmers only capture between one quarter and one third of the huge profits occurring in the sector (Changjin, 1992, cited in Ruiz-Pérez *et al*., 1996). Lim and Noor (1995) described rattan gathering in Malaysia as not very attractive. On the other hand, petai (fruit of *Parkia speciosa*) harvesting can be quite lucrative. During good days, a harvester working alone can earn up to RM 120 (US$ 48) per day. This explains why today Malays and even Indians participate in this activity, which in the past was mostly done by aborigines living within or along the forest.

Government-run marketing and co-operative schemes have also failed to get better prices for NTFP collectors. In India, the existence of a monopsony in marketing NTFPs in tribal areas has lead to inefficiency in marketing. For example, the Large Agriculture Multipurpose Societies (LAMPs) pay poorly to even as low as 7 to 15 percent of consumer's price (Sekar *et al.*, 1996). This indicates that government marketing agencies are less efficient in assisting farmers in marketing. In a competitive market environment, it is difficult for any government agency or non-government organization to play a major role in marketing. The prices and services as well as the friendship of the existing middlemen are far more attractive than the restricted services provided by the government agency (Lim and Woon, 1994). In addition, where markets have developed, the state's influence on production and consumption behaviour is dramatically reduced (Ruiz-Pérez *et al.*, 1996).

The low returns to labour and the inefficiency of co-operatives to increase price levels for NTFP collectors are compounded by the high vulnerability of traditional collectors to competition

(FAO, 1995a). As the example of petai indicates, outsiders are quick to recognize an opportunity. This is even the case in Malaysia where the frequency of NTFP extraction appears to be declining (Kumari, 1995). Thus, it is doubtful that accelerated commercialization will be in the interest of rural welfare if it attracts too many outsiders (Richardson, 1995).

The interest of rural welfare raises another crucial issue, that is the interest of individuals in the rural areas, the forest and the forest margin. As Byron and Ruiz Pérez (1996) point out NTFPs will continue to be very important to hundreds of millions of very poor people, but many current 'traditional' uses will decline as users' incomes rise and they can afford alternatives. While the importance of NTFPs in the rural economy has often been ignored the fact is also that in certain situations it may be overestimated. For example, in Malaysia, one of the most developed countries in the Region, NTFPs continue to be sold in various types of rural and urban markets. However, their numbers and their value relative to other goods are low. This finding is consistent with the general theory that the importance of forests as a source of extractive products declines during economic development (Vincent and Binkley, 1991, cited in Lim, Vincent and Woon, 1994).

Interest in NTFP collection and indigenous knowledge in collection and processing are not lost because a diminishing resource or restrictions reduce its availability. In many places, the returns to labour in alternative employment are more attractive. In other words, it is not in the interest of local people, be they forest dwellers or not, to remain in non-market economies (Richardson, 1995). In addition, even forest dwellers tend to replace natural products with synthetic products (Ros-Tonen *et al.*, 1995).

The majority of rural people in the region still rely on fuelwood for domestic cooking and heating. Since the early 1980s, improved cook stoves (IC) have been developed and distributed to reduce the demand for fuelwood. Fuel savings were anticipated to be in the order of 35 to 50 percent. The urgency to tackle "the second energy crisis" of the 1980s appears to have faded. There is only very limited information available on the adoption of ICs. Regarding the efficiency of ICs it appears to be clear that the improved stoves save wood (Bialy, 1991). Field data of fuel consumption show a wide range of efficiencies, which in one study in Karnataka, India ranged from 8 to 35 percent. Some people even claimed that ICs take more fuels than traditional stoves and Ramakrishna (1991, p. 9) concludes that "by and large, users are not concerned about saving fuel".

Outlook

It cannot be over-emphasized that NTFPs are an extremely heterogeneous group. They are collected for different reasons by different people. Some are consumed without any further processing and play no role in the market place. Others go through a long chain of traders and processors before reaching a highly competitive international market. Some come from the natural forests, while others have been domesticated for centuries. Others such as rattan are just in the process of domestication, or are losing their importance due to substitution by industrial products. Much of what happens in the forest, the processing industry and the market is very much influenced by the political framework conditions, socio-economic changes, market development, technological opportunities as well as people's perceptions and preferences.

Market development for most NTFPs from natural forests is difficult and time-consuming - many established or higher value products such as illipe and gaharu are already controlled by commodity traders; others yield limited returns; while some with potential are found in limited quantities on a seasonal basis and often need further research and development (RECOFTC, 1995). With regard to food processing Rice (1995) reports that it is not a programme for the faint-hearted. Also, particularly international markets demand attention to detail, quality control, service and delivery schedules that are difficult for small-scale indigenous micro enterprises to provide (McCallum and Sekhran, 1996). On the other hand, the examples of rattan in Malaysia or bamboo in China indicate that a successful processing and marketing programme can be implemented under the right economic conditions and private business interest. However, a successful programme neither guarantees sustainable production of NTFPs in natural forests nor is it likely to benefit the intended target groups. In fact, in both examples supply comes increasingly from plantations, a trend which is also described by Hadi (1995) for traditional medicines and Ahmad and Haron (1996) for bamboo.

This trend will likely continue for products of major commercial importance. Rattan will be increasingly produced in plantations triggered by unmet demands throughout the Region with Peninsular Malaysia and Sabah taking the lead. More than 21,000 ha of rattan plantations have been established in Sabah alone (Tay and Abi, 1995). Bamboo's future is mixed because of its gregarious flowering. In Thailand, for example, plantations of *Dendrocalamus asper* entered full production in 1994. Production and exports of bamboo shoots, however, have suffered a dramatic setback due to gregarious flowering all over Thailand that began in November 1994. By June 1995 the flowering had already meant the loss of 38,400 ha of bamboo plantations with a cost of US$ 45 million in direct investments, affecting 35,400 farmers (Thammincha, 1995, cited in Ruiz-Pérez *et al*., 1996).

In principle, exploitation of NTFPs from natural forests can be sustainable. In practice, it is frequently not. A necessary requirement (but not a sufficient one) for sustainable exploitation is a land tenure system which ensures exploitation rights to local extractors. Since we will not see any major changes in forest tenure, NTFPs will remain accessible not only to local people but outsiders too. Price increases will guarantee over-exploitation even in those cases where outsiders' resource access can be restricted. As Gurung (1995) reports, even in remote Himalayan regions, villagers feel the need for cash, and resources are subsequently overused. In fact, as Smits (1996) notices, the modern age has lead even in the remotest places to the abandoning of traditional ways of life. This hampers sustainable use, particularly where people view it as a backward activity, often less remunerative than alternative ways of generating income, and where pressures to change to foreign patterns of consumption grow (Ruiz Pérez, 1995). Hence, it can be safely assumed that "fewer people want to undertake the dangerous, illegal, difficult and sometimes barely profitable activities of temporary agriculture in forest lands" (Byron and Ruiz Pérez, 1996, p. 127).

Summary

A thorough analysis of the available literature allows for the prediction of almost any trend regarding the future role of NTFPs, in general, and for individual products. Based on the changes that are currently taking place, the future of NTFPs as raw materials from the natural forests of the Region appears bleak, which is not to say that NTFPs will lose their importance in contributing to subsistence economies. Over-harvesting and an increase in opportunity cost to

labour make the raw material supply of NTFPs from the natural forest for many products more and more unreliable. Increasing demand will result in diminishing resource supply and trigger the process of domestication. Policy changes, described for China by Ruiz-Pérez *et al.* (1996), can have a very positive effect on the production and processing of individual NTFPs. However, the increase in value will rather take place outside the natural forest and not inside. It can therefore be argued that NTFPs as "pillars of sustainable forestry" have only limited potential. Furthermore, the development that can be expected casts doubts on the underlying assumption of ICDPs that communities and individuals will conserve and protect forest resources if they receive tangible benefits from sustainable forest utilization. Tangible benefits will accrue increasingly to NTFPs from plantations. This also means that the natural forests will not become valuable enough to prevent conversion to other, financially more attractive, land uses.

Ample opportunities exist for enhancing export earnings by developing appropriate facilities for processing, drying, storing, packaging, and marketing NTFPs (Gupta, 1994). Many technologies are available and need only be adapted for local use to revive, as Robbins and Matthews (1974) predicted, a widespread use of naturally occurring raw materials. A trend towards green markets (compare with certified timber) may affect the future role of NTFPs. However, this will apply only to few products and niche markets. In fact, it provides a "dangerous distraction from the political and economic changes that must be made to encourage conservation of the world's tropical forests and improve the lot of the people who live there" (Dove, 1994).

In general, it appears that the increased attention that NTFPs have received over the last fifteen years has neither affected natural forest management nor improved the livelihoods of millions of people. While the future does not have to be necessarily a reflection of the past, it can be speculated that nothing much will change over the next fifteen years with the exception that some selected products of commercial importance, particularly rattan, will be managed more intensively and fuel a growing industry.

WOOD PROCESSING

The major wood product categories are sawntimber, wood-based panels, woodchips, paper and paper products and miscellaneous others including poles and railway sleepers. During the last several decades, forest product processing technologies have undergone extraordinary advances in some of the above categories. Improvements have been achieved in terms of recovery rates, higher qualities in terms of durability and protection, higher utilization of NTFPs such as bagasse, various grain stalks and bamboo, as well as the development of new products such as reconstituted wood-panels. Progress has not been homogenous in all the forest product utilization categories. Even though there is only little information available on the subjects of technology acquisition, adaptation and innovation for the forest-based industrial sector (Contreras-Hermosilla and Gregersen, 1991), it is clear that sawmilling has been far less affected by the spread of innovations than the manufacturing of panel products. There is still a high number of outdated mills in operation which have very low recovery rates, frequently less than 40 percent.

The technological changes that have taken place within the Region have not occurred randomly. Many of the technologies that are increasingly adopted and adapted have been developed in industrial countries. Some of them, such as medium density fibreboard (MDF) production technologies had been in use, tested and refined for more than 25 years before they

featured more prominently in the Region. Most the machinery is still imported, predominantly, from Europe. Others such as oriented strandboard (OSB) production does not exist yet in most countries of the Region and its market is underdeveloped.

The following four reasons account for the contemporary developments in those categories that have experienced changes and those that have remained largely stagnant in terms of modernization:

- decreasing raw material supply;
- reduced availability of large-sized timber;
- increasing responsiveness to environmental pressures; and
- government policies to develop domestic wood-based industries.

As a result of government support, the number of processing plants has increased substantially and products have become diversified. The first three factors disclose why the traditional sawnwood sector has lagged behind the other sectors. They also explain the declining importance of the plywood sector which has been significantly affected by a reduction in wood supplies as well as competition with MDF whose production costs are considerably lower. In Indonesia, the raw material shortage resulted in production capacities as low as 50 percent for some firms, while older facilities with inefficient machines opted to close down (Adhar, 1996). Excess capacities are also reported for Sabah (Tay and Abi, 1996), which did not, however, affect the lifting of the log export ban that had been imposed in 1993 (Anon, 1996d).

In general, the wood processing industry is currently undergoing major structural changes with a gradual switch from the production of timber products using large diameter trees to those utilizing smaller diameter from second cuts, as well as moving toward plantations and the estate sector. Product diversity has increased to such an extent and developments have been so variable that only three more recent developments will be used to illustrate which further changes might be expected in the following decade. For this purpose the developments in the MDF category, the increased use of rubberwood and the potential of oil palm as a raw material for the wood-based panel industry, will be described.

Medium Density Fibreboard Production

The recent developments in the MDF sector are very similar to the earlier developments in the plywood sector. The main difference is that the latter was a response to government policies promoting domestic wood-based industries while MDF production plants sprang up because of the raw material shortages that have become increasingly evident during the last few years and the opportunity of using formerly untapped resources. Another difference is in the installed capacity of MDF which lags behind the plywood sector. Globally, it stands at 15 million m^3/year. By the end of 1996, the Asia-Pacific Region is expected to become the leader in MDF production with an installed capacity of well over 5 million m^3/year (Anon, 1995a).

Important raw materials for MDF include radiata pine (New Zealand), mixed tropical species (Japan), rubberwood (Thailand), bagasse (Pakistan, China and Thailand) and cotton stalks (India) (Wadsworth, 1995). The only raw material used in Malaysia is rubberwood, in contrast to particleboard or cement-bonded products which rely more on a mixture of species and

wood waste. The light colour of rubberwood and uniform texture provide an ideal fibre resource for MDF production.

The MDF production process involves in the first steps debarking and chipping. Cleaned chips are cooked in a digester and refined into wood fibres which are then mixed with resin and wax. The mixture of wet fibre, resin and wax is dried and transported to the mat former before it is pressed to produce a continuous mat. In the final processing stage it is trimmed, sanded and cut to specified dimensions. Depending on customer requirements board thickness varies between 2.5 and 32 mm.

MDF and OSB have emerged as price competitive alternatives to the more traditional products such as plywood, particleboard and hardboard. With similar characteristics to plywood products, their greatest advantage is that low quality and low value raw materials (including non-wood fibres) can be turned into high value and high quality wood-panels. This clarifies why their production costs are about 50 percent lower (Adhar, 1996). Because of the desirable and user-friendly physical properties and favourable machining properties, MDF has a variety of end-uses and can replace tropical hardwood timbers for furniture. The production process can virtually use all wood species of minimum log diameter down to 5 cm. In addition, it is marketed as an environmentally friendly product which relies on sustainable resources such as rubberwood, radiata pine and non-wood fibres. The combination of these advantages testify to the massive investment in MDF production plants.

The Rubberwood Success Story in Malaysia

Until about fifteen years ago, the commercial value of rubberwood as a raw material for the wood processing industry was negligible. Due to the high sugar content, rubberwood biodegrades rapidly. In addition, it is susceptible to insect infestations after felling. Notwithstanding these problems, rubberwood has always been an under-utilized raw material with potential, particularly with the onset of log shortages from natural forests. Hence, as is the case with MDF and oil palm (see below), the initial impetus for investigating its potential came from the need to search for alternative sources for an ailing sawmilling and wood processing industry, particularly in Malaysia (Hong, 1995). While Malaysia was not the first country to utilize rubberwood, it was the first one to export it successfully.

Today the significant utilization of rubberwood can be attributed to the combination of research and development by the Forest Research Institute Malaysia and the development of marketing strategies by private companies and related government agencies (Hong, 1995). At present, rubberwood comes exclusively from plantations established for latex production. With an expected increase in demand and shortage in supply, the growing of rubber trees for the sole purpose of timber production is envisioned. This would dramatically increase recovery rates which are currently as low as 25 percent.

Most affected by the research and marketing success have been the furniture and panel products industries. In Malaysia, rubberwood has out-performed many of the traditional light-coloured species used in the production of furniture. Its availability and low price has resulted in the expansion of the furniture industry. Of the approximate USD 600 million for furniture export values in Malaysia, around 70 percent is from rubberwood.

The growth in the MDF sector in Malaysia is also the direct consequence of rubberwood abundance. As reported by Hong (1995), rubberwood has all the required ingredients to make it successful in the wood-panel sector. It is a homogenous raw material, available in large volumes and a renewable resource - a very important criterion for the sensitized wood processing industry in Malaysia. The benefits from making rubberwood attractive for the wood processors and ultimately the consumer have been spread fairly widely. Today small-holders and farmers can sell their trees per truck load to the industry, not only on Peninsular Malaysia but also in Sarawak.

Oil Palm Fibre as an Alternative Raw Material

The wood processing industry has recently experienced shortages in rubberwood supply. There are a number of reasons for this latest development. First, climatic (prolonged wet periods) conditions render harvesting of rubberwood, particularly on steeper slopes, inefficient. One has to remember that rubber plantations were established for latex not for wood production. Second, the resource is not available in more desirable large blocks affecting economies of scale. And third, even rubberwood turns out to be a finite (at least in the short- to medium-term) resource as demand outstrips supply. Therefore, the industry is already in search of alternative raw materials. Acacia mangium is receiving increasing attention. Its characteristics are well known though many questions regarding its silviculture and suitability for the timber industry still remain.

The search has recently included oil palm, plantations of which are increasingly replacing those of rubber in Southeast Asia. In common with rubber, it is an under-utilized resource with potential application in a number of industrial sectors. The empty fruit bunches of oil palm are used as mulch, boiler fuel, fertilizer, and for the production of car cushions and mattresses. Research is currently investigating the use of oil palm fibres for various wood-based boards, pulp and paper, mushroom cultivation and as animal feed (Akmar et al., 1996). The fibrous strands of the trunks and fronds are suitable for manufacturing pulp and paper, chipboard, and cement/gypsum bonded particleboard (Anon, 1995b). The fibres of the empty fruit bunches can be used for laminated isotropic fibreboard, cementboard, and pulp.

Research results suggest that the quality and physical characteristics of fibreboard made from the empty fruit bunches of oil palms surpass those of particleboard. In general, their quality is comparable to rubberwood particleboard (Yayah et al., 1995). In Malaysia, the first companies have produced furniture from oil palm fibres. Its increased use is viewed as achieving zero waste in the oil palm industry (Anon, 1995b). This translates into substantial cost savings which partially explains the enthusiasm of some companies to venture into panel manufacturing.

Outlook

The current developments in the wood processing sector are a response to a mixture of emerging constraints and opportunities that have existed for a much longer time. Advanced machinery and technologies for more efficient wood use have existed in industrial countries for decades. However, their adoption was neglected in the Region (predominantly in the tropical countries) because first, the natural forests were viewed as an infinite resources, and

second, limits to harvesting large-sized timber were not expected so soon. Looking at the processing capacity of wood processing mills and the future supply scenario of timber from natural forests, the main concern that has arisen is the future availability of logs. This concern has stimulated an entry into the reconstituted wood-panel industry as well as the use of formerly under-utilized or discarded raw materials, as the examples from Malaysia have revealed.

Wood-panel products with their advantages, in terms of cost and technical property, have developed from plywood to particleboard and MDF, through an evolution from using basically solid wood to using fibres of a variety of products. This development has not only produced more homogenous products, but reconstituted panel production also has much higher recovery rates than sawntimber or plywood. Furthermore, reconstituted panels can be made from a variety of products. Compared to solid wood and plywood, large uniform panel sizes free of any natural defects can be obtained (Yayah et al., 1995). The tremendous growth of the wood-based panel industry is clearly a reflection of the limited wood availability.

With further advances in lamination possibilities, special grades and properties, including moisture resistance, fire retardance and exterior grades, it can be safely assumed that the current growth rates will continue. The expected growth in ready-to-assemble furniture will increase the awareness of the special characteristics and advantages of wood-based panels, particularly MDF and OSB. In addition, new factories can be erected with relative ease.

The decreasing supply of large diameter logs will require a further restructuring of the plywood industry. Depending on the success of marketing strategies for boards such as MDF or OSB, the tropical plywood sector will shrink faster than expected, at least in relative terms, as substitutes and more efficient uses are developed (Anon, 1995c). Reconstituted panels will not be able to substitute all solid wood products but laminating technologies will assist in making them attractive to consumers. Also, finger jointing technologies will allow manufacturers to arrived at desired length of the final products.

Vertical and horizontal integration of productive units will provide opportunities to increase employment and efficiency of wood use. Currently there are no incentive structures for reducing wood waste during harvesting operations in natural forests, or for transporting the waste to processing mills (Kadir et al., 1994). In fact, there is even no interest in extracting waste when no royalties and fees are charged (Shaharuddin, pers. comm., 1996).

The most logical way to overcome high extraction and transportation cost is to pre-process timber at the logging site. As discussed by Kadir et al. (1994), there are several institutional, social and political problems related to licensing portable sawmills. An alternative, particularly in the vicinity of reconstituted panel manufacturers, is the use of mobile chippers which will become viable once infrastructure has been improved and rubberwood has lost its competitive edge over wood waste. Mobile chippers will be particularly attractive for secondary forests where the mean diameter of trees can be expected to be far lower than in the “primary” forest.

As Wadsworth (1995, p. 23) explained for MDF, the development of wood product consumption does not lie in the “introduction of new technologies or exotic fibres, but rather, in the more widespread application of sound and vigorous marketing”. Notwithstanding the need for better targeted marketing to increase the appeal of wood-based panels to consumers,

it is also possible that new technologies will achieve greater structural properties of panels and that recycled materials such as plastic can be used in manufacturing environmentally friendly composites.

The previous discussion has omitted any mention of potential advances in sawmilling. In comparison to how other categories within the wood processing sector will be affected by technological changes, the developments in the sawmilling sector will be less dramatic. The older and least efficient mills will slowly be phased out and replaced with new mills capable of maintaining or even improving recovery rates while their supplies are changing to smaller diameter logs. Here again, the technologies are already available. It is only a matter of providing appropriate incentives to encourage producers to upgrade their facilities.

Pulp and paper have also seen enormous growth rates over the last decade. New technologies for pulping mixed tropical hardwoods created a market for salvage timber (Byron, 1996). A change that will affect the industry are stricter environmental regulations regarding effluent discharge. A more important aspect for the pulp and paper industry (particularly the large scale complexes) is whether it will be able to satisfy its raw material demand. Most manufacturers hope to eventually rely on plantations of fast growing trees only. Recent reports summarized by Nilsson (1996) showed that they may be overly optimistic. One alternative would be to substitute non-wood fibres for wood fibres (Wilson, 1995). At present the main non-wood pulping capacities are located in China (74 percent) and India (6 percent). The potential of non-wood fibres is great but their use has also several drawbacks. Therefore, it is doubtful that in the next ten to fifteen years “they will become a hot item for the pulp and paper industry to tackle”, as Croon predicts (1995, cited in Nilsson, 1996, p. 24), or that we will experience an “agroforestry fibre revolution” as Wilson forecasts (1995, p. 13).

Summary

The technological developments that have taken place over the last couple of decades and will shape the future of the wood processing industries are mainly a response to declining raw material supplies, in particular the shortage of large diameterlogs. The sawnwood and plywood categories have reacted to shortages to some extent. Both have improved recovery rates and are able to handle smaller diameters today. However, in comparison to equipment used in industrial countries there is still a major gap.

Developments have been more pronounced in the wood-based panel categories. Not only has there been a rapid transformation from plywood to particleboard, but most processors have also switched to alternative resources. Thus, today Malaysia’s MDF producers rely solely on rubberwood. In the future, it can be expected that some producers will rely on oil palm fibres or other non-wood fibres. However, the latter are available mainly seasonally incurring additional costs in logistics and storage.

The wood processing evolution that the Region has witnessed will continue over the next ten to fifteen years. As a result, the dependence on large-sized timber will decrease further, influencing traditional forest silviculture and other forestry practices. Secondary forests and plantations will become more attractive.

Moreover, the importance of reconstituted wood-panels will gain momentum in the Region with its growing middle class spending a significant amount of its income on furniture. Marketing strategies will play a significant role in reducing consumers' preferences for solid wood products and increasing the acceptability of panel products.

CONCLUSIONS

During the last fifteen years the forestry sector of the Asia-Pacific Region has been influenced by a number of developments that will continue to shape it into the next century. In the absence of interventions to increase forest productivity and to promote end-use efficiency, wood consumption has exceeded the sustainable supply capacity of the Region's forests. Increasing wood shortages have stimulated the discussion on introducing changes in policies, management and technologies. In addition, environmental concerns and the discussion about timber certification schemes have raised the awareness of the need for sustainable forest management. This raises the question of how the forestry sector will respond to societies' demands.

It would be superficial to view the widening supply and demand gap as well as environmental concerns as the only determinants of current and future change. Though the developments in the various countries are far from uniform, a transformation from an agricultural economy to an economy based on manufacturing is currently shaping the rural landscape, industrialization and labour availability. Modernization and commercialization have particularly influenced the use of NTFPs leading in many cases to over-exploitation. Urbanization, improved educational standards and a growing middle class does not only translate into higher consumption rates. It also means a transformation in values, the realization that forests have more to offer than just wood, and an environment potentially conducive to technology changes. Market liberalization in former centrally planned economies have opened opportunities in tree growing and downstream processing. It has lead to an increasing involvement of the private sector in forestry which is also experienced in other countries. The plantation sector is especially affected by the diminishing role of the public sector. This has furthermore influenced research where the private sector is also replacing public research as the latter suffers from inadequate funding. And last, but not least, forestry in the Region is affected by globalization of production and trade which have influenced the flow of capital to areas of comparative advantage in terms of prices and government regulations.

Reasons for Technology Change

The review focused on developments in natural forest management, plantation management, the wood processing industries, agroforestry, and the use and management of non-timber forest products. Of these five sub-sectors the last two have hardly been influenced by technology changes. Only few technology changes have affected the management of the Regions natural forests whereas most changes have been recorded in the plantation and the processing sub-sectors.

Economic growth and industrialization have created employment and income generating opportunities in non-land based activities, which has reduced the dependence on the agricultural sector paralleled by a labour shortage in the rural areas. It is perhaps the last two factors, that

account for the rather insignificant technology changes in agroforestry and NTFP related activities. The opportunity costs of remaining in labour intensive activities are too high in comparison to benefits that can be achieved in other sectors. Particularly in agroforestry the emphasis has been and, to a large extent still is today, on resource conservation and long-term benefits, whereas many farmers are looking for means to increase production in the short-term. New agroforestry technologies have only partially responded to this need. Diverse agroforestry systems will remain in existence in many countries but in those limited cases where farmers maintain agroforestry, simple systems (e.g., fruit orchards in many upland environments and poplar and annual crops in India) with their financial attractiveness are the norm.

With few exceptions, the NTFP sub-sector has suffered from a lack of incentives for resource management, further value-adding and downstream processing. Harvesting of NTFP is often unsustainable, particularly for commercial products. Conflicts over resource ownership have fuelled over-exploitation and increased the risk of investing in any processing industry based on naturally occurring products. Many people view NTFP collection as a backward activity and many products themselves as primitive or old-fashioned, and replace them with more "western" products. With few exceptions, investments in new technologies have been and will remain unattractive.

As denoted above natural forest and plantation management as well as wood processing have experienced technology changes particularly in recent years due to various push and pull factors of primary and secondary importance. They include:

- increasing demand;
- decreasing supply particularly of large diameter trees in easily accessible and environmentally less sensitive areas;
- environmental pressures, in general, and stricter forest policies in particular;
- export restrictions of unprocessed or semi-processed products;
- government incentives for developing domestic wood-based industries;
- increasing involvement of the private sector;
- urbanization and labour shortages in rural areas;
- supply shortages during unfavourable climatic conditions;
- market liberalization;
- real and expected prize increases; and
- availability of formerly under-utilized raw materials (e.g., rubber and oil palm).

Natural Forest Management

Natural forest management has been particularly affected by increasing consumption and a dwindling supply of raw materials. The main wood suppliers, Malaysia and Indonesia, had to expand harvesting activities to more mountainous environments for which the conventional logging systems are less suitable. This has led to the introduction of skyline cable systems and helicopter logging. However, both systems have been introduced only recently, to a very limited extent and for operations in environmentally sensitive areas.

The second innovation in natural forest management, the introduction of reduced-impact logging, is a response to environmental concerns over the negative impacts of destructive

logging. Research into reduced-impact logging has been stimulated by the move towards sustainable forest management, timber certification and interest in carbon sequestration.

In comparison to the plantation and wood processing sub-sector, technology change in natural forest management is in its infancies. The main reason for this is that there are still ample opportunities for conventional logging. Larger-scale corporations have relocated some of their operations to other countries. Thus, from a corporate perspective there has been little pressure to innovate.

Plantation Management

The recent developments, particularly the involvement of the private sector, in plantation management, have their origin also in the widening supply and demand gap. Even many of the earlier state plantations were originally established in response to perceived supply shortages. Many such reforestation projects had, however, also conservation objectives. Area coverage of plantations appears to have been a more important indicator of success than growth and yield. This explains the use of poor planting material and low expenditures on maintenance.

With the involvement of the private players in the plantation sector the objective of reforestation has changed from protecting the environment towards producing for downstream industries. Government incentives have assisted the integration of wood fibre production with processing facilities. This is particularly the case in Indonesia and Malaysia. In order to produce to full capacity corporate investors have to ensure that sufficient raw material is produced. This has stimulated the use of improved planting stock (especially clonal material), higher expenditures for fire protection and research, and recently higher mechanization, particularly in timber harvesting. The latter development is also a response to labour shortages and the need for continuous industrial supplies. Tree improvement has also been assisted by the demand of small-scale investors. Private nurseries have been set up to cater to the demands of individual tree growers more flexibly. In the former centrally planned economies of China and Vietnam, plantation establishment has been boosted by market liberalization. Farmers have intensified plantation management (this includes also NTFPs such as bamboo) and the demand for quality planting stock is increasing.

Wood Processing Industry

The timber industry is currently undergoing a structural change with a gradual shift from the use of large diameter trees to smaller diameters, including fast growing plantation wood. The restructuring is a response to a mixture of emerging constraints and opportunities that have existed for a much longer time. Advanced machinery and technologies for more efficient wood use have existed in industrial countries for decades. Until recently, their adoption has been slow in the Region (predominantly in the tropical countries) because limits to harvesting large-sized timber were not expected so soon. Dwindling wood supplies have stimulated an entry into the reconstituted wood-panel industry.

Changes in the wood processing sector have their origin also in government policies to develop domestic wood-based industries. Not only did many governments, here again particularly in Indonesia and Malaysia, provide incentives they also restricted the export of unprocessed or

semi-processed products. The result of such policies was and still is massive investment in wood processing industries. Wood-panel products with their advantages, in terms of cost and technical properties, have developed from plywood to particleboard and MDF, through an evolution from using basically solid wood to using fibres of a variety of products. This development has produced more homogenous products and increased recovery rates.

The impact of diminishing supplies of large diameter wood was less significant in the sawmilling industry, though investments in new machinery has raised recovery rates to some extent. More dramatic have been the developments in using formerly under-utilized and discarded raw materials. Logging waste and rubberwood fall into this category. While the former is still neglected because of high transportation costs, the latter is in high demand and fuels multi-million dollar industries. In fact, the first supply shortages have been reported, to which the industry is responding. First, harvesting is slowly mechanized. Second, investments are channelled towards rubber replanting programmes with the main focus on wood and not on latex production. Third, research has been initiated to look at alternative raw materials. Oil palm is viewed as another potential supplier.

The decrease in supplies has also stimulated vertical and horizontal integration in the wood processing sector. This has decreased the amount of waste produced by the industry and increased recovery rates.

Anticipated Developments in Forestry

With few exceptions, the technologies that have shaped the forestry sector in recent years and that will most likely affect it in the future are not new. Most technologies have been transferred from the temperate countries to the Asia-Pacific Region. Improved road construction, better planning and directional felling techniques, all components of reduced-impact logging, have their origin in Europe. Skyline systems and helicopter logging have been in operations, particularly in North America. The degree of mechanization in plantation management, the production of high quality planting stock and clonal material, high recovery rates, and vertical and horizontal integration in the wood processing industries are also not recent developments in the temperate countries. The adoption of such existing technologies in the Asia-Pacific Region will depend on the perceptions about the supply situation and prices, the provision of incentives and the degree of enforcement of regulations. They changes that we anticipate will be far from uniform. The main reason for the heterogeneity is that the countries of the Region are at different in terms of degree of industrialization (indicated by the per capita energy consumption), population density, extent of forest resources, recent economic growth and population growth in the rural areas (Table 1).

Table 1 - Main Categories of Countries in the Asia-Pacific Region

	Recent economic growth	Forest/capita	Energy consumption/capita	Population growth in rural areas
Category 1	4-5 %	< 0.15 ha	very low to low	medium to high
Category 2	about 10%	0.15 to 0.2 ha	medium	low
Category 3	3-6 %	1 to 3.5 ha	very low	medium to high
Category 4	6-10%	0.17 to 0.32 ha	low to medium	low to medium
Category 5	8 - 10%	0.9 to 2.4 ha	medium to high	low
Category 6	< 3%	> 5 ha	medium	medium

Category 7	very low to very high	low to high	very high	very low to negative

While other factors such as the degree of market liberalization and the capacity for sustainable forest management and for enforcing forestry regulations will also determine the scenarios for the next fifteen years, major developments will follow according along the lines of the main variables defining individual categories.

Category 1 consists mainly of the countries in Southeast Asia that are characterized by high population pressures and a low forest cover. Furthermore, industrial development has not been as strong as in most other categories. China is the sole representative of category 2, with very high economic growth rates and declining population pressure in the rural areas. In the next category we find countries such as Laos and Cambodia which belong to the least developed country but whose forest resources are still substantial. Representatives of category 4 are Thailand and Philippines. Both had high deforestation rates during the last three decades. Today they are rapidly industrializing and have very high growth rates. Malaysia and Indonesia in category 5 have also been able to developed rapidly but in contrast to the pervious countries, vast areas of their territories remain under forest cover. Some of the Pacific islands belong to category 6, characterized predominantly by extensive forest resources but with currently weak economies. Australia, New Zealand, South Korea and Japan make up the last category. They are the most developed countries of the region and do not experience the population pressure of the other countries. Furthermore, they are able to restrict harvesting in their natural forest because they can rely on imports or plantation grown timber.

Natural Forest Management

The picture regarding current natural forest management in the Region is not very clear, but with minor exceptions, today's management is basically limited to timber harvesting operations with only little attention paid to enrichment planting and liberation thinning and other silvicultural measures. Intensive forest management plays an insignificant role. The two most common systems are different mainly in terms of logging intensity (Table 2). The first, the low intensity harvesting system, is common in the countries of the first four categories, whereas high and capital intensity systems are in place in many countries of category 5 and 6, especially in those areas earmarked for conversion.

Table 2 - Technology-related Scenarios for the Management of Natural Forests

Logging intensity	Yield/ha	Damage	Mechanization	Status of operators	Management intensity
Low	< 25 cum	medium	low to medium	private/public	low
High	25 to >150 cum	high	high	private	very low
Medium (RIL)	25 to 100 cum	medium/low	high	private/public	low/medium
Very low	< 10 cum	low	high	private	high
None (protected forest)	none	none	none	none	none

With the exception of Thailand, where the logging ban can be expected to remain in place in the medium term future, low intensity logging will continue in those countries characterized by low forest cover. The countries in category three will experience a change to high intensity logging with the commencement of timber harvesting by private, mainly foreign, companies. This development is already evident in Cambodia, where the forest department does not have the

capacity to enforce forest regulations. Similar developments can be expected in the overseas concessions in Latin America and Africa.

The natural forests of the countries in category 5 and 6 will continue to be harvested intensively. Stagnating economic growth on the timber rich Pacific islands will dictate the continuance of such activities. In countries such as Malaysia and Indonesia, developments will not be uniform. These two countries have undertaken serious steps towards sustainable forest management and reducing the impacts of logging. However, change will only be slowly in the majority of concessions and by the end of this century the area affected by improved harvesting practices will probably be no more than 10,000 ha.

In the environmentally more sensitive areas, in the future the single objective of natural forest management will be the production of high value timber as suggested by Johnson and Sarre (1995). The "utilization of wooden diamonds" will require a more intensive management, particularly liberation thinning. Because of its capital intensity it will probably be limited to countries in category 5. These countries at the same time will progressively extend their protected areas where commercial harvesting will cease. The speed with which these changes will take place, will depend on the success of the plantation programmes. Increasing raw material supplies from plantations will replace wood from natural forests. However, any plantation failure will slow down to progress towards better forest management.

There are no changes envisioned in the countries of category 7. Their countries are affected by harvesting operations only to a limited extent and they will continue to provide environmental service functions.

Accordingly, in terms of area coverage, technological change towards reducing impacts in natural forest management will be very slow. Locally, recurrence of traditional silvicultural treatments and the adoption of reduced-impact logging practices will mitigate the destructive impacts. On the other hand, in some countries first entries into formerly unlogged stands will be ecologically damaging.

Plantation Management

The plantation sector in the Region will assume increasing importance with rising raw material demands. A review of past experiences shows some success, particularly in simple plantation forestry but numerous examples also demonstrate a significant extent of poor results. Notwithstanding earlier problems, the interest in plantation establishment by the private sector will grow, fuelled by the need to feed the growing capacities of the wood processing industries as well as supported by government incentives. In general, land use conflicts between private companies and the rural population will decrease. In place of earlier conflicts, farmers and other land owners will increasingly get involved in growing trees in most countries of the Region.

In contrast to natural forest management, the plantation sector will continue its transformation from less to more intensive management. Most interest will focus on monocultures of species for which high quality planting stock is available, though the more specific developments will amongst countries (Table 3).

Table 3 - Technology-related Scenarios in the Plantation Sector

Scale	Management	Purpose	Complexity	Ownership	Former Landuse
Medium to large	extensive	undefined/multipurpose land rehabilitation	simple, single species	public	degraded lands shifting cultivation areas
Large	intensive	clearly defined end user	simple, single species improved planting stock	private	degraded lands degraded forests
Small	semi-intensive to intensive	clearly defined end users	simple, single species mixed with agri crops	private	degraded lands idle agricultural lands
Large	semi-intensive intensive	multi purpose including NTFP	species diverse semi-natural	private public	former agricultural land logged over forests
Small	semi-intensive intensive	multipurpose including NTFP	species diverse semi-natural	private	former agricultural land secondary forest

The significance of state run plantations that frequently had undefined objectives and were in general not very successful, will decline. Private investors will assume to traditional role of the state and production will follow along the lines of end user needs. Large scale plantations will dominate the landscape in those countries where land is available in the rural areas. This situation is found more commonly in the last three categories. In the first four categories of countries, it will be predominantly small-scale investors establishing plantations as is already the case in India and Thailand. Management and species choice will not depend very much on scale, but larger plantations will probably be established extensively on degraded forest land whereas small plantations will be located on idle farm land and degraded sites. While the corporate investor will focus on wood production, farmers will establish agroforestry systems on better sites to increase early returns.

Two other plantation types will develop later and differ from the previous generation of plantations in that they make use of secondary forests. They will have multiple purposes and will be species diverse. On a large scale they will be found in countries that have extensive areas of logged over but poorly stocked secondary forest. Some of the systems adopted by farmers will be semi-natural and produce next to timber NTFPs for the market.

In general, site preparation will improve with a recognition of the environmental benefits of soil management. Labour shortages will affect the degree of mechanization in the rapidly developing economies of category 5. Here it is likely that, tree felling and bunching will be performed by light feller bunchers and log extraction by light rubber-tired skidders and forwarders in large-scale plantations with high labour costs.

Strengthened collaboration between wood producers and processors will increase plantation diversity. Initially, it will lead to simplicity in individual plantations geared towards the production of consistent raw materials with uniform properties. This trend will continue as long as there are no major setbacks (e.g., pest and disease infestations).

Maintaining naturally regenerating hardwoods in plantations will be a first step towards more complexity. Once the anatomy of indigenous species is better understood and becomes more acceptable to the processing industry, it will be possible to enrich logged-over and otherwise degraded forests with dipterocarps increasing plantation complexity. This development will not only be beneficial from an environmental perspective but may also be coupled with the intensive management of NTFPs such as rattan.

Wood Processing

The wood processing sub-sectors in the Region have been severely affected by the diminishing supply of large diameter wood. The has particularly affected the traditional small-scale and labour intensive sawmills with low recovery rates. While they still exist in most countries of the Region they are slowly replaced by mills with advanced equipment in order to remain price competitive. This has increased recovery rates to some extent. However, with the diameters falling, wood processing has substantially diversified (Table 4).

Table 4 - Technology-related Scenarios in the Wood Processing Sector

Diameter	processing category	recovery rate	ownership	source	comments
Large	old sawmills old plywood mills	low	public and private	natural forest, 1. cut	few species used
Medium to large	new sawmills plywood pulp and paper	low to medium	private	natural forest, 2. Cut some farm forestry	species mix
Small to medium	boards reconstituted panels pulp and paper	medium	private	2. Cut plantation farm forestry	species mix fast growing rubber
Small to medium	pulp and paper	high	private	short rot. plantations	few species
Medium	new saw mills plywood mills	high	private	long rot. plantations	few species teak, dipterocarps

The most dramatic developments in the wood processing industry have been in the reconstituted wood-panel industry in countries belonging to category 5 and 7. Special grades and properties, including moisture resistance, fire retardance and exterior grades will fuel growth rates in the future. The expected growth in ready-to-assemble furniture will increase the awareness of the special characteristics and advantages of wood-based panels, particularly MDF and OSB. In addition, new processing lines can be erected with relative ease.

The decreasing supply of large diameter logs has also affected the plywood industry. Depending on the success of marketing strategies for boards such as MDF or OSB, the tropical plywood

sector may shrink faster than expected, at least in relative terms. Reconstituted panels will not be able to substitute all solid wood products but laminating technologies will assist in making them attractive to consumers. In addition, finger jointing technologies will allow manufacturers to arrive at desired length of final products.

Vertical and horizontal integration of productive units will also provide opportunities to increase employment and efficiency of wood use. Currently there are no incentive structures for reducing wood waste during harvesting operations in natural forests, or for transporting the waste to processing mills. The most logical way to overcome high extraction and transportation cost of wood waste is to pre-process timber at the logging site and the use of mobile chippers is predicted to increase once logging road construction has been improved. Mobile chippers will be particularly attractive for secondary forests where the mean diameter of trees can be expected to be far lower than in "primary" forests.

The more widespread application of sound and vigorous marketing will accompany the introduction of new technologies and exotic fibres. In addition, new technologies will achieve greater structural properties of panels and enable the manufacturing of environmentally friendly composites.

The most important changes that will affect pulp and paper production in the near future are stricter environmental regulations regarding effluent discharge. Another important aspect for the pulp and paper industry is whether it will be able to satisfy its raw material demand. Most manufacturers are overly optimistic regarding plantation development and productivity. Non-wood fibres will play some role in production processes. However because of their drawbacks they will not replace wood as the most significant raw material in most countries.

The recent developments in wood processing will continue. However, the capital intensity of the advanced facilities will only lead in the more industrialized countries to more widespread application of new technologies.

Non-Timber Forest Products Use And Management

Based on the changes that are currently taking place, the future of most NTFPs as raw materials from the natural forests appears bleak, which is not to say that NTFPs will lose their importance in subsistence economies. Destructive harvesting and an increase in opportunity cost to labour will make the raw material supply of many NTFPs from the natural forest more unreliable. The heterogeneity of NTFPs makes it impossible to provide any scenarios for the whole sector. Policy changes can have a positive effect on the production and processing of individual NTFPs. However, the increase in value will rather take place outside the natural forest and not inside. It can therefore be argued that NTFPs as "pillars of sustainable forestry" have only limited potential.

In general, it appears that the increased attention that NTFPs have received over the last fifteen years has not lead to the introduction of new technologies. While the future does not have to be a reflection of the past, technological change over the next fifteen years will be limited to only some selected products of commercial importance (e.g., rattan and bamboo). They will be managed more intensively, fuel a growing industry and may become viable substitute raw materials for the paper and panel industries.

Agroforestry

As with NTFPs, the future developments in agroforestry will be very diverse. There will always be a place for traditional agroforestry systems for supporting subsistence-based economies. Home gardens can also be expected to prevail in those areas where rural economies are slowly changing from land-based to industrial activities. They will be maintained as remnants of former practices in the rural landscape as long as land prices remain low. In easily accessible areas, private forestry will be in direct conflict with agricultural systems. Depending on marketing opportunities and prices, farmers and even urban residents will intensify cash crop production. Continuing demand for fast-growing tree species by the wood fibre using industries will, on the other hand, open opportunities farmers to grow trees (see Table 2).

Small-scale tree growing enterprises will boom in places which can offer alternative non land-based employment opportunities, fair marketing agreements between tree growers and the processing industry, and sufficient support structures in terms of extension and regulations. Particularly, the provision of high quality planting stock will have a tremendous impact on small-scale investors' enthusiasm in producing wood. This means that agroforestry will not be the species diverse and extensively managed home gardens but will rather be intensively managed small-scale plantations with the objective of producing only one or two products. In terms of technologies they will be managed quite similar to large-scale plantations though the degree of mechanization will remain low.

Factors Facilitating Technology Changes

The factors that have brought about changes in the forestry sector in the past will continue to affect the adoption or non-adoption of new technologies in the sub-sectors. In addition, a number of factors will facilitate technology transfer and motivate operators to innovate. Some of the issues such as land security, education and training, and research can be addressed within individual countries. Other changes with implications for the forestry sector cannot be influenced easily.

Changing prices and exchange rates affect imports and exports. As West and Hansen (1996) have pointed out, Singapore buyers of American hardwood are receiving their lumber today for 15 percent less than in 1986, while US suppliers receive 35 percent more in real terms. Thus, in this case the exchange rate fluctuations have been favourable for buyers and suppliers alike. At the same time, Asian suppliers are suffering from the opposite effect. Their timber has become more expensive. Besides wood products, equipment and machinery is also affected by price changes and may render the adoption of innovative technology in countries with weak currencies unattractive.

Currently investment opportunities overseas look promising, which accounts for the relocation of logging activities. This reduces the pressure on local resources but also delays the adoption of new technologies in the Region. Developments regarding further expansion into Africa and Latin America are difficult to predict. As indicated earlier, in Brazil opposition to the involvement of foreign companies in timber extraction is growing. Responding to environmental concerns, the Brazilian national congress has set up a special committee to look into the sale of

vast rain forest areas to companies from Malaysia, China and South Korea (Anon, 1996f). Economically weaker countries will find it more difficult to regulate logging and monitor harvesting activities. In the long term, however, it can be expected that companies operating overseas will have to follow the same standards that apply in their countries of origin.

A most important issue for natural forest and plantation management is land security. Solving the problem of overlapping land claims will reduce land use conflicts among various stakeholders. Permanent demarcation of forests and the allocation of forest resources on a long-term basis will provide an incentive to invest in infrastructure and new technologies. Particularly in natural forest management, concessionaires have to be given assurances regarding long-term and exclusive access to concession areas. This also means that the issue of illegal logging needs to be addressed vigorously.

Without appropriate training and education the impact of most new technologies that are tested in pilot projects will remain insignificant. For widespread adoption, hands-on experiences are necessary. This requires the establishment of training centres and curriculum development designed for particular professions. Besides practical aspects of planning, road construction, tree felling and monitoring, awareness raising should be targeted. Numerous authors have argued that operators are not aware of the requirements of better forest management nor do they appreciate the value of proper planning and road construction. Hence, trainees should visit sites where new technologies have been adopted to enable them to assess their impact.

As plantation management and natural forest management are diverging more, the historical all-round forester becomes obsolete. Instead, educational facilities should focus on preparing graduates for the different requirements of plantation and natural forest management. Practical training as part of the degree requirements will allow students to become more familiar with the realities in the forest. Extension capacities will have to be developed to cater to the increasing involvement of small-scale investors in tree growing.

In many developing countries, governments should focus on policies for technology search and acquisition instead of original research on the grounds that adapting what is already available and known can be the most economical way to proceed (Contreras-Hermosilla and Gregersen, 1991). Accordingly, researchers should develop capabilities in reviewing available documentation and move away from problem-solving research. This requires that research institutions provide the appropriate facilities for information searches and exchanges. To institutionalize more forward looking demand-driven research furthermore demands closer collaboration between the public and the private sector which hitherto has been neglected.

Tree-growing by small-holders is flourishing in many countries despite state interventions and competition with subsidized supplies of wood from government sources. The main reasons are that the demand for wood fibres has increased and that the better quality planting stock increasing productivity is also available to farmers. However, in many countries considerable uncertainties remain regarding the legal ownership of trees on private land. Wood transport is also impeded by often outdated regulations. Therefore, forestry regulations should be revised to support private initiatives.

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