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Research for Action

Research for Action 30

Tree Plantations in the Philippines and Thailand

Economic, Social and Environmental Evaluation

Anssi Niskanen and Olli Saastamoinen

UNU World Institute for
Development Economics Research
(UNU/WIDER)

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PREFACE

This is the main research report of the UNU/WIDER project W93/12 'Environmental-economic and Social Evaluation of Tree Plantation Programmes in Thailand and the Philippines' conducted at the Faculty of Forestry at the University of Joensuu. The report includes a general background of the study problems, a discussion and outline on economic, social and environmental impacts of tree planting, the core results of the profitability analyses based on the two separate case studies prepared under the project by Anssi Niskanen, and the conclusions of the study. The authors do hope that this study, despite its limitations, would contribute towards more holistic and balanced approach in the analysis of tree plantations badly needed in the global restoration of degraded areas.

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Study Director	Researcher

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ABSTRACT

The area of forest plantations in the tropics has increased for many reasons, but not the least as a result of natural forest depletion. Although forest plantations cannot qualitatively substitute the timber grown in natural forests, their importance in global forestry is steadily increasing. At the same time a heated public debate has been growing with them, focusing largely on the perceived negative environmental and social impacts of large-scale industrial plantations.

This research report first discusses tropical plantations in global forestry. It emphasizes that tree plantations presently include much a wider range of categories, purposes, species variety and management forms than is commonly perceived. The study states that although industrial forest plantations are mainly established solely for economic reasons, private farm-forestry and governmental plantations more often have a variety of reasons for establishment. These reasons include expectations for positive social and environmental impacts of forest plantations, e.g. increased household security and soil conservation.

Nevertheless the environmental and social impacts of plantations deserve much concern and the second part of the study widely reviews environmental and social but also economic impacts of plantations, all of which can be either negative or positive. One of the major problems in developing plantation forestry has been that the profitability analysis of plantations has based only on the economic criteria. Although financial profitability can be regarded as the most important single evaluation criteria for forest plantations in the tropics, the negative and positive social and environmental impacts should also be attempted to be included into the analysis.

The focus of the empirical part of the work, therefore, has been to study to what extent it presently is possible to monetize the varying impacts of tree plantations and incorporate them into the "multilevel" profitability analysis.

In two case study countries, Thailand and the Philippines, the profitability of industrial, community based and private reforestation was assessed for two most commonly used tree species in reforestation. The profitability assessments were aimed to be carried out at four different levels: based on comparisons between costs and benefits in market prices (financial profitability), economic efficiency prices (economic profitability), economic efficiency prices with the distributional weigh assessments (socio-economic profitability), and finally with including monetary valuation of environmental impacts into the economic analysis (environmental-economic profitability).

For the environmental-economic profitability, the study evaluated the economic costs of transpiration and nutrient loss in harvesting, and benefits in erosion control and carbon sequestration.

The results of the two case studies indicated that the economic profitability of reforestation is considerably higher than the financial profitability both in Thailand and the Philippines. It also became evident that the environmental-economic profitability was highly dependent on the environmental impact and valuation assessments; in this study, the environmental-economic valuation improved the economic profitability of reforestation. A conclusion derived from the socio-economic analysis was that the return to labour per hectare is very low in mechanized reforestation.

The empirical basis of including environmental and social impacts into traditional profitability analysis of tree plantations requires much improvement and the work done still carries a character of methodological experiments. Nevertheless a conclusion is evident: if the social and environmental costs and benefits, evaluated in monetary terms, could properly be included into the solid framework of economic analysis, that would further encourage for environmentally and socially sensitive management practices in plantation forest development.

I DEFORESTATION AND TREE PLANTATIONS

1.1 Tropical tree plantations in the global framework

During the last decades, a growing consciousness of the continuing depletion of the world's tropical forests has led to the development of two major trends: the concerns and actions of the international community towards a global conservation strategy and the growing role of forest plantations. The first trend, the actions towards a global conservation strategy for the remaining tropical forests has received overwhelming publicity. This trend started with the FAO's Tropical Forest Action Plan in 1985, culminating into UNCED reports and declarations from Rio de Janeiro in 1992, and was continued in the session of the UN Commission on Sustainable Development (CSD) in April 1995. Referring to UNCED and CSD, Schmithüsen (1995) states that both events reflect divergent positions and a considerable amount of disagreement with regard to forests, including the following: what they mean to the interest groups involved, their role at present and in the future, and their management by different societies and in different parts of the world. These controversies undoubtedly also exist for the second trend, the growing role of forest plantations. The role of plantation forestry in tropical countries has been increasing for more than a century, but has received wider attention only during the last few decades, when the battle against deforestation became a world-wide issue. Plantation forestry has received less publicity than the deforestation process as such, but whatever publicity it has received has been accompanied by an increasing debate.

The first tree plantations included small-scale manipulations of natural forests with trees planted on areas cleared by swidden methods, oil producing trees established in settled agriculture, and trees planted for religious or aesthetic reasons (Bass 1992, Evans 1992). Large-scale colonial forest plantations appeared much later, and were in the beginning mainly for military and other strategic needs. Commercial large-scale plantation forestry was not a viable source of wood until natural forests had been depleted. For example, eucalyptus was introduced to India in 1843, to avert a fuelwood shortage; by the year 1852, the environmental and social dangers of deforestation had led to extensive afforestation and forest protection (Bass 1992). Globally, the rationale for forest plantations has varied between environmental and productive; social and commercial; and have often been targeted to improve fuelwood security, sustain or expand the industrial pulpwood supply, or save the natural forest. The variety of tree and forest plantations has clearly always been much wider than commonly perceived.

The development of industrial forest plantations in the tropics perhaps from the sixties onwards was (and still is) largely due to the rapidly growing demand for wood. For example, Sedjo (1983) concluded that the favourable economics of plantations in the tropics and the temperate Southern Hemisphere (as well as in the southern United States) suggest a southward shift in the production of the world's forest resources. Sedjo

(1983) also concluded, that since high-yielding plantations were capable of annually producing from 15 to 20 cubic metres per hectare, then a modest 140 million hectares, or five per cent of the world's forest area, could have met the world's demand for wood in 1978. Similarly, Evans (1992) estimated that tropical plantations might contribute 30 per cent of the world's wood requirement for 1995; he was also confident that tropical plantations would become one of the world's major sources of forest products in the future. Although the first prediction has been proven to be too optimistic, the latter has firmer grounds on which it could be realized.

The worldwide extent of forest plantations is estimated in the range of between 100 and 135 million hectares. The estimation has been questioned due to weak data, with varying definitions (see section II.1) and sometimes utilizing unreliable national statistics. Only one quarter of the estimated total area of plantations is located in tropic or sub-tropic regions; these regions are also where the rate of deforestation is at its greatest (Mather 1990, Kanowski and Savill 1992). According to the most authoritative FAO estimate, the true area of forest plantations in the tropics by the end of 1990 was 30.7 million hectares compared to the 43.9 million hectares officially reported (Singh 1993, Pandey 1995). Although most plantations have been established for industrial wood production, the area of industrial fast-growing plantations is estimated to be only 16-18 million hectares, including 9 million hectares of pine in the southern United States (Pöyry 1987). Fast-growing plantations probably account for only one quarter of the total plantation forest area in the tropics.

Between 1965 and 1980, the area under forest plantations in the tropics tripled; this area further doubled during the 1980s (Evans 1992). From 1981 to 1990, the forest plantation area in the tropics was reported to have increased annually by an average of 2.6 million hectares. However, the FAO assessment estimates that the real increase was only about 1.8 million hectares per year (Singh 1993, Pandey 1995). During the same period the estimated annual tropical deforestation was 15.4 million hectares (FAO 1993). This disproportion has been the focus of the international forestry community for years, and lately has become a part of the global development and environmental agenda (Evans 1992, Sawyer 1993).

The role of forest plantations in easing the pressure on natural forests and countering the trend toward deforestation has received a great deal of attention. At the same time, there has been a growing environmental criticism against plantation forests in the tropics (and elsewhere) based on several reasons (e.g. Hartshorn 1983). One reason for the criticism, the conversion of natural forests to high-yielding plantations, has been highly debated in the context of deforestation. Although the character of a land area of old-growth forest is greatly disturbed after harvest, and is radically changed when converted to a plantation, the change, if the land remains under forest cover, is not generally referred to as deforestation (Rowe *et al.* 1992) as has been sometimes claimed, and there is further discussion on this issue by Jepma (1995). Consequently, deforestation is understood here in the conventional way as a change of land use or a depletion of crown cover to less than 10 per cent as defined by the FAO. Today however, the replacement of natural forests (which have not been degraded) by tree plantations can hardly be considered preferable under any circumstances; this is due to their value for the conservation of biodiversity.

In addition to environmental issues, social impacts of forest plantations have also become a focus of increasing concern and debate. The criticisms, and practical failures of many large-scale industrial plantations have effectively dismantled the paradigm, that plantations bring effective and automatic employment and cash incomes to the poor and disadvantaged people living in remote areas. Due to the combination of conflicting demands of forest plantations with agriculture, government clashes with local individuals over common-property resources and land-rights, as well as other political complexities in many tropical countries, it may even be more preferable to grow wood in the more stable conditions of the temperate countries as pointed out by Sargent (1992).

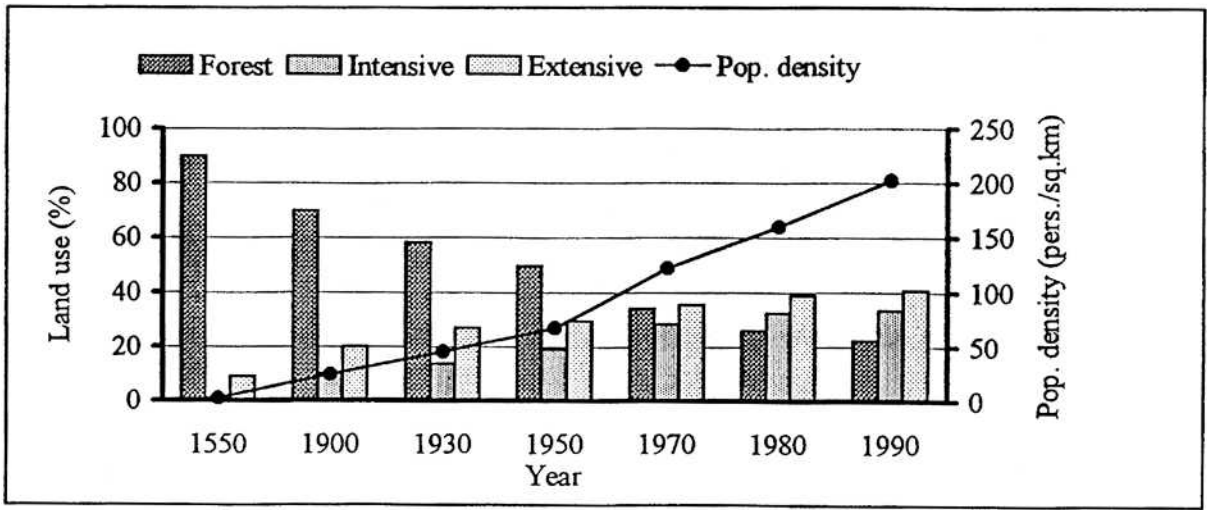
The most recent arguments and agreements on the conservation of biodiversity and carbon sequestration must be added to the discussion of the rationale for forest plantations. Therefore, one may easily agree with Kanowski and Savill (1992), who concluded that future plantations are likely to be characterized by a conception and practice of greater complexity than that to which we have become accustomed.

1.2 Tree plantations in the Philippines

Direct factors of deforestation in the tropics, like the expansion of agricultural land, shifting cultivation, fuelwood gathering, and commercial logging, are specifically relevant and the topic of much discussion in the Philippines. However, these visible symptoms may be generally less important to deforestation than the indirect causes: market and policy failures, population growth, rural poverty, corruption, ignorance, carelessness, as well as the state and development of the economy and society. Population growth has been especially important to deforestation (e.g. Allen and Barnes 1985; Bowonder 1985; Palo *et al.* 1987; Rudel 1987). Although one-reason causality has been rightfully criticized (Evans 1992, Kummer 1992) for being too narrow of an approach for such a complicated and multi-dimensional phenomena like deforestation, population growth remains among the best predictors for forest area loss in tropical developing countries. For example, when land uses and population density in the Philippines are drawn into the same figure over time (Fig. 1.1), a significant correlation between the decrease in forest land and increase in population density can easily be seen. As the areas of natural forests decrease and the growing population inevitably increases the demand for wood-based products, there are few other alternatives than to base the supply of wood and timber increasingly on plantation forestry.

Before the 1970s, the forestry sector was one of the major contributors to the Philippines' national income. The largely exploitable approach to forest utilization rapidly diminished the vast natural forest resources. The overall results were a decline in the importance of the forestry sector and serious environmental degradation. An example of the latter has been the serious negative on-site and off-site impacts of soil erosion (Francisco 1986, 1994, Cruz *et al.* 1988, David 1988, DENR 1990, NEDA 1992, Saastamoinen 1992, 1994).

FIGURE 1.1
LAND USE CHANGES IN THE PHILIPPINES, 1550-1990



The first reforestation efforts in the Philippines date back to the early 1900s, but the government has more purposefully financed reforestation since the 1970s, when the timber supply from natural forests began to decline rapidly. Government financed reforestation has had diverse objectives, which vary from improving degraded sites to satisfying the timber demand of rural households. However, the magnitude and success of reforestation remained low until the People Power Revolution in 1986, after the new government intensified its reforestation efforts. Between 1987 and 1992 annually about 98,000 hectares were planted compared to the average of about 30,000 hectares planted (of which perhaps only a half survived) during the previous thirty years (DENR 1990, FMB 1993). The new reforestation efforts shifted the emphasis from government plantation to contracting the private sector and involving the local people in the management of established plantations.

The first large-scale industrial reforestation programmes in the Philippines were started in 1972 by the parastatal Paper Industries Corporation of the Philippines (PICOP). Up to 1994, the total of the areas reforested by PICOP equalled 33,200 hectares, and was composed mainly of degraded natural forest sites. The PICOP plantation development programme was accompanied by a tree farming scheme, in which PICOP financed small woodlots on private land within PICOP's concession areas. Other reforestation by the private sector has been based on regulations within Timber Licence Agreements (TLA), which require that for each hectare selectively logged, an equivalent area of denuded land should be planted. Since 1981, TLA holders have also been required to establish Industrial Tree Plantations (ITP). By 1992, TLA and ITP regulations reforested 56,120 hectares and 312,000 hectares, respectively.

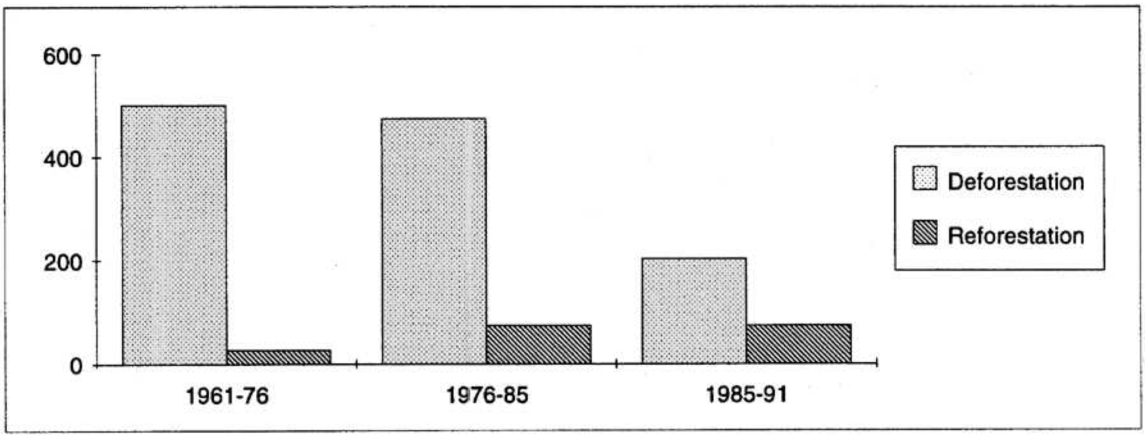
The shortage of capital for reforestation and the lack of tree species with the required wood properties and ability to successfully grow on the poor grassland sites which are left as a result of forest destruction and shifting cultivation have restricted the development of plantation forestry (ADB 1994). Tree species most commonly used for contract reforestation have been *Gmelina arborea* Roxb., narra (*Pterocarpus indicus* Willdenow), mahogany (*Swietenia macrophylla* King) and *Acacia spp.* *Acacia spp* have been especially successful in growing on grasslands.

The Philippines is envisioned to become an agri-industrial country at the turn of the century, with the planned promotion of industrialization and economic growth to be based on agricultural development (NEDA 1992). One major obstacle to development is the pressure on the country's land and forest resources exerted by the growing population; this pressure suggests continuing land use conflicts between agriculture and forestry, and increasing soil degradation. The short-term benefits from agriculture are far more attractive than the long-term benefits from reforestation, despite the serious (external) environmental costs of soil erosion and land degradation caused by agriculture, especially on steep, sloping sites. Soil rehabilitation in severely damaged watersheds has almost without exception been based on reforestation. Consequently, the Asian Development Bank (1994) has recently mobilized a significant amount of loans for the reforestation of open and denuded forests in order to repair environmental degradation and limit soil erosion. This funding played a key role in facilitating the previously mentioned increase in government financed reforestation.

1.3 Tree plantations in Thailand

Deforestation in Thailand peaked in the mid-1970s, when the annual loss of forest cover was about 500,000 hectares, or approximately 2.5 per cent of the total forest area (Fig. 1.2). Historically, the two main underlying causes of deforestation have been the increasing demand for agricultural land, and commercial logging (RFD 1993b). Since the mid-1970s the annual deforestation rate has dropped, although in the late-1980s more than 200,000 hectares of forests were still deforested annually (RFD 1993b). A logging ban on commercial operations in natural forests, declared after a devastating flood in 1988, partially explains the decreased rate of deforestation. Another reason for the reduced deforestation rate is the change in the international agricultural commodity markets which has discouraged the planting of such cash crops as cassava (*Manihot esculenta* Crantz). For the migrant farmer, the gradually increasing supply price of forest land, which is to be converted to agriculture, is an additional reason for the decreased deforestation rate (Tongpan *et al.* 1990).

FIGURE 1.2
ANNUAL DEFORESTATION AND REFORESTATION (1,000 HA) IN THAILAND, 1961-1991



Thailand's local timber production has been reduced due to rapid and extensive deforestation, which has made large areas of land no longer able to produce timber; in addition, parts of the remaining forests are now protected for the purpose of environmental conservation. This reduction has produced acute shortages in the domestic timber supply. These shortages can be offset in the short-term only by importing timber. In the medium term, since logging bans or export restrictions may also be declared in most neighbouring countries, Thailand will have to secure part of its wood and timber demand with forest plantations. In the long run, the domestic wood and timber supply could be based on a combination of the sustainable management of natural forests and efficient wood production from forest plantations.

The first teak (*Tectona grandis* L.) plantations were established in 1906, but significant attempts at tree plantation establishment did not occur until 1967 when the first Forest Village projects were established by the parastatal Forest Industry Organization (FIO). Since 1975, the Royal Forest Department has also established its own Forest Village projects on government owned land (Niskanen *et al.* 1993). Other government and non-government programmes including the Village Woodlot Programmes, have also been launched to involve local people in tree planting. In practice, however, participation by the villagers in these programmes has been minor. For example, in the Forest Village Programmes, which began in 1967 only about 54,000 hectares of land had been reforested by 1992. During the 1980s, tree planting on individually owned farmland spread, especially in the Northeast around the pulp and paper industries in Khon Kaen (Niskanen *et al.* 1993). Up to 1993, a recorded total of 800,000 hectares of land has been planted in the entire Kingdom: approximately 600,000 hectares were at government cost, 146,000 hectares were planted by concessionaires, and 32,000 hectares were paid for by the FIO (RFD 1993a). Most of the reforestation in the North and Northeast has been done by the government, private concession owners, and industries. Farmers' reforestation efforts have been the highest in the South and East where para rubber plantations have financially been very profitable. The official estimates of the area reforested may overestimate the true total reforested area in Thailand, since many plantations which failed were replanted and added to the statistics again.

The most important tree species planted include teak and *Pinus spp.* in the North, teak and *Eucalyptus spp.* in the Northeast, and the para rubbertree (*Hevea brasiliensis* Müll.) in the South and East. Teak and pines are grown for saw timber, eucalypts for poles and for pulp and paper manufacturing. Para rubbertrees produce latex, sawn timber, and veneer for plywood production. The para rubber plantations have increased rapidly since the mid-1980s due to subsidies provided to partly offset plantation establishment costs.

The combined reforestation programmes have not reached the targeted total area planted, despite the long history of tree planting and the need to secure the domestic timber supply. Governmental reforestation (Forest Village and Village Woodlot programmes) and large-scale corporate reforestation have provided the major efforts toward reforestation, responsible for about two thirds of the total, but to achieve significant progress in tree planting would require greater involvement by private farmers (RFD 1993b). Development of private farm forestry in Thailand to date has been restricted by the insecurity of land tenure, insufficient capital, and weaknesses in the wood and timber markets. The insecurity related to land use rights especially limits farmers' interests in long-term planning and investments which are vital for successful reforestation.

The extent of land tenure insecurity can be illustrated with a simple example. Onchan (1990) reported that 60 per cent of the total land area remained under forest cover in the late 1980s (this value was calculated by deducting the area with land use certificates from the total land area). The actual forest cover in the 1980s, however, was only about 28 per cent of the total land area (RFD 1993a). The difference between the two estimates, approximately 32 per cent of the total land area, it can be concluded to have had no land use certificates whatsoever, even though the land may have been used continuously for cultivation or was left abandoned after soil degradation. Started by the Agricultural Land Reform Office in 1975 and expanded to include the Royal Forest Department in 1982, the process of granting usufruct certificates has been too slow to solve the whole land tenure problem, and has not only restricted the development of private land ownership, but has so lead to extensive land speculation.

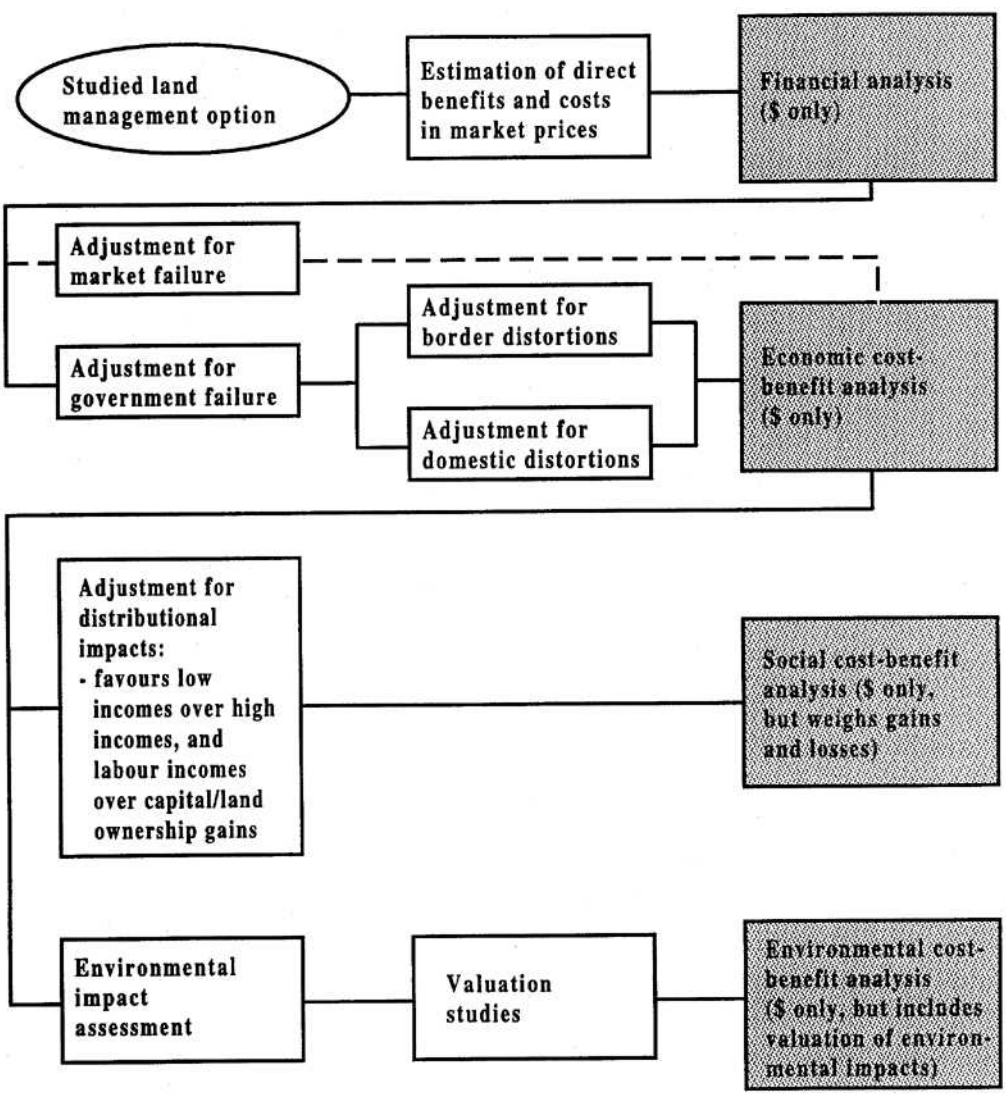
1.4 Objectives and the scope of the study

The general aim of the study was to evaluate whether tree plantations in the Philippines and Thailand promote economic development in a way that is socially and environmentally sustainable. The main criterion for economic development is a sufficient financial or economic return from reforestation investments. Social and environmental sustainability were studied by including the socio-economic and environmental-economic impacts of tree planting in the profitability analyses.

One specific objective of the study was to assess the financial, economic, socio-economic, and environmental-economic profitability of industrial and community-based reforestation, and reforestation using agroforestry (intercropping) methods. Another specific objective was to estimate the financial benefits of the studied land management options to non-educated labour. This was part of a social analysis aimed at examining whether small-scale land management practices (agroforestry or grain production) generated better profitability or higher benefits than large- or medium-scale reforestation practices (industrial and community-based reforestation). The study also attempts to assess monetarily the results of reforestation on the following environmental impacts: soil erosion, transpiration, nutrient losses from soil, and carbon sequestration. A further objective was the evaluation of how much economic profitability would change if the valued environmental impacts were included in the economic analysis.

The methodological focus of the study was to investigate possibilities for including environmental and social dimensions in the economic analyses of forest plantations in the Philippines and Thailand by adding extensions to the conventional cost-benefit analysis (Fig. 1.3).To provide baseline comparisons with competitive agricultural land uses, the profitability of corn (*Zea mays* L.) cultivation in the Philippines and cassava (*Manihot esculenta* Cantz) cultivation in Thailand were also studied.

FIGURE 1.3
STUDY METHODOLOGY



II TREE PLANTATIONS AND THEIR IMPACTS

2.1 A discussion of the definition and the variety of tree plantations

For the purposes of forest resource inventory, the FAO defines plantations 'as a class of forest that is established artificially, either on land that did not previously carry forest or involving the replacement of the previous forest cover by a new and essentially different species or mix of species' (Singh 1993). In this study, the concept of a tree plantation is adopted and defined as an artificially established group of trees grown for wood or non-wood purposes. This 'wider' definition excludes cases where trees are regenerated naturally with or without human assistance and is flexible to some extent with respect to the size, shape, origin, species, or purpose of the plantation (cf. Evans 1992: 8-10).

The problem for the definition of the term 'tree plantation' used in this study and for many other definitions of forest or tree plantations is the borderline between plantations and agriculture (cf. Pandey 1995). Agroforestry is by definition a mixture of trees and agricultural crops. Some large-scale commercial agricultural plantations are based on non-wood products gathered from trees (rubber, palm oil, coconuts); these plantations have recently also become a source of wood. The definition of 'tree plantations' given above includes trees in agroforestry configurations, but excludes the larger scale agricultural plantations of trees.

Although often used interchangeably, the term 'tree plantation' is preferred here for the sake of flexibility rather than the term 'forest plantation'. Consequently, the difference between the terms which is sometimes noted, in that 'tree plantation' refers to trees cultivated for non-timber crops and that 'forest plantations' are strictly for wood production, is not recognized here. The term 'tree plantation' includes many types of perennial crop plantations, which is contrary to the common view that forest plantations are only industrial plantations established for the rapid production of pulpwood. Tree plantations can be categorized (Table 2.1) by their management schemes, management intensity, level of mechanization, selected species, purposes for establishment, reasons for management, or by their evaluation criteria. Table 2.1 demonstrates why the concept of 'tree plantation' illustrates the variety of plantations better than the concept of 'forest plantation'. The use of the term 'tree plantation' allows for the inclusion of such unconventional plantation types, as those with fruit trees, agroforestry, or for enrichment planting in natural forests. The characteristics for categorizing the various tree plantation alternatives presented here (Table 2.1) is incomplete and other factors could also be added (cf. Kanowski and Savill 1992, Sawyer 1993). Since in principle all of the alternatives given in Table 2.1 can be combined, the conclusion that a wide variety of tree plantation options exist requires little additional evidence.

TABLE 2.1
TREE PLANTATION ALTERNATIVES

Plantation management category	Intensity and mechanization	Plantation species group	Main purpose of a plantation	Evaluation criteria
Tenant farmers	Mechanized/ semi-mechanized/ non-mechanized	Fruit trees	Food	Domestic consumption
Small-scale farmers	Intensive/semi-intensive/ extensive	Agroforestry species	Fodder	Import substitute
Medium-scale family plot		Agricultural tree crops	Rattan, bamboo	Export earnings
Large-scale farmers		Multipurpose species	Fuelwood	Financial and economic profits
Companies or large concession owners		Native species	Pulpwood	Social development
Industrial large-scale owners		Fast-growing indigenous species	Veneer and saw timber	Environmental protection
Rural community		Fast-growing exotic species	Environmental improvement	Development of small-scale processing
Urban community		Other woody plants	Enrichment of natural forests	Development of large-scale processing
State agency		Hybrids	Landscape amenity	Aesthetic values
			Carbon sequestration	
			Urban greening	

A key question in plantation development is the selection of the 'right' alternative among those regarded as appropriate in a certain situation, and the further specification and modification of the selected alternative. The choice of tree plantation may be a routine decision in the stable and predictable conditions of many temperate countries, but it is very seldom so in the tropics. In tropical countries, under the context of rural development (the category to which most plantations belong), the magnitude of important factors is large and the selection of the right type and proper specifications for a tree plantation is a difficult task.

The purpose of a tree plantation is the most decisive single factor when choosing between the alternatives. It is therefore important that the plantation manager first carefully determines the objectives for tree planting with respect to the most important evaluation criteria. The intensity of plantation management and tree species used for planting, are then selected to fulfil the stated objectives.

2.2 Specific factors and issues affecting reforestation

Deforestation has caused shortages of wood and other forest products and benefits in almost all tropical countries. The sequential land use development following deforestation, often results in vast tracts of unoccupied or abandoned degraded lands which are no longer suitable for agriculture, but on which trees could be grown. It can be expected that the most fertile and valuable soils are used for agriculture due to the high demand for land for food production; therefore, degraded lands will continue to have high priority for reforestation. Land degradation, although a negative phenomenon, creates an opportunity for the development of plantation forestry.

Factors supporting the development of tree plantations are sometimes classified into negative and positive ones (Evans 1992, Table 2.2). Negative factors favouring plantation forestry include deforestation, land degradation, the inaccessibility of remaining natural forests, and poor natural regeneration. Reforestation and afforestation are also recommended due to several positive factors: high productivity, economic development, employment, and environmental benefits. In the tropics, land scarcity and the insecurity of land tenure are found to limit interests in reforestation (Table 2.2). The social and environmental impacts of reforestation are assumed to favour tree planting, but paradoxically also to limit interests in reforestation. These contradictory results of the social and environmental impacts of reforestation are discussed in more detail in sub-sections 4 and 5.

TABLE 2.2
FACTORS FAVOURING AND LIMITING INTERESTS IN REFORESTATION

Negative factors favouring reforestation	Positive factors favouring reforestation	Factors that may limit interest in reforestation
Decreased timber supply/ increased wood demand	Plantation silviculture	Land scarcity
	Environmental benefits	Environmental disadvantages
Land degradation	Economic benefits	Land tenure issues
Remaining natural forests either inaccessible or protected by laws	Social benefits	Social disadvantages
Poor natural regeneration		

Source: (Evans 1992, Sargent and Bass 1992)

The supply of high-quality tropical timber has decreased throughout the world. This decrease in supply includes the Southeast Asian countries, especially Thailand and the Philippines. In these two countries the demand for timber has been partially compensated for by imports from other tropical countries like Malaysia, Myanmar (Burma), Kampuchea, and Ghana (FMB 1993, RFD 1993a). However, possibilities for the sustainable import of timber from natural forests are bleak. Those Southeast Asian countries which have large forest reserves have recently been banning log exports (e.g. Malaysia and Indonesia); other exporting countries will also probably favour development of their own domestic forest processing industries in the future.

For the countries where deforestation has been the most destructive (e.g. Thailand and the Philippines), reforestation programmes offer the most realistic way to increase the domestic timber supply; although the management of secondary forests is also of high importance. Often limited financial resources require a choice, or a compromise between the two alternatives. In the Philippines, for example, the recent policy has been to shift logging from old-growth forests to secondary forests and to increase plantation efforts. This re-orientation has not been easy, but has been facilitated to some extent by external funding and the community forestry approach. The community approach aims to combine plantation development and secondary forest management (DENR 1990).

A greater increase in the demand for paper products is seen in rapidly developing economies, such as in Thailand and recently also in the Philippines. These countries have imported paper products partially because of an inadequate domestic wood supply, and partially because their chemical wood processing industry is also poorly developed. In general, for all of tropical Southeast Asia, the demand for pulpwood could be technically satisfied with fast-growing plantations; however, interest in tree planting in many countries is limited either by the present structure or capacity of their wood processing industries.

The total value of the import of wood and wood-based products in 1993 was about US$ 1,540 million and US$ 445 million in Thailand and the Philippines, respectively (FMB 1993, RFD 1993a). Recent import figures increasingly include logs which dramatically indicate the consequences of deforestation in these countries which previously have had extensive forest resources. Wood or wood-based product importation decreases not only the available foreign exchange capital, but also reduces income opportunities and economic development in other sectors of a country's economy. Once established, reforestation could substitute for a part of the imports, and some backward and forward benefits could be achieved. Simultaneously, some environmental disadvantages could be reduced: adverse impacts of soil erosion or possible negative environmental impacts in the country where the imported wood was harvested.

In general, the future development of plantation forestry has been constrained primarily by issues relating to the following: socio-economics, land rights, personal rights, the environment, and management (Sargent 1992). Socio-economic issues include the inequitable distribution of costs and benefits, and the insufficient opportunities and inadequate returns to labour. Land and personal rights issues are related to individual and common property rights to forest resources, improper land tenure, and inappropriate unplanned land use. Environmental issues consist of ecological vulnerability, resource scarcity, biological impoverishment, erosion, hydrological problems, and the consequences of inappropriate tree and site selection. Managerial issues include inadequate plantation management and design, inappropriate policy and legislation, and misdirected incentives and malfeasance (Sargent 1992). These issues lay behind, or are part of, the general economic, social, and environmental impacts of tree plantations, which are the criteria used in the final evaluation of the successes or failures of reforestation.

2.3 Economic impacts of forest plantations

Ninety per cent of the world's forest plantations, including three quarters of the plantations in developing countries, are classified as industrial plantations (from data compiled by Kanowski and Savill 1992). Economic objectives are decisive especially for industrial plantations, but also for non-industrial reforestation. In fact, those plantations established primarily for the protection of natural forests, carbon sequestration, or for environmental protection and rehabilitation often also have indirect economic rationale. Therefore, almost all plantation establishment is based on economic reasoning, by targeting either direct or indirect economic benefits. Kanowski and Savill (1992) have discussed comprehensively the varying economic rationale for forest plantations; they also point out that the rationale often interacts, and that an individual plantation is likely to be established as the result of a variety of reasons. There is also a large variation in the expected major economic impacts of plantations (Table 2.3).

Plantations are able to provide a large variety of economic benefits and impacts to different agents participating in their establishment, harvesting, and processing of the raw materials harvested from them. It is also evident that the agents, such as small-scale farmers, large-scale landowners, labourers, technicians, private or public companies, and state forest agencies emphasize the various rationale, benefits, and costs involved differently.

TABLE 2.3
ECONOMIC RATIONALE AND IMPACT OF PLANTATION FORESTS

Economic rationale for plantation forests	Statement of rationale (cases)	Expected or realized impacts
Fast-growing resource base for new or existing pulp industries	Low cost wood for pulp mill Aracruz), export income (Chile)	Profit, multiplier impacts, foreign exchange
A substitute for or complementary to diminishing natural forest timber	Sustained wood supply for sawmill or plywood production, import substitute	Maintaining production and employment, value-added, foreign exchange saving
An energy source for industrial or non-industrial use	Domestic market (charcoal), low-cost household firewood, new competitive energy sources (wood gas, ethanol)	Rural employment, cash income, labour and time saving, energy self-sufficiency
Diversifying income opportunities of small-scale farmers and maintenance or enhancement of agri-cultural productivity	Small woodlot, agroforestry	Cash income, product diversification, increased agricultural income
Productive use of surplus land	Enhancement of a country's productive capacity	National income, employment
Reinforcement of individual land tenure rights	Permanent ownership, land speculation	Economic safety, speculation rents
Taking advantage of available incentives	Any reason above	Free inputs, subsidy income, tax reliefs, production increase

Source: Pöyry (1987) Kanowski and Savill (1992) and Morrison and Bass (1992)

Financial profitability is the most important single characteristic illustrating the revenue producing capacity of an investment. The higher the financial profitability, the greater the overall expected economic impacts. In general, the profitability of tropical plantations has been estimated to be higher than the profitability of reforestation in the temperate zone (e.g. Sedjo 1983). As previously mentioned, this generally higher profitability serves as a major attraction for plantation development in the tropics. Conversely, cash crops and subsistence farming are usually more profitable, and therefore are preferred by the small farmer involved in sedentary or slash-and-burn agriculture unless the land is badly degraded. In fact, the profitability differences create major dilemmas for plantation development; first, between the farmer and the external investor interested in tree plantation development, and second, between the private and social profitability for sloping marginal lands where agriculture causes externalities.

The extent to which the expected economic impacts of plantations are realized shows great variation. Economic successes are evident in some countries (e.g. New Zealand, Chile) and in some large-scale development projects (e.g. Jari in Brazil, to some extent PICOP in the Philippines) but in many countries, they are more numerous for location specific small-scale developments (Pandey 1995). In many cases, the financial profitability has been lower than predicted; this is due to either neglect or ignorance of risks in the profitability analyses, or due to poor planning and/or implementation of the reforestation projects. Often, the failures of large scale plantations have been due to other than technical reasons, such as conflicts over the control of the plantation, which have resulted in political backlashes, labour problems, and illicit felling (Morrison and Bass 1992).

In addition to the financial and economic analysis of the profitability of tree planting 'as such', the fundamental economic question is to what extent reforestation projects are capable of maintaining, or creating permanent and sustainable development impacts. This capability depends largely on what kind of forward and backward linkages plantations are able to produce. Although the impacts of protective plantations (such as increased soil fertility for agriculture) may be called development linkages, only the impacts of tree production are discussed in detail here.

Forest growth is primary production, where the material input requirements are usually modest; therefore, the backward linkages of reforestation are few. Perhaps the most important backward linkage for local production is the growing of seedlings, which always needs to be done in local nurseries because seedlings cannot stand long transportation. Other material inputs, like fertilizers and/or pesticides are seldom produced locally. Although some inputs may be transported either from other districts, or may even be imported (seeds of exotic trees, fertilizers, plastics etc.), many material inputs in nurseries are produced locally.

Seedling production is labour-intensive. For example, in the Philippines, according to the government standard, the total working time spent for full forest plantation development is 204 person-days per hectare for three years. Of this total, 83 days, or 41 per cent is due to nursery operations (Ramirez at al. 1993). Similarly, in small-scale agroforestry farm development under the Integrated Social Forestry Program, nursery operations for tree species (horticulture and forestry species) require 79 person-days per hectare for each hectare of plantation established, or 35 per cent of the total labour requirement. However, joint reforestation with enrichment planting on appropriate sites by Timber Licence Agreement Holders, requires only 4 person-days for seedling production per hectare, or 3 per cent of the total labour requirement, during a three-year enrichment planting period per hectare (Ramirez *et al.* 1993). The purpose of enrichment planting is to only assist natural regeneration, which keeps the labour requirement rather low.

The forward linkages of forest plantations depend on the purpose of the plantation, and on the labour and capital intensity of the related processing chains. For example, if tree plantations are established to improve the household fuelwood supply, the extraction-processing chain is very short. Even if fuelwood production serves other industries such as labour-intensive baking or tobacco-curing, the extraction-processing chain remains relatively short.

It has been estimated that in the Philippines, a total of 21.8 jobs are provided per one thousand cubic metres of log consumption: 15.8 in wood and wood products processing, 2.3 in wood furniture manufacturing, and 3.7 jobs in the pulp and paper industries. However, as only 15-20 per cent of the output of the pulp and paper industries is manufactured from domestic wood (the major input is imported recycled paper), the number of jobs in the pulp and paper industries per thousand cubic meters of log consumption is only 0.7, and the adjusted total of the labour requirement is only 18.8 jobs per one thousand cubic metres of log consumption (Ramirez *et al.* 1993).

Unfortunately, there are no direct data on the wood consumption of each sub-industry. However, since wood in its various forms is the major raw material for these industries, the ratio of total employment to expenditures for purchased materials and supplies in forest-based processing is, therefore, highly indicative of the consumption by each sub-industry (Ramirez *et al.* 1993). Table 2.4 shows that the employment ratio was the highest for the manufacture and repair of furniture and fixtures (with the exception of furniture composed primarily of metal, PSIC 332); the ratio was 20.7 and 68.5 persons per million Philippine pesos for large and small establishments, respectively (5.2 and 17.1 persons per US$ 10,000). The lowest employment capacity was found for the manufacture of pulp, paper, and paper products by large establishments (PSIC 341), where the employment ratio was only 2.6 persons per million Philippine pesos of raw material consumption (0.6 persons per US$ 10,000). In all industries, small establishments provide two to ten times more employment than the large establishments.

These employment ratios can be used indicatively to consider the development impacts of forest plantations. They clearly suggest that plantation species which provide wood material for value-added wood products, such as furniture and wood carvings, have the highest potential development impacts. This indicates that plantations of native species which could substitute for high-quality wood from natural forests, should be among future priorities.

TABLE 2.4
EMPLOYMENT RATIOS IN PERSONS PER MILLION PHILIPPINE PESOS
(OR PER US$10,000) IN THE PHILIPPINES, 1988

Industries	Large establishments employing more than 10 persons	Small establishments employing less than 10 persons
Manufacture of wood and wood products (PSIC 331)	8.8 (2.2)\1	44.6 (11.2)\1
Manufacture and repair of furniture and fixtures (PSIC 332)	20.7 (5.2)\1	68.5 (17.1)\1
Manufacture of pulp, paper and paper products (PSIC 341)	2.6 (0.6)\1	24.8 (6.2)\1

Source: Ramirez *et al.* (1993)

Note: \1 Figures in parenthesis per US$10,000.

The slower growth and longer rotations of native plantations have been hindrances to their development. The availability of wood from natural forests (although harvesting often is illegal) has also hampered price increases for substitute wood from plantations. Consequently, the result of the Philippine case study reaffirms that the profitability for slow-growing native species usually is lower than that for fast-growing species.

The large differences between the profitability of mahogany (*Swietenia spp.*) plantations in the Philippines and teak (*Tectona grandis* L.) plantations in Thailand may also be an indication of market failures. Although the quality of mahogany is not comparable to that of teak, the large differences in the profitability estimates could be partly explained by the fact that the market price of mahogany did not sufficiently reflect its correct utilization value. The high market price of teak timber may similarly illustrate that the wood payment capacity for value-added production is relatively high in Thailand. This may be indicative of the future development of the market prices of mahogany in the Philippines.

There is no straight forward answer on how the development component of forest plantations should be taken into account for economic analysis. The simplest way to account for the development component is to consider that the available or predictable stumpage prices of plantation wood will sufficiently reflect the 'value-added' creation capacity. If the 'market evidence' cannot be considered sensitive enough, then the other complementary option is to prepare a comprehensive market study to supply the basis for the prediction of stumpage prices for slow-growing, but high-quality native species.

To conclude, the backward and forward linkages as well as the employment opportunities for the present plantation forests are rather low, especially when wood is used in large-scale pulp and paper production. However, for most industrial forest plantations, establishment decisions are made according to the needs of the existing industry, or based on the future needs of an investment plan for the establishment of a new factory or pulp mill. Consequently, plantation development is directly related to the future development of the wood processing industries. The evaluations of the financial, economic, social, or environmental profitability of tree plantations should not only be considered separately, but also as an integrated part of analysing the whole investment package from the economic, social, and environmental points-of-view.

2.4 Social impacts of forest plantations

Tropical forest plantations are sometimes perceived in public discussion and criticism as industrial, commercial, and large-scale operations which trample environmental and social values and cultural minorities. Examples of these can no doubt be found. However, it is important to note that the general purposes of plantation forestry have been defined more appropriately, and are concisely given in the subtitle of an authoritative textbook as 'Tree plantations for industrial, social, environmental, and agroforestry purposes' (Evans 1992). In fact, the point that much of forestry is basically a social and environmental service (Evans 1992) has led to the re-evaluation of forestry's development role, with an emphasis on plantations at village level and an enormous expansion in social (community) forestry programmes.

Distinct social impacts of tree plantations are not easy to define. They are related to the interactions of plantations to the society at large, but especially to the needs of local people. Morrison and Bass (1992) see essential ways by which the perceptions, needs, and rights of local people may best be taken into account to achieve sustainable development and emphasize genuine participation and a dialogue between local people and plantation developers at all stages.

Sustainable development has social and economic dimensions. These dimensions overlap to some extent, which can be seen in the following discussion where many social impacts are identified as being economic by nature. When compared to conventional economic analysis, social impact analysis examines economic phenomena from the wider points-of-view of welfare, equity, and sustainable human development.

Employment prospects and improved cash income opportunities for rural people are usually regarded as the most important social benefits of reforestation (Table 2.5). However, employment from plantations cannot be considered as sufficient rationale for plantation establishment if an alternative land use generates greater labour opportunities for rural people. This emphasis on the greater job-producing alternative may be true even if the financial profitability of reforestation far outweighs the profitability of the alternative land use; this will be shown later in two case studies. Work opportunities for rural people may, however, be improved considerably if the reforested land has no other uses. Morrison and Bass (1992) point out that the introduction of a cash economy is beneficial only when it adequately increases the net social benefits, thus compensating for the removal of the subsistence economy.

Development of a local infrastructure and multiplier impacts on the village economy are other positive social impacts of reforestation. Increased incomes, especially from non-farm activities, are used for direct consumption or farming investments, whereas incomes from farming are used for every day living. Consequently, increased cash incomes benefit village economies by increasing direct consumption, as well as improving the possibilities for investments in infrastructure.

The impacts of reforestation which result in changes to cultural and social life, or traditional land use patterns can be regarded as beneficial or harmful. The difficult philosophical and ethical aspects of development may arise at this point, creating many queries. Are the social and cultural benefits from economic development higher than its respective costs? Is it beneficial to change social ranking in a village or in families due to someone's better adjustment to changing economic conditions? Is it moral to attain financial profit if it occurs at the cost of losing traditional land use patterns? These questions will remain without any single, correct answer, and may largely depend on who is evaluating the impacts.

Tree planting has also some clearly negative impacts. For example, reforestation may increase the insecurity of land-use rights as well as promote inequitable distribution of costs and benefits. In many developing countries, like the Philippines and Thailand, forest land is owned by the government, and often the only way to have a legal right to use land is to continue cultivation. Thus, if the (old agricultural) land is reforested, the right to use the land may change. Similarly reforestation may increase inequitable distribution of costs and benefits by widening the income gap between the rich who can afford to invest in reforestation and other (poor) people.

There are cases where the welfare either at the village level or at the national level may not be improved by reforestation. The annual financial return on certain land types may be substantially lower for tree planting than for agriculture. Inappropriate and unplanned land use (for reforestation) may, therefore, actually decrease general welfare.

TABLE 2.5
SOCIAL IMPACTS OF PLANTATION DEVELOPMENT

Positive impacts	Adverse impacts
Clarification and strengthening of tenure (in some cases)	Compulsory acquisition of land
	Damage to subsistence economy
Employment	Marginalization of local /indigenous people
Income and welfare	Loss of employment
Household consumption	Loss of spiritual and cultural values
Infrastructure development	Conflicts with agriculture or other intensive uses
	Reduction of common land
	Community disintegration

Source: Evans (1992), Leslie (1992), Morrison and Bass (1992), and Klock (1995).

The adverse social impacts of tree plantations could be avoided or considerably reduced by proper plantation planning and management. Key issues include the following: local people's participation and motivation, small-scale reforestation with intermediate technology, and concentrating reforestation efforts on lands with a low opportunity cost. In addition to these, it is also essential that proper markets for plantation timber exist, and that the benefits from tree planting are not only to the investors, but are also brought to villagers and farmers.

To conclude, it is evident that reforestation has both negative and positive social impacts. It is more important to minimize the negative social impacts of tree planting than to argue whether they exist. In addition, circumstances should be created where the positive social impacts can exceed the adverse ones. It is the net social impact that matters most.

2.5 Environmental impacts of forest plantations

Negative and positive environmental impacts of forest plantations vary according to plantation species and various site specific conditions (Table 2.6). The major positive environmental impacts of plantation forestry in the tropics have been identified to be: erosion control, which is often cited as the most important environmental benefit (e.g. Shepherd 1990, Evans 1992, Nilsson Axberg 1993); protection of watersheds; improvement of physical and chemical properties of degraded soils (Poore and Fries 1985, Evans 1992); and delaying, if not preventing, the destruction of natural forests (Budowski 1984, Spears 1984). Protection of watersheds through improved vegetation cover improves the capabilities of the environment to resist the stresses caused by high precipitation (e.g. Satterlund 1972, Mathur *et al.* 1976), although vegetation other than trees may also be successful. Recently, an emphasis has also been placed on the role of afforestation in reducing the negative impacts of fossil fuel combustion to the carbon dioxide balance of the atmosphere (e.g. Vitousek 1991, Woodwell 1992). This role of afforestation applies to situations where grasslands or other ecosystems with low carbon storage are replaced with fast-growing plantations.

Plantation forests and industrial plantations, especially single species plantations (e.g. eucalyptus), have been criticized because of their presumed negative environmental impacts. For example, when a natural forest is replaced by a single species plantation, the biological diversity of the site is diminished (Spears 1984, Hunter 1990). Similarly, large industrial monoculture plantations are cited for their high environmental risk since they are often vulnerable to environmental hazards (Poore and Fries 1985). Plantation forests in general are also accused of reducing the water flow (Sargent 1992), suppressing ground vegetation (Kanowski and Savill 1992), and degrading the site (Shephard 1986).

Concluding this review, careful planning and location of sites, and optimal selection of species for the prevailing ecological, social, and economic circumstances are the major keys to minimizing the adverse impacts of reforestation and maximizing the positive ones. This is also a way to adjust plantation development to meet the requirements of the new criteria and indicators for sustainable forestry, which are presently being discussed and compiled as a part of the post-UNCED processes. The sustainability approach also provides clear recognition that due to environmental, social, or economic reasons, there are many places where the establishment of forest plantations is not recommended at all.

TABLE 2.6
MAJOR ENVIRONMENTAL IMPACTS OF PLANTATION FORESTRY IN THE TROPICS

Positive impacts	Reference	Negative impacts	Reference
Erosion control	Poore and Fries (1985) Sargent (1992) Evans (1992)	Impoverish-ment of the soil	Poore and Fries (1985) Shephard (1986)
Improved physical and/or chemical properties of the soil	Chijicke (1980) Poore and Fries (1985) Evans (1992)	Increased water consumption	Evans (1984) Poore and Fries (1985) Florence (1986)
Watershed protection	Satterlund (1972) Mathur *et al.* (1976) Nilsson Axberg (1993) Klock (1995)	Suppression of ground vegetation	Florence (1986) Kanowski *et al.* (1992) Sargent (1992)
Land rehabilitation	Lovejoy (1985) Grainger (1988) Evans (1992)	Diminished biodiversity	Wilson and Johns (1982), Prescott-Allen (1982), Hunter (1990) FAO (1992)
Shelter and protection	Shepherd (1990) Kanowski *et al.* (1992)	Damage to the habitat of native species	Shephard (1986)
Sequestration of carbon dioxide	Vitousek (1991) Woodwell (1992)	Declined water quality	Shephard (1986)
Improved water quality and/or stability	Sterk and Ginneken (1987) Evans (1992)		
Decreased pressure on natural forests	Spears (1984), Budowski (1984), Shephard (1986), Davidson (1987)		

III EXTENDED COST-BENEFIT ANALYSIS FOR ASSESSING THE PROFITABILITY OF REFORESTATION

3.1 Extending the cost-benefit analysis

Previous analyses of the profitability of forest plantations in many developing countries have been focused on efficient wood production; these were evaluated with conventional financial and economic cost-benefit analyses. Social and environmental issues have often been neglected in the design of plantation forestry planning and practices; these issues have also been excluded from profitability analyses due to problems with data and for methodological reasons. The questions that need to be raised are, whether an economic analysis could be improved, by including social and environmental issues or should the analysis only concentrate on the aspects it was primarily created for (financial and economic)?

Reforestation may not be an efficient way to improve the economic conditions at community level even if its profitability is high. This may be especially true if the benefits to rural people are limited to the returns from plantation establishment work. Under such conditions, plantation forestry practices, when compared to labour-intensive agricultural practices, cannot be considered socio-economically beneficial to rural inhabitants. Traditional economic analyses normally do not include the socio-economic aspects of income distribution and employment.

The demand for land is another socio-economic aspect related to the future development of plantation forestry. If plantations are established on land where there are competing needs, rights, and interests, then more complex methods than just conventional economic analysis may be needed to evaluate projects. In the end, the answer to the question of competing needs for land is a matter of politics rather than economics; a well-prepared and extended economic analysis may, however, provide substantial basis for making the final decision.

An economic analysis in which the environmental impacts of plantation forests (external economic impacts) are assessed in monetary terms, may also improve the quality of decision-making for the planning or management of forest plantations. Although it may not be possible to value all of the environmental impacts in monetary terms or perhaps not even to quantify some of them in physical terms, the assessment of major environmental effects is badly needed in economic planning.

3.2 Financial and economic profitability analyses

The profitability of reforestation was estimated using slow-growing indigenous species, mahogany *(Swietenia macrophylla* King) in the Philippines and teak *(Tectona grandis* L.) in Thailand, and fast-growing exotic species, *Racosperma auriculiformie* (Cunn. ex

Benth.) Pedley (syn. *Acacia auriculiformis* A. Cunn. ex Benth.) in the Philippines and *Eucalyptus camaldulensis* Dehnh. in Thailand. Assumptions on the utilization of raw materials from the various species were as follows: mahogany and acacia timber was to be used for high- and low-quality lumber, respectively, teak timber in parquet or furniture industries, and eucalyptus wood in pulp and paper manufacturing.

Studies on the growth and yield rates of forest plantations on different soil types and for different establishment densities have not been done systematically in Thailand or the Philippines. Thus, the estimated mean annual increment (MAI) had to be based on separate, rather diverse studies and growth estimates (Chayamporn 1983, FAO 1983, Firewood Crops 1984, Board of Investment 1988, Wellendorf and Kaosa-ard 1988, DENR 1990, Niskanen *et al.* 1993, Perhutani 1993, RFD 1993b, ADB 1994, Pohjonen and Pukkala 1994). Due to the lack of detailed growth and yield data, the optimum financial or economic rotations were not even roughly estimated. Instead, the rotation periods were fixed for the commonly used 10, 15, and 25 years for pulpwood, low-quality timber, and high-quality timber production, respectively.

Financial cost data for industrial reforestation were obtained from forestry sector master plans produced in the study countries (DENR 1990, RFD 1993b). For community-based reforestation, the standard cost data used for operative planning by governmental reforestation agencies (DENR 1989; Forestry Research Centre 1994) were applied. Cost data for cultivation of cassava from Wannawong (1989) and of corn from BAS (1994) were used for the land management options of agriculture and agroforestry. The cost data were updated for 1993 using wholesale price indexes (Bank of Thailand 1993; NSCB 1993).

Since the profitability of reforestation often has been evaluated only in financial terms, the methodology of the profitability studies here was also principally laid on the foundation of a financial cost-benefit analysis. However, the financial analysis was extended by evaluating the profitability from the point-of-view of a society using a conventional cost-benefit analysis. It has been considered an appropriate tool for the economical examination of forestry projects. It is, however, used sparingly due to the specific difficulties found in forestry project appraisals: the importance of non-market products, joint forest production, the externalities of production, the economic nature of forest products (public and private mixed goods), and the lack of information on the production functions of forests (Nautiyal 1988). This study attempted to strictly and holistically apply the methodology of cost-benefit analysis (see Little and Mirrlees 1974, Gittinger 1982, Squire and van der Tak 1988, Price 1989, Ward and Deren 1991, Gregersen and Contreras 1992). The results of the economic valuation of goods and factors of production, the economic efficiency (shadow) values, are presented in Appendix A.1.

The same profitability criteria were used throughout the study. Maximization of the net present value (NPV) of a reforestation investment using market prices for expenditures and commodities was used for analysing the financial profitability of the reforestation options. Similarly, maximization of the NPV of a reforestation investment using economic efficiency (shadow) prices for goods and factors of production was used to analyse the economic profitability of the reforestation options. The discount rate was set at 12 per cent for all NPV calculations, representing a rate of return often required by international financing institutions (e.g. Asian Development Bank) for invested capital. The financial and economic internal rates of return for a reforestation investment were also estimated, to allow for a comparison between the profitability of reforestation investments when the inputs were not close to equal (Nautiyal 1988, Price 1989, Pearce 1990). The internal rate of return (IRR) is, by definition, the discount rate that results when the NPV is set equal to zero.

3.3 Social cost-benefit analysis and return to labour

The social cost-benefit analysis was based on an assumption that the governments of both countries have an objective to equalize income distribution, and to weigh implicitly the incomes of poor members of the society over those of the rich. In practice, an obvious way to weigh the incomes of poor people is to use a low (shadow) wage rate for project evaluation. This low wage rate will favour labour-intensive development projects over capital-intensive ones. In this study, it was also examined how much the economic profitability would change when a distributional objective was incorporated in the estimation of the shadow wage rate.

Theoretically, the shadow wage rate for social cost-benefit analysis can be lowered from the shadow wage rate used in economic analysis, if the net social cost of increased consumption due to an increase in incomes is negative. This will be the case, if the incomes accrue to the poor members of society and if those incomes are strongly weighed over the economic growth objective (maximization of society's consumption). Crucial to the valuation of a wage rate for a specific income group in a socio-economic analysis are the value of the elasticity coefficient (n), and the income group's relative share of total incomes. Determination of the value of 'n' must be done subjectively. Little and Mirrlees (1974), for example, estimated that most people would put 'n' in the range of 1 to 3 for developing countries. Squire and van der Tak (1988) estimated more conservatively that 'n' should be set between 0.5 and 1.5 for countries that have an interest in income redistribution.

The equity of incomes is at about the same low level in Thailand as it is in the Philippines (NSCB 1993, TDRI 1993). In the Philippines, it can be assumed that a political will exists to improve the uneven income distribution (e.g. Republic of the Philippines 1993). However, the economy cannot be considered as being unduly oriented towards better distribution, because of the high external debt and low economic growth. A conservative estimation was used in this study; the elasticity coefficient (n) was set equal to 0.5 for the Philippines. In Thailand, the growth of the economy has been rapid in recent decades; the growth rate of the gross national income has been constant at about six to seven percentages in the 1970s, 1980s, and early 1990s (World Bank 1992). Despite this economic growth (or perhaps because of it), income distribution has been more uneven in the 1990s than it was in the early 1980s (TDRI 1993). It can be concluded that the economic growth should have allowed the government of Thailand economic space within which it could have used incentives or enacted laws to equalize income distribution. However, at present, improvement in income distribution has been restricted; perhaps this is due to the lack of concerted actions, or the inefficiency of governmental operations. Since true progress to improve income distribution has not occurred in Thailand, the value of the elasticity coefficient (n) was set to be as low as it was for the Philippines (n = 0.5), although for different reasons. Calculations of the shadow wage rates with distributional weights between 0.25 and 0.75 are presented in Appendix A.2.

3.4 Environmental cost-benefit analysis

The major environmental impacts of plantation forestry in the tropics have been identified in Table 2.5. Four environmental impacts were quantified and valued for the Philippines: on-site impacts of erosion control, off-site impacts of erosion control, loss of nutrients due to harvesting, and impacts of carbon sequestration. Similarly, four environmental impacts were valued and added to the economic analysis for Thailand: on-site impacts of erosion control, loss of nutrients due to harvesting, transpiration, and impacts on carbon sequestration. The environmental impacts valued were almost the same for both countries, except that off-site costs of soil erosion were valued only for the Philippines, and transpiration only for Thailand. Other environmental impacts listed in Table 2.5 had to be rejected from the environmental-economic analysis due to the valuation methodology (e.g. decrease in biodiversity) and data limitations (e.g. decreased pressure on natural forests).

The on-site costs of soil erosion were estimated with the replacement cost method. More specifically, the amount of fertilizers needed to replace the nutrients lost in the eroded material were valued with the economic parity values for fertilizers. It was assumed that one megagram (Mg) of soil contains 2.3, 0.062, and 0.758 kilograms of nitrogen, available phosphorus, and exchangeable potassium, respectively (Salzer 1993, Francisco 1994), and that the average bulk density of soil is equal to 1.28 kilograms per cubic decimetre (Seckler 1987). Therefore, in fertilizer equivalent one Mg of soil was assumed to contain nutrients equal to 5.11, 0.13 and 0.91 kilograms of urea, P_2O_5, and K_2O, respectively, and to be worth approximately 30 baht and 22.5 pesos in Thailand and the Philippines, respectively.

Forest plantations reduce soil erosion as compared to occasionally burned and grazed grassland, although teak and eucalyptus species are not particularly good for erosion control. Large teak leaves (e.g. Sawyer 1993), and root competition by eucalypt species (e.g. Poore and Fries 1985) may suppress ground vegetation, which plays a central role in erosion control. Conversely, burning of grasses during the rainy season to promote juvenile grass production greatly increases soil erosion, by leaving the soil unprotected.

In this study, the amount of sheet and rill erosion was estimated with the modified universal soil loss equation (MUSLE) (David 1988). The estimated gross soil erosion rates for gently sloping (0-18 per cent) grassland and plantation sites are presented in Table 3.1. The gross soil erosion rates were generally lower in Thailand than in the

Philippines due to the assumption that the value of the rainfall erosivity factor used in the MUSLE for Thailand was half of the value for the Philippines.

TABLE 3.1
ESTIMATED GROSS SOIL EROSION RATES (MG/HA/YR AND MM/YR)

	Cover factor	Erosion (Philippines)		Erosion (Thailand)	
Land management option	(C)	Mg/ha/yr	mm/yr	Mg/ha/yr	mm/yr
Grassland	0.3	60	4.7	29	2.3
Forest plantation	0.08	16	1.3	8	0.6
Agroforestry	0.2	40	3.2	19	1.5
Corn/Cassava cultivation	0.4	81	6.3	39	3.0

Off-site costs of soil erosion were estimated for the Pantabangan watershed of Central Luzon, the largest island of the Philippines, because of the availability of data on the impacts of sedimentation on electricity production by the regional dam, and agricultural production near it. The approach of Cruz *et al.* (1988) to study the off-site effects of soil erosion only at the gate of the water reservoir was followed because of the estimate (David 1988) that only 3-6 per cent of the total sediment quantity normally passes the gates of the Pantabangan Dam.

Since the volume rate of erosion differs from the volume rate of sedimentation, the real sedimentation rate was obtained by using a 0.4 sediment delivery ratio. Following the estimation by David (1988) that 3-6 per cent of the sediment can be transported beyond the reservoir, the study assumed that 95 per cent of the total volume of sediment was deposited on the bottom of the reservoir. It was further assumed that 25 per cent of the sediment would settle in the reservoir's active storage area, while the rest would sink into dead storage causing no direct harm to irrigation or to the production of electricity (Cruz *et al.* 1988). With the assumption that one ton of sediment is equal to 0.67 of a cubic metre (Hufschmidt and Srivardhana 1986), the results indicated that one ton of soil erosion in the Pantabangan watershed was equal to 0.06 of a cubic metre (10.4 x 0.95 x 0.75 x 0.67) of sediment in the active pool of the reservoir.

Using the loss of earnings method, the impacts of soil erosion were determined by means of the effects of sedimentation on electricity production and agricultural irrigation. The negative impact of soil erosion on the electricity production of the Pantabangan Dam was obtained by dividing the average active storage capacity of water (1,753 x 10^6 m^3) by the annual electricity production (186 x 10^6 kWh) and then multiplying the quotient (0.106 m^3/kWh) by the sedimentation into the active storage area caused by one ton of erosion (0.06 m^3) and the retail price of electricity (1.50 peso/kWh). Thus, one ton of soil erosion resulted in a 0.01 peso reduction in the annual electricity production.

With regard to the effect of soil erosion on irrigated agriculture, the study used the estimate by Cruz *et al.* (1988) that one hectare of irrigated rice requires 13,000 cubic metres of storage of water. The 0.06 of a cubic metre reduction in the storage capacity as a result of sedimentation was assumed to cause a 4.6×10^{-5} of a hectare loss to agricultural irrigation. Irrigated agriculture was considered only as an option to non-irrigated agriculture, therefore only the value of the difference between irrigated and non-irrigated agriculture was assessed. The difference (2,024 pesos) between the net values of irrigated and rainfed rice production for the Pantabangan watershed (BAS 1994) was multiplied by the per hectare loss to agricultural irrigation to determine the reduction (0.01 peso) of agricultural productivity per one ton of soil erosion near the Pantabangan Dam.

The opportunity cost (i.e. benefits lost from agricultural irrigation) for construction of a large non-productive sediment pool in the water reservoir to offset the adverse effects of sedimentation was also estimated. The opportunity cost was determined from the dam's volume of dead storage (approx. 225×10^6 m^3 storage, Cruz *et al.* 1988). The potential area which could be irrigated by the volume of dead storage (13,000 m^3/ha) was multiplied by the net value of irrigated agriculture, 2,024 pesos per hectare. The product was then divided by the volume of the dead storage to arrive at the value per cubic meter of sediment, which was then multiplied by the reduction in the storage capacity as a result of soil erosion (0.06 m^3/ton) to determine the opportunity cost per ton of soil erosion. The dam's present dead storage was estimated to have an opportunity cost of 34.9 million pesos.

Nutrients accumulated in and removed with the harvested wood or timber were valued with the replacement cost method. The relative amounts of nitrogen, phosphorus, and potassium accumulated in a tree trunk were estimated to be equal to 0.2 per cent, 0.02 per cent, and 015 per cent of the stem oven dry weight, respectively (derived from Evans 1992: 207). Consequently, for a basic density (oven dry weight per fresh volume) of 600 kilograms per cubic metre, the fertilizer equivalent for the nitrogen, phosphorus, and potassium lost due to harvesting totalled 20.8 baht per cubic metre.

Kimmins (1977) estimated that 1.5 to 4 times more nutrients are removed for whole tree harvesting than for bole only harvesting (cf. Sawyer 1993). Thus, the risk of nutrient depletion from soil is greater for the whole tree harvesting of eucalyptus trees in Thailand than for the bole only harvesting of acacia in the Philippines. The lowest estimate by Kimmins (1977) for nutrient depletion was applied to this study, and it was assumed that the depletion due to whole tree harvesting of eucalyptus would be 1.5 times higher than for bole only harvesting.

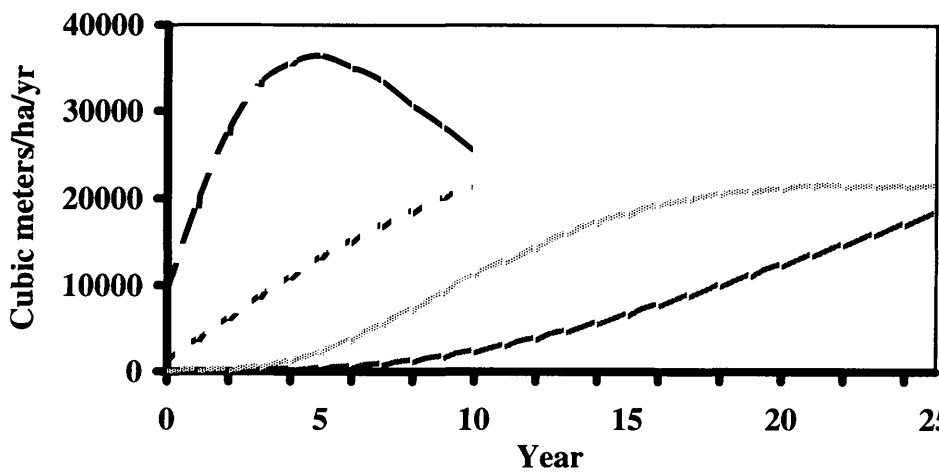
Transpiration depends principally on the following: climatic factors (radiation, atmospheric humidity deficit, temperature, and wind speed), physiological response mechanisms (e.g. stomata aperture), canopy structure (especially the leaf area index), and availability of soil water to roots (Calder 1991). Despite the complexity of the phenomenon, Calder *et al.* (1991) predicted that the transpiration rate can be estimated, if the basal area of the tree trunk is known, and if the tree does not face soil water stress. In Equation 3.1, q (m^3d^{-1}) is the daily transpiration rate of a tree, and g (m^2) is the basal area of the tree at the breast height (1.3 m).

(3.1) $q = (6.6 \cdot 0.3) \cdot g$

The transpiration ratio approach is another way to estimate the transpiration rate of plants; this ratio is based on the assumption that during the growing season a plant consumes a specific volume of water in litres per kilogram of dry matter produced (e.g. Larcher 1980). Larcher (1980) estimated that the transpiration ratio for herbaceous C_3 plants (like trees) would be 1.25-1.43 grams of dry matter per liter of water. Jones (1992) estimated that the transpiration ratio for C_3 plants can vary generally between 0.88 and 2.65 grams of dry matter per liter of water. In this study, the transpiration ratio was assumed to be 1.3 grams of dry matter per liter of water.

An example of the estimated transpiration rates for afforestation in Thailand is presented in Figure 3.1. For the basal area approach it was assumed that trees transpire only during the five month growing period. Thus, it gave lower estimates for the annual transpiration than the transpiration ratio approach.

FIGURE 3.1
TRANSPIRATION RATES FOR EUCALYPTUS (10-YEAR ROTATION) AND TEAK (25-YEAR ROTATION) PLANTATIONS IN NORTHEAST THAILAND



Note: The upper lines represent the Basal area Approach, and the lower lines the transpiration ratio approach.

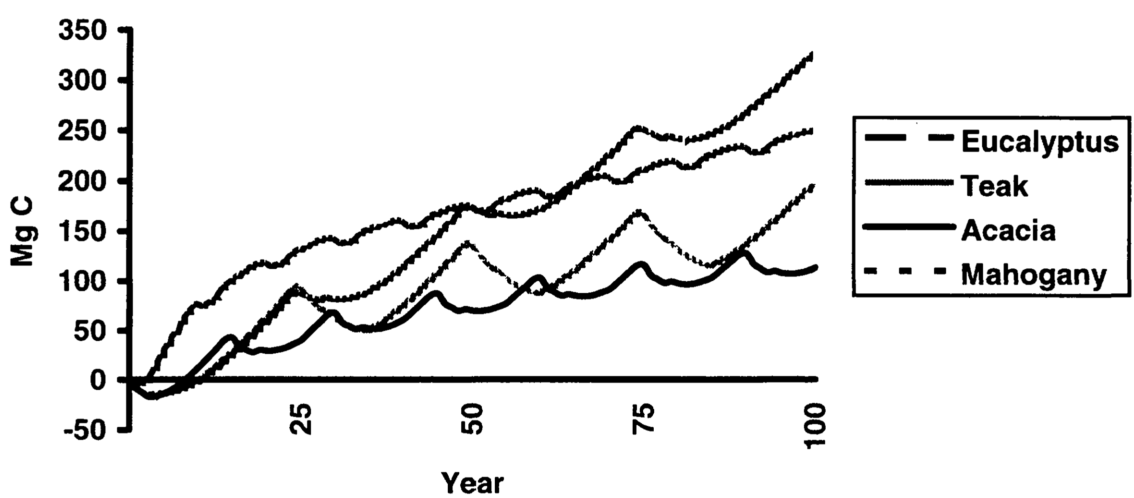
The unit value of water depends on the local conditions, and can vary from site to site, and from one season to another. For this study, it was assumed that transpired water would have no economic value in the Philippines. In Thailand, however, since water severely limits agriculture, especially in the Northeast, it can be assumed that water transpired by trees has economic value, if it could have been used for irrigation. Irrigated agriculture was considered only as an option to non-irrigated agriculture, therefore only the value of the difference between irrigated and non-irrigated agriculture was assessed.

Net annual value for the cultivation of irrigated rice is approximately 2,025 baht per hectare more than for non-irrigated rice (Ministry of Agriculture 1993). Assuming that 13,000 cubic meters of water are required to irrigate one hectare of rice per year (Cruz *et al.* 1988), the value of transpired water would be 0.15 of a baht per cubic metre.

Carbon sequestration by plantation forests was quantified using the same approach as Nabuurs and Mohren (1993). This method is based on the assumption that an estimation can be made of the total carbon sequestered by all the various structures of a tree (trunk, foliage, etc.) if the annual volume increment of the trunk is known. In contrast to Nabuurs and Mohren (1993), the decomposition of detrious material and the residence time of carbon in wood-based products were included in this study to provide a better estimation of carbon flows.

It was assumed that the average carbon storage by grassland is equal to 18 megagrams per hectare (Woodwell *et al.* 1978, King *et al.* 1992), and that this storage decomposes within four years after the establishment of a forest plantation. It was also assumed that the carbon sequestered into wood that is used for pulp or fuel will be emitted back to the atmosphere earlier than the carbon sequestered in saw timber or plywood (Karjalainen *et al.* 1994). The differences in the quantities of carbon sequestered, and the occurrence time for carbon sequestration between the different tree species and plantation establishment techniques were basically due to variations in the residence times for carbon in different tree structures, and in the growth and yield patterns (Fig. 3.2).

FIGURE 3.2
CARBON SEQUESTRATION BY TREE PLANTATIONS



The shadow price for a unit of carbon dioxide (CO_2) is the value of the external damage caused by its emission, or the benefit achieved by control of its emission. Determination of the shadow price level for emission control varies strikingly according to the method for pricing the external damages, or the costs of preventing them (Table 3.2). Since the unit values for carbon emissions are usually presented as present-valued lump sums, the shadow price for CO_2 also depends on the discount rate applied. It can be assumed that the shadow price of carbon dioxide emission is positive, although it seems impossible to objectively determine any exact or core estimates.

Theoretically, it has been shown that marketable emission permits will minimize the total cost of pollution control, if limitations for maximum pollution level are given and when market distortions are rejected (Randall 1987). This theory was also assumed to be relevant for the valuation of carbon sequestration for the following reasons: forests clearly offer an opportunity for emission control investments (e.g. for industrial and energy production concerns), and emission control costs can be assumed to describe the value of carbon sequestration by forest plantations. The recommendation made by Andersson and Williams (1994) that the Global Environmental Facility (GEF) should apply a shadow price for carbon sequestration to GEF funded projects (e.g. afforestation projects), starting from US$ 25 per megagram of carbon in the year 1993, and increasing by 10 per cent per annum until the year 2010, was considered most relevant for this study. However, the shadow price for the carbon flows (US$ 25 /Mg) was considered constant as were wood prices, in order to avoid doing both compounding and discounting to the same carbon values in the same profitability analysis.

TABLE 3.2
UNIT VALUE FOR CARBON EMISSION CONTROL

Method for pricing CO_2	Unit value (USD/Mg C)	Reference
Cost of damages due to global warming	20	Frankhauser (1992) cf. Pearce and Brown (1994)
Marginal cost of abatement	1-6	Falk and Mendelson (1993)
Eight various methods	1-380	Price and Willis (1993), Price (1994)
Marginal cost of limiting C emissions during energy production	25-120	Andersson and Williams (1994)
Direct subjective estimation by nine experts (interview)	113 (s.d. 150)	Schauer (1995)
Reforestation costs	1-60	Sedjo *et al.* (1995)

Note: s.d. = standard deviation

IV PROFITABILITY OF TREE PLANTATIONS IN THE PHILIPPINES AND THAILAND

4.1 Financial and economic profitability

Reforestation was estimated to be financially more profitable in Northeast Thailand than in Luzon, the Philippines. Comparisons were made only to gently sloping sites in the Philippines, since the results were not assessed on moderately or steeply sloping sites in Northeast Thailand where the terrain is normally flat. Teak plantations in Thailand with a 25-year rotation period were most profitable from the point-of-view of the private investor, although some uncertainties related to the growth and yield assumptions remained. The high profitability of teak plantations was primarily based on the capability of parquet and furniture manufacturing industries to pay high stumpage prices for timber. Eucalyptus plantations in Thailand were also more profitable than acacia or mahogany plantations in the Philippines. In the Philippines acacia plantations were financially more profitable to grow than mahogany plantations. In the future, the order of profitability between these species in the Philippines may change, if more rational utilization of mahogany timber by the wood processing industries occurs, thus raising its price. As an example, the net present value of the industrial reforestation investment in the Philippines was 8,769 and 3,161 pesos per hectare for acacia and mahogany, respectively (Table 4.1, also see table note \1).

TABLE 4.1
FINANCIAL PROFITABILITY OF REFORESTATION IN THE PHILIPPINES AND THAILAND

	Philippines (pesos/ha)\1		Thailand (baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	8,769	3,161	23,269	51,412
Community-based reforestation	347	-3,856	10,234	34,387
Agroforestry	4,679	1,095	2,628	22,961
Corn/Cassava cultivation\2	13,585		-12,755	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

Industrial reforestation was financially more profitable than community-based reforestation in both countries due to the estimation that its growth and yield rates would be superior. Intercropping of corn improved the financial profitability for community-based reforestation in the Philippines, whereas intercropping of cassava decreased the financial profitability for community-based reforestation in Thailand. This was basically due to the estimated labour costs calculated using the official minimum rural wage rates (Table 4.1), which caused corn cultivation in the Philippines to be profitable, while making cassava cultivation in Thailand unprofitable.

Economic profitability for reforestation and agricultural production was higher than financial profitability, mainly because the shadow prices for the produced outputs (e.g. timber or grain) were higher than their prices for the financial profitability analyses (see also Appendix A.1). Economic profitability for agroforestry plantations, grain production, and industrial- and community-based reforestation with acacia was higher than financial profitability. In contrast, economic profitability of reforestation with mahogany was only slightly higher than its financial profitability (Table 4.2).

The economic profitability of acacia plantations in the Philippines was about equal to that of eucalyptus plantations in Thailand. For example, net present value of the reforestation investment for industrial reforestation with acacia in the Philippines was 26,032 pesos per hectare, and for eucalyptus in Thailand 26,536 baht per hectare. However, mahogany plantations in the Philippines were economically less profitable than teak plantations in Thailand, reflecting the considerably lower economic value of mahogany timber (Table 4.2).

TABLE 4.2
ECONOMIC PROFITABILITY OF REFORESTATION

	Philippines (pesos/ha)\1		Thailand (baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	26,032	5,569	26,536	67,523
Community-based reforestation	12,354	-3,504	17,933	50,723
Agroforestry	22,884	9,309	20,474	47,972
Corn/Cassava cultivation\2	43,532		1,396	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

4.2 Social profitability and the return to labour

The incorporation of distributional weights to the economic profitability analysis lowered the economic shadow wage rate for large-scale reforestation options in the Philippines, and for all land management options in Thailand (Table 4.3). The decrease in the economic shadow wage rate for large-scale reforestation in the Philippines was basically due to an assumption that labourers in industrial and community-based reforestation activities belong to the lowest income group, whereas people working at agroforestry or grain production were assumed to belong to the second-lowest income group. The incomes of labourers working at industrial and community-based reforestation were therefore weighted more than the incomes of people working at agroforestry or grain production (see also Appendix A.2). Consequently, the social shadow wage rate of the second-lowest income group in the Philippines was estimated to be higher than the economic shadow wage rate, and the net present value of the change in the labour costs due to the incorporation of the distributional objective to the economic profitability analysis was negative.

The net present values for the changes in labour costs due to a change in the shadow wage rate were rather low. For example, in community-based reforestation with teak in Thailand, the net present value of the decrease in the shadow wage rate (net social costs of increased consumption) equalled 4,396 baht per hectare. However, this was considerably higher than the net present value of the decrease in the shadow wage rate for agroforestry, (3,266-3,419 baht/ha) or for cassava cultivation (3,246 baht/ha) (Table 4.3). The overall socio-economic profitability for the different land management options can be calculated by totalling the values presented in Tables 4.2 and 4.3 (see also the first table in Appendix A.3).

TABLE 4.3
NET SOCIAL COSTS OF INCREASED CONSUMPTION (NET PRESENT VALUE OF THE CHANGE IN THE ECONOMIC SHADOW WAGE RATE)

	Philippines (pesos/ha)\1		Thailand (baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	115	101	1,038	922
Community-based reforestation	448	446	4,923	4,396
Agroforestry	-2,790	-2,784	3,419	3,266
Corn/Cassava cultivation\2	-5,303		3,246	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

The return to labour was estimated from the point-of-view of non-educated labour, assuming that the labour costs were the only cash income from large-scale reforestation options. In the Philippines, however, the return to labour was assumed to be a sum of incomes from the work opportunities, and from the net timber sales in the community-based reforestation. This summing of incomes was based on the agreements for community-based reforestation between the government, the Department of Environment and Natural Resources, and the rural communities, which normally allow the communities to use the incomes from timber sales after the initial plantation establishment costs have been paid back. Thus, the return to labour was considerably higher for community-based reforestation in the Philippines than in Thailand. The return to the non-educated labour in small-scale land management options (agroforestry and agricultural production) was estimated by deducting production costs (other than labour costs) from the sale incomes (Table 4.4).

Industrial reforestation options generated lower benefits to the non-educated labour than the other studied land management options. For example, in Thailand, labour-intensive community-based and machine-intensive industrial-based reforestation with teak improved the cash income earnings of non-educated workers, or communities by 13,774 and 2,890 baht per hectare, respectively. Similarly, in the Philippines, the return to labour from industrial reforestation with mahogany was only 9,444 pesos per hectare, while the return from community-based reforestation was 37,081 pesos per hectare (Table 4.4).

Cash incomes to non-educated workers were generally lower for reforestation than for agricultural production. Although cassava cultivation in Thailand was estimated to be financially unprofitable at the minimum rural wage rate (Table 4.1), it generated a higher financial return to the non-educated labour than community-based reforestation with teak (Table 4.4), which was financially very profitable.

TABLE 4.4
NET PRESENT VALUE OF THE RETURN TO NON-EDUCATED LABOUR

	Philippines (pesos/ha)\1		Thailand (baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	9,599	9,444	3,394	2,890
Community-based reforestation	47,673	37,081	15,426	13,774
Agroforestry	20,814	16,864	38,338	57,075
Corn/Cassava cultivation\2	41,228		30,896	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

4.3 Environmental-economic profitability

The net present value for environmental impacts was higher for industrial reforestation than for community-based reforestation. This unexpected result was due mainly to the superior growth and yield rates attributed to industrial reforestation, which raised the value of carbon sequestration, and also due to the relatively high discount rate applied to the analyses. Accordingly, the net present value of environmental impacts was higher for fast-growing than for slow-growing tree plantations.

The estimated environmental disadvantages of reforestation were nutrient loss due to harvesting and irrigation water loss due to transpiration by trees. As an example, the net present values of the estimated environmental impacts for community-based reforestation on gently sloping sites are presented in Table 4.5. In Table 4.6, the net present values of environmental impacts of the different land management options are totalled.

The net present value of environmental impacts was lower for agroforestry-based reforestation than for industrial or community-based reforestation. The nutrient consumption of corn and cassava sharply decreased the environmental-economic profitability, as did the growth and yield rates for trees with intercropping, which were lower than the rates without intercropping. For example, the net present value of the environmental impacts of agroforestry and community-based reforestation with acacia was 302 and 4,470 pesos per hectare, respectively (Table 4.6). The overall environmental-economic profitability for the different land management options can be calculated by totalling the values presented in Tables 4.2 and 4.5 (see also lower table in Appendix A.3).

TABLE 4.5
NET PRESENT VALUE OF THE ENVIRONMENTAL IMPACTS OF COMMUNITY-BASED REFORESTATION

	Philippines (pesos/ha)[1]		Thailand (baht/ha)[1]	
Environmental impact	Acacia	Mahogany	Eucalyptus	Teak
Erosion control (on-site)	2,746	2,320	1,473	1,789
Erosion control (off-site)	65	77	n.e.	n.e.
Nutrient loss due to harvesting	-389	-209	-1,631	-573
Transpiration	n.e.	n.e.	-6,775	-2,235
Carbon sequestration	2,048	1,803	14,630	1,516
Total	4,470	3,991	7.697	497

Note: [1] The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
n.e. = not estimated.

TABLE 4.6
TOTAL NET PRESENT VALUE OF THE ESTIMATED ENVIRONMENTAL IMPACTS

	Philippines (pesos/ha)[1]		Thailand (baht/ha)[1]	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	7,455	7,345	11,680	85
Community-based reforestation	4,470	3,991	7,697	497
Agroforestry	302	-107	2,041	-4,529
Corn/Cassava cultivation[2]	-7,936		-6,870	

Note: [1] The Philippine Peso is approximately equal to the Thai Baht, or US$ 0.04.
[2] Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

V DISCUSSION AND CONCLUSIONS

The future development of forestry and wood processing industry in the Philippines as well as in Thailand will have to rely more and more on plantation forests. Deforestation has been very rapid during the last decades, and the timber supply from natural forests has decreased dramatically. In Thailand, the timber supply from natural forests also declined in 1989 because the Royal Thai Government banned logging in natural forests (RFD 1993b). In the Philippines, a heated debate has been going on around the logging ban issue; in 1992, a ban on logging in old-growth forests was introduced (Ramos and Umali 1993). Despite urgent needs to improve the timber supply and the rather long history of tree planting, reforestation has not been very successful in Thailand or the Philippines so far.

Government forestry planning in the Philippines and Thailand has outlined important issues related to the development of plantation forestry. According to the recent Thai Forestry Sector Master Plan (RFD 1993b), the major obstacles to reforestation in Thailand have been socio-economic and environmental. Competing needs for land resources, and environmental concerns against monoculture tree plantations have restricted the acceptance of plantation forestry among rural inhabitants and nature conservationists. In the Philippines, the Master Plan for Forestry Development (DENR 1990) emphasized that some of the key issues for the development of plantation forestry are political and socio-economic. Insecure land tenure and incomplete benefit sharing among interest groups were regarded as major obstacles to reforestation.

This study aimed to estimate how profitable reforestation with two important tree crops *Eucalyptus camaldulensis* Dehnh. and teak (*Tectona grandis* L.) in Thailand, and *Racosperma auriculiformie* (Cunn. ex Benth.) Pedley (syn. *Acacia auriculiformis* A.Cunn. ex Benth.) and Mahogany (*Swietenia macrophylla,* King) in the Philippines) is from the financial, economic, social, and environmental-economic points-of-view. First, the paper investigated whether forest plantations contribute to the economic development of the countries studied by promoting a substantial return on invested capital. A wider scope was then adopted by studying the effects of including distributional and environmental impacts into the economic analysis. By doing so, the study also aimed to provide more information on the economic values of reforestation on income distribution and the environment.

Three basic plantation establishment approaches were studied in both countries; these approaches represented practices used by industry, rural communities, and private farmers. It was assumed that industrial reforestation practices have a higher growth and yield rate than other, less mechanized, reforestation approaches. Private farmers were assumed to intercrop cassava (*Manihot esculenta* Cantz) in Thailand and corn (*Zea mays* L.) in the Philippines during the first three years after the establishment of a forest plantation (agroforestry option).

The rotation periods for timber production were fixed at ten years for eucalyptus, at fifteen years for acacia, and at twenty-five years for teak and mahogany. Studies on growth and yield rates have not been systematically completed in Thailand or the Philippines for different soil types or with varying establishment densities; therefore after literature and data survey, values were assumed for the mean annual increment for the various establishment approaches. For the mechanized plantation establishment methods the mean annual increment was estimated to be 18 cubic metres per hectare for eucalyptus, and 12 cubic metres per hectare for acacia. For teak and mahogany the mean annual increment was estimated to be 10 cubic metres per hectare. The growth and yield rates for community-based reforestation were assumed to be 25 per cent lower than those for mechanized industrial reforestation. Intercropping was assumed to further decrease the growth and yield rates by 15 per cent.

Mainly due to the lack of growth and yield data, it was not possible to conclude whether the optimum rotation periods for the studied tree species are shorter or longer than those periods used in this study. Another major obstacle to the evaluation of the profitability of reforestation was the uncertainty related to future timber prices. A common solution was adopted to disregard price fluctuations and to derive average timber prices and then assume they remain constant over the planning period.

In general, the financial and economic profitability for reforestation were relatively good, but highly sensitive to changes in the growth and yield rates and to timber prices. Thus, even slight improvements either in timber prices, or in growth and yield rates, would improve the profitability of reforestation considerably. For example, if the wood processing industry would be in a position to raise the stumpage price even slightly, the financial profitability as well as the general attractiveness of reforestation would be improved considerably. Improvement of the growth and yield rates, for example, by provenance testing and tree breeding, would also substantially impact on the financial profitability. Of course, the opposite holds true if growth and yield rates, or timber prices remain lower than assumed in this study.

In the Philippines, the financial and economic profitability of acacia plantations were slightly higher than those of mahogany plantations. This was primarily a consequence of the timber markets in the Philippines, where the incomplete supply of high-quality tropical timber has also increased the price of acacia timber, even though the quality of acacia timber is not comparable to that of mahogany or other indigenous tropical hardwood species. For the same reason, the shadow price of acacia timber was estimated to be relatively high compared to its financial price, whereas the economic price of mahogany timber was only slightly higher than its financial price. Consequently, the difference between the economic profitability of acacia and mahogany plantations was larger than the difference between the financial profitability of the same plantations.

In Thailand, the financial and economic profitability for teak plantations were considerably higher than those for eucalyptus plantations. Consequently, investments in reforestation could consider the potential planting of teak more than eucalyptus. Furthermore, the price of teak timber may in the future rise more than that of eucalyptus wood, since the supply of teak harvested from natural forests either (illegally) in

Thailand or in neighbouring countries will inevitably decrease. The international supply of eucalyptus wood, or short fibre pulp in general, may even increase in the future, if plans for large-scale reforestation with fast-growing trees in some other Southeast Asian countries (like in Indonesia) become reality. For these reasons, the price of teak may perform comparatively better than that of eucalyptus in the future, and the growing of teak will benefit the national economy of Thailand (and private investors as well) even more than the results of this study may let one expect. It is also evident that the history of, and the potential for, small-scale and labour-intensive value-added production of teak is superior to that of eucalyptus.

In the Philippines, the timber supply shortage will continue into the near future and will require, even though the nation's foreign exchange capital is very limited, a reliance on imported timber to meet demand. This may increase the potential for reforestation. It might be reasonable to balance the timber supply between fast-growing (acacia) plantations and slow-growing (mahogany) plantations. This balancing of the supply would improve the low-quality timber supply in the short run, and restrict the high-quality timber trade's foreign exchange flow abroad in the long run.

It is generally recognized that intercropping will improve the financial profitability of forest plantations. This was true in the Philippines, where intercropping corn with either acacia or mahogany improved the profitability of reforestation. In Thailand, cassava cultivation was estimated to be financially unprofitable; therefore, intercropping cassava with tree plantations generally decreased the financial return to the investor, as compared to reforestation without intercropping. It can be concluded that proper selection of the agricultural species is essential to the profitability of agroforestry-based reforestation.

The level of the rural wage rate is important to attract investment, especially for industrial reforestation, where the expected financial profitability influences plantation establishment decisions more than the impacts of social welfare or income distribution. A high rural wage rate will generally promote mechanized reforestation, especially by the industrial sector. According to present findings, labour costs affect the profitability of reforestation substantially in Thailand and the Philippines. If a minimum rural wage rate comes into effect, financial profitability of manual reforestation methods will clearly remain lower than those for mechanized reforestation methods. However, if the wage rate is low enough, manual reforestation will be financially more profitable than mechanized reforestation. In Thailand, this would require that the rural wage rate drops to 15 baht per day, which is unlikely due to the country's strong economic performance.

The economic profitability of reforestation was much lower, when the opportunity cost of land was at its highest. This means that forest plantations are seldom able to compete with agriculture for more fertile lands. For this study, it was assumed *a priori* that forest plantations were established on moderately grazed grasslands; the opportunity cost of land was, therefore, implicitly low and economic profitability was not dependent on the opportunity cost of land. However, it can be conclued that from society's point-of-view, forest plantations should be established on soils with a low opportunity cost. It can be assumed that this kind of land management policy simultaneously decreases the conflicts between the land users and the agency responsible for reforestation programmes.

Loans with low interest rates or direct governmental subsidies for reforestation are often needed or required to attract more private enterprises or private land owners. Both of these financial aids would improve the financial profitability of reforestation. The difference between the economic and financial profitability of reforestation, which implies that it is more profitable to reforest grasslands from the point-of-view of the society than from the point-of-view of a private investor, supports payment of an incentive for the reforestation of grasslands. Reforestation in the Philippines, is often used as a means of soil conservation, and if incentives were paid for tree plantations they would support environmental protection as well. In Thailand, tree plantations are established primarily for commercial purposes, and tree planting can be expected to continue into the future even without public incentives. However, incentives would play a role, if the goal was to expand the total area of plantations significantly.

The net present value of the financial returns to non-educated labour, a social dimension, was highest among the small-scale land management options. In these small-scale options non-educated labourers do not receive a wage for the work they do on their own land; however the net incomes accruing to them from sales per hectare far outweigh the wage payments earned from the large-scale reforestation options for similar work and land area. This income disparity may partially explain why industrial or similar large-scale reforestation options do not seem to be socio-economically desirable to rural inhabitants. To improve the cash-generating possibilities of large-scale reforestation, at least part of the incomes from sales should be allocated locally. An example of this improved allocation in the Philippines is community-based reforestation, where the incomes from sales incur to the local communities after the initial plantation establishment costs are paid back.

An unexpected finding of this study was that the growth and yield rates for tree crops were directly related to the environmental values of tree planting, so that the higher the growth and yield rates the higher the environmental value. This was mainly due to estimated economic benefits from carbon sequestration. High growth and yield rates resulted in environmental benefits from carbon sequestration which were so large, that the environmental costs of transpiration and nutrient consumption were totally compensated for. However, erosion control benefits on moderately and steeply sloping sites in the Philippines were also substantial.

The environmental-economic profitability is dependent, as shown above, on which environmental impacts it is possible to include into the analysis, what unit prices are used in the valuation of those impacts included, and what discount rate is chosen. There are also some problems with the estimation of the physical environmental impacts, and the commensurability of the values applied to the impacts. Despite these difficulties, it seems justified to conclude that the environmental benefits of tree planting in the Philippines and Thailand normally outweigh the environmental disadvantages. Especially, if tree plantations are established on degraded land, and environmental impacts are included into the analysis, the resulting 'extended' economic profitability can be quite high.

Practical problems arise when environmental-economic values need to be transformed for implementation into plantation policies. This would require that the positive and negative external impacts of plantation forests would be appropriately compensated. However, without proper and well-planned incentive policies, this will be quite difficult to realize. In the Philippines, reforestation programmes which operate with aid from international financing institutions often use environmental reasoning as an important part of the programme and for subsidy justification

Environmental impact assessment and the valuation of the assessed external environmental impacts of reforestation need more attention in future research. Experiences from this study, in addition to those from several other environmental-economic studies, support the endeavour to monetarily evaluate environmental impacts. On the whole, the valuation of environmental effects might considerably improve the planning for natural resource allocation in developing countries, as it has in many respects already done in developed countries. Increased data on environmental impacts and a developed methodological basis for environmental-economics will also support this approach in developing countries (as is already the case in some countries).

In conclusion, from the economic point-of-view, the environmentally and socially sensitive management practices of plantation forestry could be favoured, if the social and environmental costs and benefits, evaluated in monetary terms, could be properly included into a solid framework of economic analysis. The methodological development and practical applications are emphasized by the necessity to increase the role of tree plantations to meet growing demands for economic and social development as well as environmental restoration (WCED 1987, UNU/WIDER 1991, FAO 1995).

APPENDIX

A.1 Market prices and economic values for tradables and nontradables, 1993

TABLE A1.1
THE MARKET PRICES AND ECONOMIC VALUES FOR LAND TRANSPORTATION, FERTILIZERS, TIMBER, NON-EDUCATED LABOUR, AND LAND IN THAILAND AND THE PHILIPPINES, 1993

	Philippines (Pesos)		Thailand (Baht)	
	Financial	Economic	Financial	Economic
Tradable (Unit)				
Land transportation on local roads (m^3/km)	25.5	20.7	5.5	4.5
Land transportation on national roads (m^3/km)	1.53	1.28	1.25	1.0
Urea-fertilizer (kg)	5.1	5.9	-	5.0
NPK-fertilizer (kg)	6.1	5.9	7.0	5.3
Acacia timber (m^3)	2000	2913	-	-
Mahogany timber (m^3)	3100	3644	-	-
Teak timber (m^3)	-	-	8000	9385
Maize (kg)	4.8	6.9	3.6	2.8
Rice (kg)	5.1	10.5	3.3	6.3
Cassava pellets (kg)	-	-	2.3	2.3
Non-tradable (Unit)				
Non-educated labour (day)	91	54	94	57
Land (ha/a)	-	1155	-	350

A.2 Estimation of the shadow wage rate for the social profitability analyses

The basis for valuation of unskilled labour for the social cost benefit analysis is the economic shadow wage rate, 'SWR_e', calculated as the opportunity cost of labour in terms of forgone marginal production, at shadow prices. When among other economic objectives for a society, there exists an objective to equalize the income distribution; the net social cost of increased consumption should be added onto the economic shadow wage rate (Squire and van der Tak 1988). Parameters used in the evaluation of a social shadow wage rate, 'SWR_S' and their numerical values for the Philippines and Thailand are introduced in the following (Equations A-D; Tables A.2.1 - A.2.4):

$$(A) \quad SWR_s = SWR_e + (W - M) \cdot (CCF - d_i / v)$$

$$(B)\quad d_i = (c / c_i)^n$$

$$(C)\quad v = q / (CCF \cdot CRI)$$

$$(D)\quad CRI = n \cdot g + p$$

Parameter 'W' (Equation A), is the official minimum wage rate for plantation work by non-educated labour. Here 'M' (Equation A), is the forgone marginal product of non-educated labour valued at market prices. The difference between 'W' and 'M' (W-M) is equal to the increased income to non-educated labour for plantation work. The consumption conversion factor, 'CCF' (Equations A and C), describes the relative share of the increased income used for consumption, when the consumption is measured by foreign exchange. The 'CCF' can be approximated by dividing the value of imports and exports at border prices by the value of imports and exports at domestic prices (Squire and van der Tak 1988). Parameter 'd_i' (Equations A and B), is a consumption distributional weight, describing the marginal utility of consumption at the present average level of per capita consumption. The value of public income relative to private consumption, 'v' (Equations A and C), is the ratio of the incomes accruing to the government over the income flows that lead to private consumption. The net social cost of increased consumption is described by the difference between 'CCF' and the quotient of 'd_i' and 'v' (CCF-d_i/v).

Values for the consumption distributional weight, 'd_i' (Equations A and B), come from an exponential function for the elasticity coefficient, '*n*' (Equation B), calculated from the ratio for the average level of per capita consumption, 'c' (Equation B), and the per capita consumption by a certain income group, 'c_i' (Equation B). By setting values above zero for the elasticity coefficient, '*n*', it is possible to weight the incomes of poor people within the society (Irwin 1978). The higher the value of '*n*', the lower the value of public incomes is, that is considered relative to private consumption.

The value of public income relative to private consumption, 'v' (Equations A and C), can be estimated by dividing the marginal product of capital, 'q' (Equation C), by the product of the consumption conversion factor, 'CCF' (Equations A and C), and the consumption rate of interest, 'CRI' (Equations C and D), if reinvestment is assumed to be equal to zero (Squire and van der Tak 1988, Kuyvenhoven and Mennes 1985). Here 'q' implies the return requirement for investment within the public sector. Marginal product of capital was estimated to equal to the social time preference rate (15 per cent) in the Philippines. In Thailand, marginal product of capital was estimated to be 15.5 per cent.

The consumption rate of interest, 'CRI' (Equations C and D), is calculated by summing the product of the diminishing marginal utility, 'n' (Equation D), and the growth rate per capita consumption, 'g' (Equation D), with the pure time preference rate, 'p' (Equation D)(Squire and van der Tak 1988). The value for 'g' was calculated using the average growth rate of the gross national product, for the period 1985-1990, as a proxy (Intal 1991, World Bank 1992). The recommended value for 'p' is between 0 and 0.05 (Squire and van der Tak 1988). Here 'p' was set at 0.03 (also used by Kuyvenhoven and Mennes 1985). Squire and van der Tak (1988) estimated that if the 'CRI' is approximately equal to five percent, it implies that a country is very growth-conscious, which can be concluded to hold true for Thailand and the Philippines.

TABLE A2.1
SOCIAL SHADOW WAGE RATES FOR THE LOWEST AND SECOND-LOWEST INCOME GROUPS IN THE PHILIPPINES, 1993

Value	n=0.25	n=0.5	n=0.75	Source
SWR_s\1	92.8	53.8	-12.5	See Equation A
SWR_s\2	96.9	74.4	34.5	See Equation A
SWR_e	57.0	57.0	57.0	SWR_e valued in efficiency prices
W	90.9	90.9	90.9	Minimum rural wage rate
M	13.0	13.0	13.0	SWR_e valued in market prices
d_i\1	1.81	3.26	5.89	See following Table and Equation B
d_i\2	1.57	2.45	3.84	See following Table and Equation B
v	4.76	3.97	3.40	See Equation C
q	0.15	0.15	0.15	Marginal product of capital
CCF	0.84	0.84	0.84	Ratio of border and domestic prices
CRI	0.0375	0.045	0.0525	See Equation D
g	0.03	0.03	0.03	Intal (1991)
p	0.03	0.03	0.03	Assessed

Note: \1 SWR_S and d_i of the lowest income group.
\2 SWR_S and d_i of the second-lowest income group.

TABLE A2.2
DISTRIBUTIONAL WEIGHTS (D_i) AND MARGINAL UTILITY OF CONSUMPTION (C/C_i) AT AVERAGE PER CAPITA CONSUMPTION (C_i) WITH ALTERNATIVE VALUES FOR THE ELASTICITY COEFFICIENT (N) IN THE PHILIPPINES, 1993

	Present income level\1	Shares of total incomes	Marginal utility of consumption (c/c_i)\2	Distributional weights (d_i)			
				Elasticity coefficient (n)			
				0.25	*0.5*	*0.75*	*1.0*
Lowest	20%	4.70%	10.64	1.81	3.26	5.89	10.64
Second	20%	8.30%	6.02	1.57	2.45	3.84	6.02
Third	20%	12.50%	4.00	1.41	2.00	2.83	4.00
Fourth	20%	20.00%	2.50	1.26	1.58	1.99	2.50
Highest	20%	54.60%	0.92	0.98	0.96	0.94	0.92

Note: \1 NSCB 1993.
\2 Incomes were assumed to be equal to consumption.

TABLE A2.3
SOCIAL SHADOW WAGE RATES FOR THE LOWEST AND SECOND-LOWEST INCOME GROUPS IN THAILAND, 1993

Value	n=0.25	n=0.5	n=0.75	Explanation/source
SWR_s \1	68.5	17.8	-97.5	See Equation A
SWR_s \2	72.9	39.4	-25.4	See Equation A
SWR_e	48	48	48	SWR_e valued in efficiency prices
W	94	94	94	Minimum rural wage rate
M	39	39	39	SWR_e valued in market prices
d_i \1	1.87	3.51	6.58	See following Table and Equation B
d_i \2	1.61	2.59	4.18	See following Table and Equation B
v	3.24	2.34	1.83	See Equation C
q	0.155	0.155	0.155	Marginal product of capital
CCF	0.95	0.95	0.95	Ratio of border and domestic prices
CRI	0.04875	0.0675	0.008625	See Equation D
g	0.075	0.075	0.075	World Bank (1992)
p	0.03	0.03	0.03	Assessed

Note: \1 SWR_s and d_i of the lowest income group.
\2 SWR_s and d_i of the second-lowest income group.

TABLE A2.4
DISTRIBUTIONAL WEIGHTS (D_i) AND MARGINAL UTILITY OF CONSUMPTION (C/C_i) AT AVERAGE PER CAPITA CONSUMPTION (C_i) WITH ALTERNATIVE VALUES FOR THE ELASTICITY COEFFICIENT (N) IN THAILAND, 1990

	Present income level	Shares of total incomes (c_i)\1	Marginal utility of consumption (c/c_i)\2	Distributional weights (d_i)			
				Elasticity coefficient (n)			
				0.25	*0.5*	*0.75*	*1.0*
Lowest	20%	4.05%	12.35	1.87	3.51	6.58	12.34
Second	20%	7.43%	6.73	1.61	2.59	4.18	6.73
Third	20%	11.92%	4.19	1.43	2.05	2.93	4.19
Fourth	20%	20.11%	2.49	1.26	1.58	1.98	2.49
Highest	20%	54.48%	0.89	0.97	0.94	0.92	0.89

Note: \1 TDRI (1993).
\2 Incomes were assumed to equal to consumption.

It was assumed that the labourers for the large-scale reforestation options belonged to the lowest income group, and those for the agroforestry and corn cultivation options to the second-lowest income group. In the Philippines, the critical consumption level was reached when the value of the elasticity coefficient, 'n', was 0.51 and 0.64 for the lowest and second-lowest income groups, respectively. Therefore in the Philippines, if the distributional impacts are stressed even slightly (n=0.51) they can be considered to compensate for the net social costs of the increased consumption by the lowest income group. At the equilibrium (n=0.51) the social shadow wage rate, 'SWR_s', is equal to the economic shadow wage rate, 'SWR$_e$', and the real resource cost incurred by the government, and the social benefits enjoyed by the labourers as a result of a marginal increase in consumption are exactly offsetting. Similar values for the elasticity coefficient in Thailand were 0.39 and 0.46.

A.3 Socio-economic and environmental-economic profitability estimates

TABLE A3.1
SOCIO-ECONOMIC PROFITABILITY FOR REFORESTATION IN THE PHILIPPINES AND THAILAND AT A 12 PER CENT DISCOUNT RATE

	Philippines (Peso/ha)\1		Thailand (Baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	26,147	5,670	27,574	68,445
Community-based reforestation	12,802	-3,058	22,856	55,119
Agroforestry	20,094	6,525	23,893	51,238
Corn/Cassava cultivation\2	38,229		4,642	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht or US$ 0.04.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

TABLE A3.2
ENVIRONMENTAL-ECONOMIC PROFITABILITY FOR REFORESTATION IN THE PHILIPPINES AND THAILAND AT A 12 PER CENT DISCOUNT RATE

	Philippines (Peso/ha)\1		Thailand (Baht/ha)\1	
Land management option	Acacia	Mahogany	Eucalyptus	Teak
Industrial reforestation	33,487	12,914	38,216	67,608
Community-based reforestation	16,824	487	25,630	51,220
Agroforestry	23,186	9,202	22,515	43,444
Corn/Cassava cultivation\2	35,596		-5,474	

Note: \1 The Philippine Peso is approximately equal to the Thai Baht or US$ 0.04 Land management.
\2 Corn (Philippines) and cassava (Thailand) cultivation for a fifteen-year period.

REFERENCES

Asian Development Bank (ADB). 1994. *Forestry sector study of the Philippines.* Manila: ADB, Agriculture Department.

Allen, J.C. and D.F. Barnes. 1985. The causes of deforestation in developing countries. *Annals of the Association of American Geographers* Vol. 75, No 2: 163-84.

Andersson, D. and R.H. Williams. 1994. *The cost-effectiveness of GEF projects,* UNDP/UNEP/The World Bank. Working Paper Vol. 6.

Bank of Thailand. 1993. *Annual economic report.* Bangkok: Bank of Thailand.

BAS. 1994. (Bureau of Agricultural Statistics) 1994. Quezon City: Unpublished statistics.

Bass, S. 1992. Building from the past: forest plantations in history. In *Plantation politics: forest plantations in development,* edited by C. Sargent and S. Bass. London: Earthscan Publications Ltd.

The Board of Investment (BOI). 1988. *Ten-year development plan for the plantation sub-sector.* Manila: BOI.

Bowonder, B. 1985. Deforestation in developing countries. *Journal of Environmental Systems* Vol. 15, No. 2: 171-92.

Budowski, G. 1984. Biological diversity and forestation in the tropics. In *Strategies and designs for afforestation, reforestation and tree planting,* edited by K. F. Wiersum. Proc. of an Int. Symp. on the Occasion of 100 years of Forestry Education and Research in the Netherlands. Wageningen.

Calder, I. R. 1991. Water use of eucalypts - a review. In I. R. Calder, R. L. Hall, and P. G. Adlard (eds.). Proc. of the Int. Symp. held at Bangalore, India, 4-7 February 1991.

Calder, I. R., M. H. Swaminath, G. S. Kariyappa, N. V. Srinivasalu, K. V. Srinivasa Murthy and J. Mumtaz. 1991. Measurement of transpiration from eucalyptus plantations, India, using deuterium tracing, In: I. R. Calder, R. L. Hall, and P. G. Adlard (eds.). Proc. of the Int. Symp. held at Bangalore, India, 4-7 February 1991.

Chayamporn, S. 1983. *Optimum rotation of teak plantation in Thailand.* Bangkok: Thailand Development Research Institute (TDRI).

Chijicke, E. O. 1980. *Impact on soils of fast-growing species in lowland humid tropics.* FAO Forestry Paper Vol. 21: 111.

Cruz, W. D., H. A. Francisco and Z. T. Conway. 1988. The on-site and downstream costs of soil erosion in the Magat and Pantabangan watersheds. *Journal of the Philippine Development* Vol. XV, No. 1: 85-111.

David, W. P. 1988. Soil and water conservation planning: policy issues and recommendations. *Journal of the Philippine Development* Vol. XV, No. 1: 47-84.

Davidson, J. 1987. *Bioenergy tree plantations in the tropics, ecological implications and impacts.* Commission on Ecology Papers Vol. 12: 47.

DENR. 1989. (Department of Environment and Natural Resources) *Policies, memoranda and other issuances on the national forestation program,* Vol. II. Quezon City: DENR.

_______. 1990. *Master plan for forestry development in the Philippines,* Quezon City: DENR.

Evans, J. 1984. Soil and water management aspects of forestation. In *Strategies and designs for afforestation, reforestation and tree planting,* edited K. F. Wiersum. Proc. of an Int. Symp. on the Occasion of 100 years of Forestry Education and Research in the Netherlands. Wageningen.

Evans, J. 1992. *Plantation forestry in the tropics* 2nd edition, Oxford: Clarendon Press.

Falk, I. and R. Mendelsohn. 1993. The economics of controlling stock pollutants: an efficient strategy for greenhouse gases. *J. Env. Economics and Management* Vol. 25.

FAO. 1983. (Food and Agriculture Organization of the United Nations) *Growth and yield of plantation species in the tropics.* Rome: (FAO).

_______. 1992. (Food and Agriculture Organization of the United Nations). *Mixed and pure forest plantations in the tropics and subtropics.* FAO Forestry Paper Vol. 103.

_______. 1993. (Food and Agriculture Organization of the United Nations). *Forest resources assessment 1990: tropical countries.* Rome: FAO.

_______. 1995. (Food and Agriculture Organization of the United Nations). *Forest resource assessment 1990: global synthesis.* FAO Forestry Paper Vol. 124.

Firewood crops: Shrub and trees species for energy production. 1980. Washington, DC: National Academy of Sciences.

Florence, R. G. 1986. Cultural problems of eucalyptus as exotic. *Commonwealth Forestry Review* Vol. 65, No. 2: 141-63.

FMB. 1993. (Forest Management Bureau) *Philippine forestry statistics.* Quezon City: FMB.

Forestry Research Centre. 1994. *Reforestation of denuded forest lands in Khao Kho,* Bangkok: Faculty of Forestry, Kasetsart University.

Francisco, H. A. 1986. Economics of soil erosion and conservation: the case of Magat watershed. Ph.D. Thesis. Los Baños: University of the Philippines.

Francisco, H. A. 1994. *Upland soil resources of the Philippines: resource assessment and accounting for soil depreciation.* Quezon City: Environmental and Natural Resources Accounting Project (ENRAP).

Gittinger, J. P. 1982. *Economic analysis of agricultural projects.* Baltimore: John Hopkins University Press.

Grainger, A. 1988. Estimating areas of degraded tropical lands requiring replenishment of forest cover. *International Tree Crops Journal* Vol. 5: 31-61.

Gregersen, H. and A. Contreras. 1992. *Economic assessment of forestry project impacts.* FAO Forestry Paper Vol. 106: 134.

Hartshorn, G. S. 1983. Ecological implications of tropical plantation forestry. In *The comparative economics of plantation forestry: a global assessment*, edited by R. Sedjo. Washington, DC: Resources for the Future.

Hufschmidt, M. M. and R. Srivardhana. 1986. The Nam Pong water resources project in Thailand. In *Economic valuation techniques for the environment: a case study workbook,* edited by J. A. Dixon and M. M. Hufschmidt. London: The John Hopkins University Press.

Hunter, M. L. Jr. 1990. *Wildlife forests and forestry: principles of managing forests for biological diversity.* New Jersey: Prentice Hall.

Intal, P. S. 1991. Real exchange rates, price competitiveness and structural adjustment in Asian and Pacific economies, *Asian Development Review*, Vol. 10, No. 2, pp. 86-125.

Irwin, G. 1978. *Modern cost-benefit methods: an introduction to financial economic and social appraisal of development projects.* London: The Macmillan Press Ltd.

Jepma, C. 1995. *Tropical deforestation: a socio-economic approach.* London: Earthscan Publications Ltd.

Jones, H. G. 1992. *Plants and microclimate: a quantitative approach to environmental plant physiology.* 2nd ed. Cambridge University Press.

Kanowski, P. J. and P. S. Savill. 1992. Forest plantations: towards sustainable practice. In *Plantation politics. Forest plantations in development*, edited by C. Sargent and S. Bass. London: Earthscan Publications Ltd.

Kanowski, P. J., P. S. Savill, P. G. Adlard, J. Burley, J. Evans, J. R. Palmer and P. J. Wood. 1992. Plantation forestry. In *Managing the world's forests, looking for balance between conservation and development*, edited by N. P. Sharma. International Bank for Reconstruction and Development.

Karjalainen, T, S. Kellomäki and A. Pussinen. 1994. Role of wood-based products in absorbing atmospheric carbon. *Silva Fennica* Vol. 28, No. 2: 67-80.

King, A. W., W. R. Emanuel and W. M. Post. 1992. A dynamic model of terrestrial carbon cycling response to land-use change. In *Carbon balance of world's forested ecosystems: towards a global assessment*, edited by M. Kanninen. Helsinki: Academy of Finland.

Klock, J. 1995. Indigenous woodlot management and ethnobotany in Ifugao, Philippines. *International Tree Crops Journal* Vol. 8: 95-106.

Kummer, D. M. 1992. *Deforestation in the postwar Philippines.* Geography Research Paper Vol. 234. Chicago: The University of Chicago

Kuyvenhoven, A. and L. B. M. Mennes. 1985. *Guidelines for project appraisal,* The Hague: Government Printing Office.

Larcher, W. 1980. *Physiological plant ecology* 2nd rev. edition. Berlin: Springler-Verlag.

Leslie, A. 1992. How much wood do we need? In *Plantation politics. Forest plantations in development,* edited by C. Sargent and S. Bass. London: Earthscan Publications Ltd.

Little, I. M. D. and J. A. Mirrlees. 1974. *Project appraisal and planning for developing countries.* London: Heineman Educational Books.

Lovejoy, T. E. 1985. Rehabilitation of degraded tropical forest lands. *The Environmentalist* Vol. 5, No. 1: 13-20.

Mather, A. 1990. *Global forest resources.* Belhaven Press.

Mathur, H. N., R. Babu, P. Joshie, and B. Singh. 1976. Effects of clearfelling and reforestation on run-off and peak rates in small watersheds. *Indian Forester* Vol. 102, No. 4: 219-26.

Ministry of Agriculture. 1993. *Agricultural statistics of Thailand,* Bangkok: Ministry of Agriculture.

Morrison, E. and S. Bass. 1992. What about the people? In *Plantation politics. Forest plantations in development,* edited by C. Sargent and S. Bass. London: Earthscan Publications Ltd.

Nabuurs, G. J. and G. M. J. Mohren. 1993. *Carbon fixation through forestation activities.* IBN Research Report 93/4. Wageningen: Institute for Forestry and Nature Research.

Nautiyal, J.C. 1988. *Forest economics: principles and applications.* Toronto: Canadian Scholars' Press Inc.

NEDA. 1992. (National Economic Development Authority) *National physical framework plan, 1993-2022.* Mandalyong: NEDA.

Nilsson Axberg, G. 1993. *Forestry sector and forest plantations sub-sector planning in south and south-east Asia.* Uppsala: Sveriges Landbruksuniversitetet. [Institutionen för Skog-Industri-Marknad Studier, Rapport Nr. 34.].

Niskanen, A., O. Luukkanen, O. Saastamoinen and S. Bhumibhamon. 1993. Evaluation of the profitability of fast-growing tropical trees: Eucalyptus camaldulensis, Acacia mangium and Melia azedarach as plantation tree crops in Thailand. *Acta Forestalia Fennica* Vol. 241: 1-38.

NSCB. 1993. (National Statistical Coordination Board). *Philippine statistical yearbook.* Manila: NSCB.

Onchan, T. 1990. *A land policy study.* Bangkok: Thailand Development Research Institute (TDRI).

Palo, M., G. Mery and J. Salmi. 1987. Deforestation in the tropics: pilot scenarios based on quantitative analyses. In *Deforestation or development in the third world?,* edited by M. Palo and J. Salmi. Metsäntutkimuslaitoksen tiedonantoja Vol. 272: 53-106.

Pandey, D. 1995. *Forest resource assessment 1990: tropical forest plantation resources.* FAO Forestry Paper Vol. 128: 81.

Pearce, P. H. 1990. *Introduction to forestry economics.* Univ. of British Columbia Press.

Pearce, D. W. and K. Brown. 1994. Saving the world's tropical forests. In *The causes of tropical deforestation,* edited by K. Brown and D. W. Pearce. London: University College London.

Perhutani, P. 1993. Teak in Indonesia. In *Teak in Asia.* Bangkok: FORSPA Publication Vol. 4.

Pohjonen, V. and T. Pukkala. 1994. Optimum rotation for Eucalyptus camaldulensis Dehnh. in Northeast Thailand. *Thai Journal of Forestry* Vol. 13, No. 1: 29-37.

Poore, M. E. D. and C. Fries. 1985. *The ecological effect of eucalyptus* FAO Forestry Paper Vol. 59: 88.

Pöyry, Jaakko. 1987. Fast-growing plantations: impact on the international market pulp, linerboard and woodfree paper business. Helsinki: Jaakko Pöyry Consulting Ltd.

Prescott-Allen, R. 1982. *What's wildlife worth?* London: International Institute for Environment and Development.

Price, C. 1989. *The theory and application of forest economics.* Oxford: Blackwell.

______. 1994. Time profiles and pricing of CO_2 externalities *Scandinavian Forestry Economics* Vol. 35: 320-36.

Price, C. and R. Willis. 1993. Time, discounting and the valuation of forestry's carbon fluxes. *Commonwealth Forestry Review* Vol. 72, No. 4: 265-71.

Ramirez, D. L., L. A. Lanzona Jr., and J. G. Laarman. 1993. *Forestry employment models,* Natural Resources Management Program Policy Studies Report No. 93-27. Quezon City.

Randall, A. 1987. *Resource economics: an economic approach to natural resource and environmental policy.* New York: Wiley.

Ramos, V. M. and R. M. Umali. 1993. Philippines. *Forestry policies of selected countries in Asia and Pacific.* FAO Forestry Paper Vol. 115: 121-37.

Republic of the Philippines. 1993. *Medium term Philippine development plan 1993-1998.* Manila.

RFD. 1993a. (Royal Forest Department) *Forestry statistics of Thailand 1993.* Bangkok: RFD.

______. 1993b. *Thai forestry sector master plan: subsectoral plan for production and utilization* Bangkok: RFD.

Rowe, R., N. Sharma, and J. Browder. 1992. Deforestation: problems, causes and concerns. In *Managing the world's forests, looking for balance between conservation and development,* edited by N. P. Sharma. Iowa: Kendall/Hunt Publishing Company.

Rudel, T. K. 1987. Population, development and tropical deforestation: a cross-national study. *Rural Sociology* Vol. 54, No. 3: 327-38.

Saastamoinen, O. 1992. Soil erosion costs in the Philippines: a preliminary assessment. In *Monetäre Bewertung Landeskultureller Leistungen der Forstwirtschaft,* edited by V. Bergen, H. D. Brabänder, A. W. Bitter, and W. Löwenstein. Frankfurt: J. D. Sauerländer's Verlag.

______. 1994. *Off-site costs of soil erosion and watershed degradation in the Philippines: sectoral impacts and tentative results.* Philippine Institute for Development Studies (PIDS) Discussion Paper No. 94-18. Makati: PIDS.

Salzer, W. 1993. *Eco-economic assessment of agricultural extension recommendations for shifting cultivators in Northern Thailand,* Dr. sc. agr. Dissertation. University of Hohenheim.

Sargent, C. 1992. Natural forests or plantations. In *Plantation politics. Forest plantations in development,* edited by C. Sargent and S. Bass. London: Earthscan Publications Ltd.

Sargent, C and S. Bass. 1992. (eds.). *Plantation politics. Forest plantations in development.* London: Earthscan Publications Ltd.

Satterlund, D. 1972. *Wildland watershed management.* Washington, DC: John Wiley & Sons Inc.

Sawyer, J. 1993. *Plantations in the tropics. Environmental concerns.* The IUCN Forest Conservation Programme. IUCN / UNEP / WWF. IUCN, Gland, Switzerland and Cambridge, U. K.

Schauer, M. J. 1995. Estimation of the greenhouse gas externality with uncertainty. *Environmental and Resource Economics* Vol. 5: 71-82.

Schmithüsen, F. 1995. The meaning of forests in a perspective of social and political development, Paper presented at the seminar 'Man and forests, 13th-18th century', 8-13 May 1995. Prato: Instituto Internazionale di Storia Economica Francesco Datini.

Seckler, D. 1987. Economic costs and benefits of degradation and its repair. In *Land degradation and society,* edited by P. Blaikie and H. Brookfield. London and New York: Methuen.

Sedjo, R. 1983. *The comparative economics of plantation forestry: a global assessment.* Washington DC: Resources for the Future.

Sedjo, R. A., J. Wisniewski, A. V. Sample and J. D. Kinsman. 1995. The economics of managing carbon via forestry: assessment of existing studies. *Environmental and Resource Economics* Vol. 6: 139-65.

Shephard, K. R. 1986. *Plantation silviculture.* Netherlands: Martinus Nijhoff Publishers.

Shepherd, G. 1990. Forestry, social forestry, fuelwood and the environment: a tour of the horizon. *Social Forestry Network Paper* Vol. 11a: 12..

Singh, K. D. 1993. The 1990 tropical forest resource assessment. *Unasylva* Vol. 174, No. 44: 10-9.

Spears, J. S. 1984. Role of forestation as a sustainable land use and strategy option for tropical forest management and conservation and as a source of supply for developing country wood needs. In *Strategies and designs for afforestation, reforestation and tree planting,* edited by K. F. Wiersum. Proc. of an Int. Symp. on the Occasion of 100 years of Forestry Education and Research in the Netherlands. Wageningen.

Sterk, A. and P. van. Ginneken. 1987. Cost-benefit analysis of forest plantations in a watershed in Northeastern Thailand. Proc. of an International Workshop, November 2-5, 1987. Pattaya.

Squire, L. and H. G. van der Tak. 1988. *Economic analysis of projects.* 6th edition. Washington DC: World Bank.

TDRI. 1993. (Thailand Development Research Institute). The TDRI 1993 year-end conference: who gets what and how? Challenges for the future. *TDRI Quarterly Review* Vol. 9, No. 1: 3-7.

Tongpan, S., T. Panayotou, S. Jetanavich, K. Faichampa and C. Mehl. 1990. *Deforestation and poverty: can commercial forestry break the vicious circle?* Bangkok: Thailand Development Research Institute (TDRI).

Uitamo, E. 1996. Land use history in the Philippines. In *Sustainable forestry challenges for developing countries: a multidisciplinary and multilevel approach*, edited by M. Palo and G. Mery. Kluwer Academic Publishers.

UNU/WIDER. 1991 (World Institute for Development Economics Research). *The environment and emerging development issues.* Study Group Series, Vol. 7: 28.

Wannawong, S. 1989. Benefit-cost analysis of selected agroforestry and monocropping systems in Northeastern Thailand. M.Sc. Thesis. University of Idaho.

Ward, W. A. and B. J. Deren. 1991. *The economics of project analysis: a practitioner's guide.* EDI Technical Materials. Washington, DC: World Bank.

WCED. 1987. (World Commission on Environment and Development). *Our Common Future.* Paris: WCED.

Wellendorf, H. and A. Kaosa-ard. 1988. Teak improvement strategy in Thailand. *Forest Tree Improvement.* Vol. 21, No. 43.

Wilson, W. L. and A. D. Johns. 1982. Diversity and abundance of selected animal species in undisturbed forest, selectively logged forest and plantations in East Kalimantan, Indonesia. *Biological Conservation* Vol. 24.

Vitousek, P. M. 1991. Can planted forests counteract increasing atmospheric carbon dioxide. *Journal of Environmental Quality* Vol. 20: 348-54.

Woodwell, G. M., R. H. Whittaker, W. A. Reiners, G. E. Likens, C. C. Delwiche and D. B. Botkin. 1978. The biota and the world carbon budget. *Science* Vol. 199: 141-46.

Woodwell, G. M. 1992. The role of forests in climatic change. In *Managing the World's forests, looking for balance between conservation and development,* edited by N. P. Sharma. International Bank for Reconstruction and Development.

World Bank. 1992. *Trends in developing economies.* Washington, DC: World Bank.

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