Forest Perspectives

Fast-Wood Forestry

Myths and Realities

Christian Cossalter and Charlie Pye-Smith

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Bogor, Indonesia, May 2003

Foreword

Each year the area of fast-growing tree plantations in the world expands by around one million hectares. The planting of large areas of eucalypts, acacias, pines and poplars has sparked off bitter controversy, especially in the developing world. Some claim plantations will destroy the environment and displace small farmers. Others say they will help protect natural forests and provide economic growth. Most of the public does not know what to believe.

As four of the main international organizations concerned with forests, we are committed to promoting an informed debate about this controversial topic. We believe that 'Fast-Wood Forestry—Myths and Realities' by Christian Cossalter and Charlie Pye-Smith makes a major contribution to that debate. It is the most up-to-date, credible and balanced report on the topic thus far. Over thirty of the world's leading experts from all sides of the debate have reviewed the report and provided detailed comments. While not every one of them agrees with all the report's findings, it reflects their collective wisdom.

Given the rapidly rising demand for paper and other wood products, the increase in fast-growing plantations is likely to continue for some time. We believe that laymen and experts alike will benefit from reading this report. Good policy requires sound evidence, and this report summarizes what is known to date. While there is still a lot we don't know and many legitimate disagreements about fast-growing tree plantations remain, this report provides an indispensable point of departure for anyone who wants to know the truth about plantations.

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Plantations are established for a variety of reasons and they vary in composition and structure, as well as in the intensity of management. Here we deliberately focus on 'fast-wood' plantations. These are intensively managed commercial plantations, set in blocks of a single species, which produce industrial round wood at high growth rates (mean annual increment of no less than 15m^3 per hectare) and which are harvested in less than 20 years. Fast-wood plantations can be large-scale estates owned by companies or a concentration of a large number of small- to medium-scale commercial woodlots owned by smallholders.

4 year-old clonal stand of *Eucalyptus* hybrid, Pointe-Noire, Congo

Introduction

Establishing plantations might sound like a laudable activity. Trees, after all, have many virtues. They convert water, sunlight and carbon dioxide into wood and oxygen, and it is frequently claimed that they regulate the water cycle, stabilise steep slopes against erosion and prevent flooding. Trees also provide a habitat for countless creatures and micro-organisms, and hundreds of millions of people rely on them for timber, firewood, fruit, nuts, resins and other products. Planting trees, it would seem, is an unreservedly good thing.

Or is it? During recent years the planting of large areas of fast-growing trees has sparked off much controversy, especially in the developing world. Critics of these 'fast-wood' plantations include environmentalists, who argue that they are replacing natural forests and causing harm to wildlife, water resources and the soil, and local communities, who complain that plantations are taking over land which previously provided them with the means to feed themselves and earn a living. The controversy is also about the use, or misuse, of public money.

The fast-wood controversy has set governments, plantation owners and pulp companies against peasant farmers in countries as far apart as Brazil and Indonesia. It has seen environmental protesters take to the streets in Chile, India, Portugal and Thailand, to name but four of the countries where demonstrations have been particularly volatile. It has forced development agencies to rethink their policies, and in some countries led to violent clashes between the authorities and local communities. In short, this has become a major issue, particularly where fast-wood plantations are a significant land use.

That fast-wood plantations are spreading so rapidly should come as no surprise. Population growth and a steady increase in the per capita consumption of wood and wood-based products such as paper, especially by urban populations, has led to an increase in the demand for the sort of timber which fast-wood plantations provide. The international trade in fast-wood products such as wood-fibre panels and paper has also been steadily increasing, and most of the paper produced in countries like Brazil and Chile is now destined for developed country markets. Rising incomes and population growth, especially in the developing world, have also led to an expansion of arable land and pasture and the loss of vast areas of natural forests. Inevitably,

industries and governments have increasingly sought to satisfy the burgeoning demand for wood by establishing plantations of fast-growing trees.

Over the past half century, growing trees to provide wood for industry has become big business, and the expansion of fast-wood plantations has been particularly rapid in a relatively small number of countries, in both the developed and the developing world. Some 30 years ago, Brazil became the first country in South America to establish large fast-wood plantations. Chile, Argentina and Uruguay soon followed. Today these four countries have approximately 2 million hectares of intensively managed eucalypt pulpwood plantations, while Brazil has a further 2 million hectares of eucalypt plantations devoted to the production of industrial charcoal. During the same 30-year period, Portugal and Spain established over 1 million hectares of eucalypt pulpwood plantations, around two-thirds of which qualify as fast wood. What happened in South America and southern Europe has been mirrored within the last 10 years in South-East Asia, particularly in Indonesia, which now has over 1 million hectares of pulpwood plantations, most devoted to *Acacia mangium*.

We estimate that there are now approximately 10 million hectares of fast-wood plantations worldwide. To this a further 0.8 to 1.2 million hectares is being added each year. The expansion of the fast-wood estate is expected to continue for the foreseeable future. The paper industry will continue to demand large quantities of fresh wood fibre, most of which will come from fast-wood plantations. The recycling of waste paper, currently encouraged by environmentalists and some governments, will not be enough to meet the rising demand for paper. Likewise, the steel industry will continue to demand large quantities of charcoal, another fast-wood product, for the smelting of iron ore. Most of the expansion of fast-wood plantations is expected to take place in South America and East Asia, particularly in China. Fast-wood plantations are evidently here to stay, whether we like it or not.

This booklet examines the various arguments for and against fast-wood plantations. This is a complex topic. Sometimes planting trees is an excellent way to use the land; sometimes it is not. In one location a plantation of fast-growing eucalypts might have a profoundly negative impact on wildlife, or reduce the amount of water available to other users. Yet a similar plantation elsewhere might do little or no harm to wildlife and water resources. A plantation of fast-growing pines might produce significant social and economic benefits. Yet a similar plantation elsewhere might lead to changes that hurt local communities.

Besides looking at the impact of fast-wood plantations on wildlife, water and the soil, we also examine the claim made by those in favour of fast-wood plantations that their ability to produce large quantities of wood fibre over a relatively short period of time helps to reduce the pressure on natural forests. We also examine in some detail the desirability, or otherwise, of using public money to encourage fast-wood forestry.

Our principal objective is to separate fact from fiction, science from speculation. In some cases established scientific findings are at odds with popular perceptions, and we highlight these. But science cannot provide answers to complex questions that have an ethical, political and social dimension. Rather, science provides information, and we must do our best to use the information as an aid to better decision-making, rather than as the sole basis for it. We hope that this booklet will make a constructive contribution to the debate on fast-wood forestry and provide a useful guide to policy-makers.

It is important to define, at the outset, precisely what we mean by fast wood and to indicate the ways in which fast-wood plantations differ from other plantations.

Plantations come in many shapes and guises, and are established for a variety of reasons. Some provide shelter, shade and fodder for livestock; others fuelwood for households, and timber for furniture and the construction industry. Sometimes they are established for the benefit of wildlife or as a recreational resource. Plantations may even provide a valuable service to urban populations, particularly in arid zones, by absorbing storm and sewage water. And plantations frequently fulfil a whole range of roles—for example, by providing peasant farmers with fodder, villagers with fuelwood and industry with high-quality timber.

The sole purpose of fast-wood plantations, in contrast, is to produce large volumes of small-diameter logs at competitive prices as quickly as possible, yielding at least 15m^3 of wood per hectare per year. Although fast-wood plantations produce a range of goods, most have just one function. Some supply wood to make panel products and reconstituted boards; some supply charcoal; a few provide sawn logs; and, most important of all, fast-wood plantations supply pulpwood, the raw material for the paper industry.

Typical of the fast-wood plantations whose impact we examine here are short-rotation plantations consisting of single-species blocks of eucalypts, poplars, acacias and pines. These plantations generally constitute a major land use, or at least they dominate the landscape. They may be owned by a single company or by a large number of smallholders, with the latter growing trees in individually owned woodlots, often for sale to large companies. This is plantation forestry at its most intensive—and controversial.

A brief word is in order here about the organisations and individuals who have done most to challenge industrial wood production from fast-wood plantations. Regardless of whether or not you agree with their thesis—in whole, in part or not at all—there is no denying that they have helped to raise public awareness about the potential impact of fast-wood plantations on both people and nature.

At the forefront of the anti-plantation movement is the World Rainforest Movement. Other environmental groups that have been voluble in their criticism of tropical fast-wood plantations include Greenpeace, the Environmental Investigation Agency, the Native Forest Network and the Rainforest Action Network. Several others are

sympathetic to the cause, even though they do not devote much time to campaigning on the issue themselves. All these groups would more or less concur with the critique advanced by Ricardo Carrere and Larry Lohmann in *Pulping the South.* 'As swatches of exotic trees invade native woodlands, grasslands, farmlands and pastures,' suggest the authors, 'the results, in country after country, have been impoverishment, environmental degradation, and rural strife.'[1]

No coherent lobby actively promotes fast-wood plantations at an international level. However, industry-led groups lobby for plantations, and rebut the allegations of those opposed to fast-wood forestry, in several countries. Many companies, foresters, academics, development agencies and institutions also believe that fast-wood forestry is useful to society, and we examine their arguments as assiduously as we do those of the anti-plantation movement.

Nursery of *Acacia mangium*, Riau province, Sumatra, Indonesia

Chapter 1

A Brief History of Plantations

The practice of planting trees goes back to ancient times, and many economically important species have been widely planted outside their natural range for thousands of years. Prior to 1900, low population density and the widespread availability of natural forests meant that there was no need to plant trees extensively as an industrial resource. However, some nations became progressively more concerned about their lack of natural forests, and in the first half of the 20th century tree planting began in earnest in western Europe, the United States, Australia, New Zealand, South Africa and a small number of developing countries such as India, Chile, Indonesia and Brazil. Later, in the 1950s, Japan, Korea and China embarked on massive reforestation programmes.[2]

The 1960s saw the launching of large-scale plantation programmes in many tropical and subtropical countries, and between 1965 and 1980 the area devoted to tropical plantations trebled. During this period the United Nations Food and Agriculture Organisation (FAO) played an important role by disseminating technical information and promoting plantations. In most cases, plantations were established with financial support from foreign donors or with soft loans. Plantations often benefited from direct subsidies, and they were mostly managed by state organisations. Poor marketing and a failure to establish viable links between plantations and industrial consumers of wood products meant that many tree-planting activities came to an end when external support ceased. Nevertheless, the area under plantations continued to expand at a rapid rate. According to the *Global Forest Resource Assessment 2002*, conducted by FAO, the global plantation estate increased from 17.8 million hectares in 1980 to 43.6 million hectares in 1990 and 187 million hectares in 2000.[3]

A third of today's plantations are found in the tropics and two-thirds in temperate and boreal zones. A relatively small number of countries dominates the plantation business, with five, each possessing over 10 million hectares of plantations, accounting for 65 per cent of the world's plantations. These are China, the United States, the Russian Federation, India and Japan. However, few of their plantations could be classified as fast wood.

The FAO assessment estimates the global rate of new planting at 4.5 million hectares a year, with Asia accounting for 79 per cent

and South America 11 per cent. There was a significant increase between 1991 and 2000 in the area of plantations established for industrial purposes—this includes all fast-wood plantations—as a result of increased private-sector involvement. Companies from North America, Europe, the southern cone of South America, South Africa, New Zealand and Australia had previously dominated private investment in plantation forestry. However, the 1990s witnessed the emergence of Asian multinational investors as major players.

The way in which countries record their plantation data, and report these to FAO, varies considerably, thus making comparative analysis difficult. All the same, the *Global Forest Resource Assessment 2002* is the most comprehensive available source of statistics on the nature and extent of the global forestry estate, both natural and planted. It recognises three broad categories of plantations: industrial plantations, which produce wood or fibre to supply wood-processing industries and charcoal for industrial use; non-industrial plantations, which produce fuelwood for domestic use, or are established to protect soil and water resources; and plantations whose purpose and end products are unspecified. Fast-wood plantations are industrial plantations. However, FAO's figures make no distinction between fast-wood and other types of industrial plantation.

Fast-wood plantations are relatively limited in extent, and involve a relatively small number of countries and industrial operators, but they are disproportionately significant in economic terms. Perhaps this helps to explain why there is no fast-wood equivalent to FAO's *Global Forest Resource Assessment*. Most of the information on the location, expansion, ownership, physical and financial performance of fast-wood plantations is contained in market intelligence studies, resource analyses and feasibility studies done by private consultancy firms. In most cases the information is confidential.

Nevertheless, we have attempted to establish as thorough a picture as possible of today's fast-wood estate, and have done so by consulting several of the studies alluded to above. The result is Table 1, in which we present the key characteristics of the main types of fast-wood plantation, together with their extent and distribution. The key players are Brazil, Indonesia, China, India, South Africa, Thailand, Vietnam, Malaysia, Venezuela and Swaziland, as far as tropical and subtropical species are concerned, and China, Chile, Portugal, Spain, Argentina, Uruguay, South Africa and Australia for the temperate species.

In compiling the data we realise that there are two obvious grey areas. The first concerns the 11.25 million hectares of tropical and subtropical eucalypt plantations outside Brazil, China and South Africa. How much of this resource is fast-wood plantation? India alone has 8 million hectares of eucalypt plantations, a very large portion of which cannot be regarded as fast wood: its productivity is simply too low. The second area of uncertainty concerns the poplar plantations of China. Planting poplars outside block plantations is common practice in China, and we do not know how much of the 3.7 million hectares of

Table 1. High yield, short-rotation plantation forestry: main species and countries involved

Species	Mean annual increment at an operational scale (m^3/ha/year)	Time to reach maturity (years)	Estimated extent fast-wood plantations only ('000 ha)	Main countries (In decreasing order of importance)
Eucalyptus grandis and various eucalypt hybrids[1]	15—40	5—15	± 3,700	Brazil, South Africa, Uruguay, India, Congo, Zimbabwe
Other tropical eucalypts[2]	10—20	5—10	± 1,550	China, India, Thailand, Vietnam, Madagascar, Myanmar
Temperate eucalypts[3]	5—18	10—15	± 1,900	Chile, Portugal, north-west Spain, Argentina, Uruguay, South Africa, Australia
Tropical acacias[4]	15—30	7—10	± 1,400	Indonesia, China, Malaysia, Vietnam, India, Philippines, Thailand
Caribbean pines[5]	8—20	10—18	± 300	Venezuela
Pinus. patula and *P. elliottii*	15—25	15—18	± 100	Swaziland
Gmelina arborea	12—35	12—20	± 100	Costa Rica, Malaysia, Solomon Islands
Paraserianthes falcataria	15—35	12—20	± 200	Indonesia, Malaysia, Philippines
Poplars[6]	11—30	7—15	± 900	China, India, USA, central and western Europe, Turkey

[1] Mainly hybrids involving: *E. grandis*, *E. urophylla*, *E. tereticornis*, *E. camaldulensis*, *E. pellita*.
[2] Mainly *E. camaldulensis*, *E. tereticornis*, *E. urophylla*, *E. robusta*, *E. pellita*, *E. deglupta*. India alone reports 8 million hectares of eucalypt plantation (FAO 2001). Our estimate is that a large share of this does not qualify as fast wood due to its modest growth rates.
[3] Essentially *Eucalyptus globulus*, but also several frost-resistant species (mainly *E. nitens*).
[4] Essentially *Acacia mangium,* but also *A. auriculiformis* and *A. crassicarpa*.
[5] Essentially *Pinus caribaea var. hondurensis*.
[6] The last forest inventory in China reports an equivalent of 3.7 million hectares of poplar plantations. Our estimate is that a large share of this is line planting, and that not all block planting is fast-wood plantation.

poplars reported in the last (1998) national forest inventory is actually fast wood, and how much is devoted to poplars outside large blocks.

The reason for the rapid expansion of fast-wood plantations is purely economic. Fast-wood plantations can produce one and a half to two times more wood per hectare per year, and reach maturity two to three times faster, than longer-rotation softwood plantations (see Table 2).

Quantity matters, especially when it comes to producing wood for pulp, or wood that can be chipped or flaked to provide material for reconstituted products. The higher the yield, the lower the cost of

Table 2. A comparison of the volume of wood produced in two well-known forest plantation models

Plantation type	Area of operation (ha)	Mean annual increment at an operational scale (m^3/ ha/ year)	Time to reach maturity (years)	Wood produced per hectare (m^3)
Fast wood Aracruz Celulose S.A	180,000	43	6.5 to 7	After 4 rotations: 28 years ± 1,000 m^3
Longer-rotation softwood New Zealand average	1,650,000	20	25 to 30	After 1 rotation: 28 years ± 560 m^3

the raw material. Less land is needed to produce the same amount of wood, and this helps to reduce the costs of land purchase, production and transport. The use of fast-wood tree crops may also enable companies to concentrate their estates on the most productive land. This simple equation, matching higher yields to lower costs, goes a long way towards explaining why markets in Europe and elsewhere have increased their demand for the sort of wood fibre grown in fast-wood plantations: it is cheaper than wood available from other, non-fast-wood sources.

Quality matters too, and it depends to a considerable extent on successful tree breeding. Good-quality fast wood comes from plantations where there is uniformity in tree size and shape. This leads to cheap and efficient harvesting, and lower transport and processing costs. If the end product is to be of high quality, then there must be uniformity of certain characteristics: less internal tension for sawn timber, better opacity for pulp, and so forth.

With their cheap land, low labour costs and potential for higher tree growth rates, developing countries located in the tropics and subtropics have a competitive advantage over cooler, temperate regions when it comes to producing plantation wood. However, large investors are interested in other factors too, and have so far concentrated on a limited number of developing countries, only a handful of which are in the tropics and subtropics. The risk of land appropriation, concern about the lack of legal and commercial structures capable of supporting complex investments, and a lack of good infrastructure are likely to deter some investors. However, while some investors undoubtedly gravitate towards countries that have a strong legal framework and relatively open economies that allow for the free flow of capital, others are happy to do business wherever governments ensure the profitability of their enterprises.[4]

It is clear that some developing countries are in a better position to establish fast-wood plantations than others. Over time, they are likely to become increasingly cost competitive, as their inherent

advantages translate into lower production costs. However, the burden of loan repayments initially keeps production costs at a relatively high level for new players.

This booklet is concerned with fast-wood forestry and its impacts, but before we examine these in detail it is worth pointing out that fast-wood plantations are at one end of a continuum of intensity. Immediately below fast wood, on a scale ranking tree plantations in declining order of productivity, are softwood plantations which produce sawn logs on rotations of 20 to 35 years. The most productive plantations of this type cover a total land area two to three times greater than fast-wood plantations. The southern states of the US alone have 11.6 million hectares of four commercial pine species: *Pinus taeda, P. echinata, P. palustris* and *P. elliottii*. New Zealand, Chile, Australia, Spain and South Africa have established 4.1 million hectares of *Pinus radiata*, and *Pinus patula* and *P. elliottii* cover about 1.3 million hectares in South Africa, Argentina and Uruguay.

Plantations such as these are found not just in temperate regions, but in the tropics and subtropics too. Brazil has 400,000 hectares of *Pinus caribaea* and *P. oocarpa*, and 16 provinces in China have 8.75 million hectares of plantations devoted to the Chinese fir, *Cunninghamia lanceolata*. In Brazil, Australia, Zimbabwe and Malawi plantations of *P. elliottii*, *P. taeda* and *P. patula* cover about 1.7 million hectares.

These longer-rotation softwood plantations are not immune to criticism from environmental groups, largely on the grounds that they are large-scale monocultures. However, they are generally perceived as being a more acceptable form of land use than fast-wood plantations. The fact that they have a longer history of cultivation, and are often of vital importance to local economies, goes some way towards explaining why they are viewed more charitably by plantation critics.

The expansion of longer-rotation softwood plantations has been particularly evident in developed countries. There is a good reason for this. Since longer rotations imply a longer-investment period, wealthier, developed countries have a comparative advantage over poorer, developing countries. In terms of good corporate governance and risk reduction, developed countries in temperate regions are better able to attract investors than less stable countries in the tropics. Longer rotations also create the potential for improving the quality, and hence the value, of the logs they yield. Pulpwood is at the bottom of the value scale. Sawn logs and veneer logs provide a much higher return, and some fast-wood growers are showing an interest in managing their trees on a longer, high-value rotation.

Although these longer-rotation plantations are not the focus of this publication, we refer to them on several occasions. Some of the problems associated with fast-wood plantations are shared, at times, by longer-rotation softwood plantations, or have been encountered at an earlier stage of their development.

Fast-Wood Plantations: A Family Portrait

Many plantation specialists regard Aracruz Celulose SA in Brazil as the archetypal fast-wood plantation company. It holds the growth record for eucalypts, and averages growth rates of 43m^3 per hectare per year on six- to seven-year rotations. The company owns 180,000 hectares of eucalypt plantation in three regions and has contractual agreements with some 2,200 outgrowers who produce pulpwood on 37,000 hectares of farmland. Aracruz Celulose SA's pulp production in 2002 was 1.6 million tonnes, derived from 6.1 million m^3 of eucalypt wood.

However, not all fast-wood plantations are owned by, or grown for, large corporations. On the tablelands around Antananarivo in Madagascar, there are 100,000 hectares of *Eucalyptus robusta*. These plantations were established 50 to 100 years ago, almost entirely on smallholdings. They are very much part of the local economy, and the charcoal they produce supplies Antananarivo with most of its domestic and industrial energy needs. They also provide thousands of jobs in hundreds of small charcoal-making and transport enterprises. Most of these plantations are now managed as coppice on a three-year rotation.

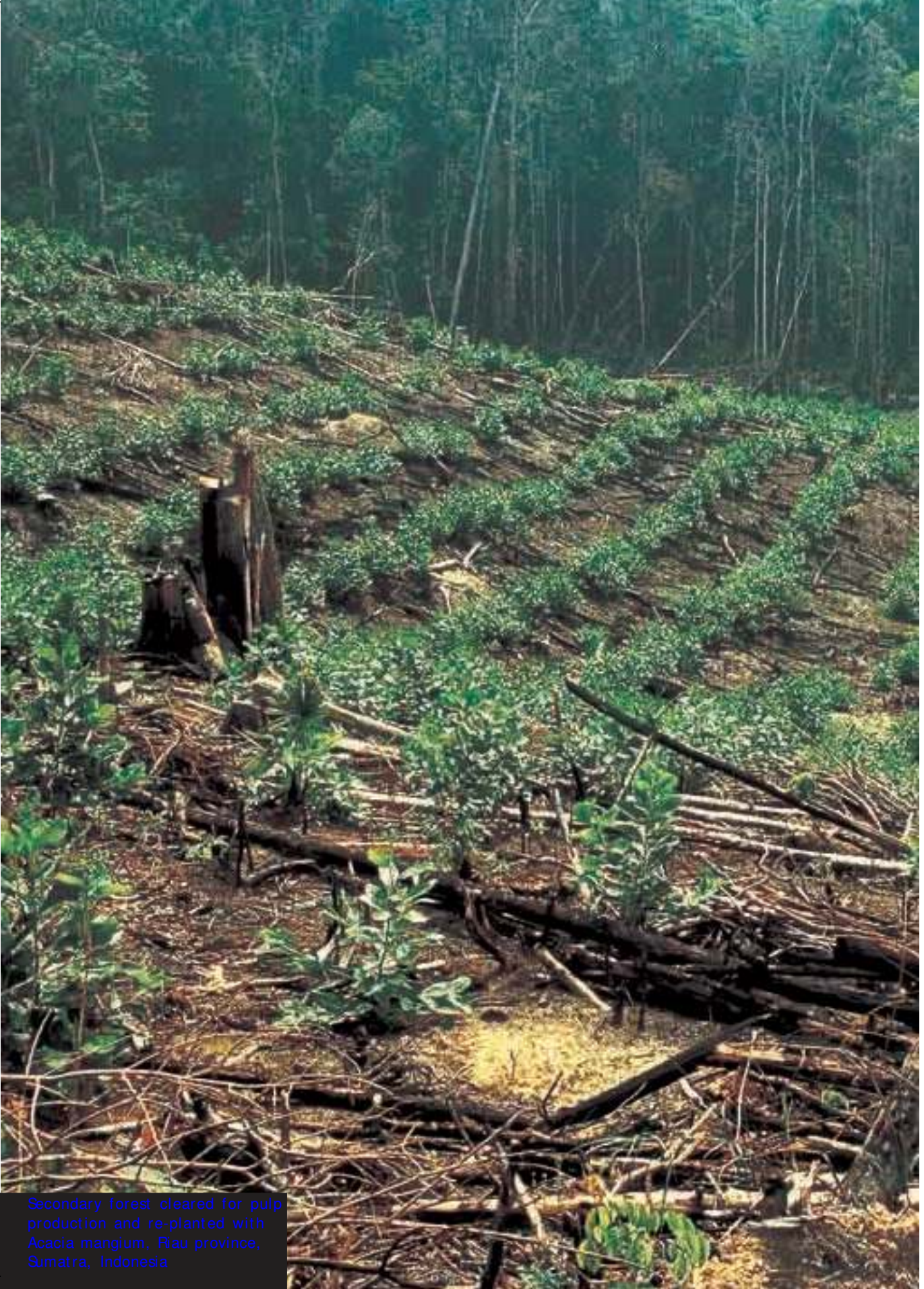
The tropics and subtropics are not the only regions where fast-wood plantations occur. Poplar is a good example of a genus almost entirely confined to temperate regions. Poplar is typically cultivated in riparian zones and deltas, with rotations of 20 years or less. There are many intensive poplar farms in southern Europe, North America and northern China. Growth rates above 20m^3 per hectare have been recorded in Romania and Yugoslavia. Poplar is common in Turkey, where plantations are grown on shorter rotations of 5 to 10 years with more modest annual growth rates, although these still exceed 15m^3 per hectare.

Pulpwood and charcoal are the main products of fast-wood plantations, but not the only ones. Fast-wood plantations are increasingly being used for the commercial production of reconstituted products: hardboard, particleboard, medium density fibreboard (MDF), oriented strand board (OSB) and laminate strand lumber (LSL). With the recent advances made in the utilisation of small logs and in the use of eucalypts as solid timber, there is also a trend towards producing appearance-grade lumber from fast-wood eucalypt plantations. The lumber is used to make furniture, flooring and joinery. Aracruz Produtos de Madeira, a subsidiary of Aracruz Celulose SA, was recently created to market 'Lyptus', a new line of high-quality eucalypt timber products. *Paraserienthes falcataria,* grown in Java, is another example of a high-yielding plantation tree that can produce a range of export-quality wood products in approximately 10 years.

Not all fast-wood plantations are planted with hardwoods. Softwoods such as *Pinus patula* and *P. elliottii* in Swaziland are grown on a 15- to 18-year rotation. A large part of their production goes for woodchips.

And not all fast-growing species make fast-wood plantations. The genus *Paulownia* is widely distributed in East Asia, in temperate, subtropical and tropical areas. *P. tomentosa* is the best-known species and it is planted in northern China for its high-quality timber. It grows rapidly, but only on fertile land. It therefore tends to be planted in lines around fields, along roads and canals and together with crops, rather than in blocks. *P. tomentosa* has been introduced as an ornamental in many European countries and in the US, while attempts to grow it for timber in Brazil, Paraguay, Argentina and Australia have so far had only limited success. Two other species, *P. elongata* and *P. fortunei,* also grow rapidly, but are rarely used in block plantations.

7 month-old clonal plantation of *Eucalyptus* hybrid, Pointe-Noire, Congo



Secondary forest cleared for pulp production and re-planted with Acacia mangium, Riau province, Sumatra, Indonesia

Chapter 2

Environmental Issues

Much of the opposition to fast-wood plantations is based on the belief that they have a damaging impact on the environment. Plantations stand accused on various counts. They are seen, most notably, as a threat to biodiversity, to water resources and to soil fertility. Many environmental groups also fear that the planting of genetically modified tree crops will lead to problems in the future. There are, too, concerns about the spread of pests and diseases in single-species tree plantations. The ability of trees to remove carbon dioxide from the atmosphere has encouraged some governments and organisations to advocate planting fast-growing trees to counter the threat of global warming. However, many environmentalists are opposed to such a move, in part because they believe developed countries should reduce their carbon emissions at source, in part because they consider plantations to be environmentally and socially harmful.

All these issues are examined in this section, but it is worth bearing in mind that generalisations about the impact of fast-wood plantations on the environment, or for that matter on local communities, are often misleading. The problems related to plantations are often site-specific, and the way in which they are planned and managed is of paramount importance.

Plantations and Biodiversity

If a large swathe of natural forest is cleared to make way for a fast-wood plantation, there will be a loss of biodiversity. The same applies when a natural savanna ecosystem is replaced by a plantation of alien species, as has frequently happened in South Africa, Uruguay and Argentina. Yet a similar plantation, established on degraded land, might bring about an increase in biodiversity. In other words, the impact of plantations on biodiversity will be a function of what they replace. Other factors of importance include the location of the plantation, its size, length of rotation and species composition. The issue of contiguity is also important. If new plantations are sited close to existing natural forests, they may benefit from their biodiversity: animals, birds and insects will be readily available to invade the new plantations. However, if no such reservoir of biodiversity exists, then the chance of the plantations being invaded by wildlife from outside, and providing a new habitat, becomes more remote.

The term biodiversity describes all the biological capital within a particular area. It refers to both variety, in terms of genes and species, and processes, in that it describes the complex and diverse interactions between different species, and between living organisms and the non-living environment. As a general rule, biodiversity is at its richest in the humid tropics, at or close to sea level, and declines on a continuum towards the poles and from sea level to high altitude. If a plantation replaces primary forest in, say, Costa Rica or Indonesia, it will lead to a greater loss of biodiversity than it would in southern Chile or Canada. This is not to imply that destroying natural habitats in boreal regions is less damaging than destroying habitats in the humid tropics.

Recent figures provided by FAO suggest that natural forests in the tropics are being converted to other land uses at an alarming rate, with an area half the size of Finland being lost every year. Conversion to forestry plantations accounts for 6—7 per cent of these losses. The remaining 93—94 per cent is lost to agriculture and industrial development.[5]

There are no precise figures to indicate how much tropical rainforest—the most biodiverse of all habitats—has been lost to fast-wood plantations. One estimate, made in the late 1980s, suggested that 15 per cent of all plantations in tropical countries were established at 'the cost of natural closed forests.'[6]

One country that has witnessed a massive conversion of tropical forest to fast-wood plantations is Indonesia. By the end of 2001, it had 1.4 million hectares of industrial pulpwood plantation, approximately half of which had been established on land cleared of natural closed forest during the previous 20 years. Indeed, pulp companies often locate their mills in or near large areas of natural forest with the intention of 'mining' the forests prior to establishing fast-wood plantations, which generally take at least 10 years to come on stream. In the meantime, the mills continue to use large quantities of timber from natural forests. This has been the case for four out of the five giant pulp mills recently built in Indonesia, the exception being the Tanjung Enim Lestari mill, which is served by the Barito Pacific pulpwood plantation in South Sumatra.

Pulp companies often establish new plantations on a range of habitats. Take, for example, the plantations of the Sinar Mas Group Company, which operates in Riau and Jambi provinces in Sumatra. By the end of 2001 it had established around 217,000 hectares of plantations. Some of the plantations were sited on grassland and scrub, but by far the largest area was established on logged-over natural forest. Over the next ten years, the company plans to establish a further 290,000 hectares of plantations. Most will replace peat swamp forest, a habitat already in serious decline in Indonesia.

These losses, both past and projected, should been set in the context of other activities which threaten the country's rainforest. During the past 20 years, the clearance of forests to provide wood for the pulp and paper industry, and land for fast-wood plantations and

their associated infrastructure, has accounted for 5—7 per cent of the natural rainforest lost in Indonesia. The conversion of forests to oil-palm plantations, other tree crops, and food crops, including those grown by shifting cultivators, has caused much greater losses.

Natural forests have been cleared to make way for plantations in other parts of the world too. For example, in Chile 31 per cent of the native forests in the coastal region was converted to plantations between 1978 and 1987. However, nationwide, the expansion of agriculture and pasture has been, and still is, the main cause of native forest conversion. Chileans might also point out that the forestry industry has created a $2bn a year export business, and that many people have benefited as a result. Plantations have meant prosperity, albeit at the expense of some of the country's forests and some communities.[7]

Some critics of fast-wood plantations accuse the industry of deliberately targeting forested land. 'The industry would like to replace diverse forests with fast-growing... monocrops,' claims the Native Forest Network.[8] Elsewhere it states that plantations 'usually replace native forests.' This is misleading. In some countries—Indonesia, for example—governments and industry have undoubtedly targeted natural forests, but in other countries, Brazil being an obvious example, significant areas of fast-wood plantation have been established on land that had already been cleared of natural forests by farmers and others. This is not to say that plantation companies in Brazil have not cleared natural forests too. They have. However, as a general rule, it costs much more to clear natural forests and replace them with plantations than it does to plant trees on agricultural land.

When new fast-wood plantations are established, the existing vegetation—closed forest, scrubland, grassland or whatever—must be removed, and before a single tree is planted the vast majority of mammals, birds and other creatures will be forced to flee. Furthermore, the building of new roads by plantation companies may provide easy access to surrounding natural forests and render hitherto pristine areas more vulnerable to exploitation and illegal logging. This is precisely what has happened in many parts of Indonesia.

In the humid tropics, the larger the area of natural forest converted to new plantation, the greater the number of species that will be affected. Take, for example, East Kalimantan, where fast-wood forestry linked to the Kiani Kertas pulp mill is one of various activities that threaten a particularly rich rainforest. A recent study in East Kalimantan found that a 1-hectare plot contained some 200 species of tree, while a 5-hectare plot contained double that number and a 10-hectare plot over 500 species. This means that the larger a plantation, the greater will be its impact on biodiversity if it replaces pristine forest. The same, of course, could be said when forests are converted to cropland, or cleared to make way for other activities.[9]

However, there are two sides to this story. In some situations fast-wood plantations may have a positive impact on biodiversity. When the natural vegetation has already been destroyed or seriously

damaged—for example, by logging, unsustainable agriculture or overgrazing—plantations may help to restore some biodiversity, either by sheltering relics of the original flora and fauna and allowing them to proliferate, or by creating a new ecosystem, albeit with a different mix of species from the one which originally occupied the site. In many parts of India and China, plantations have been established on barren land or abandoned agricultural land. On the whole, this has been good for biodiversity, although growing plantations on land no longer capable of sustaining farm crops might result in mediocre wood yields, and a regime that requires the liberal use of fertiliser.[10] In the People's Republic of Congo, eucalypt plantations established on savannas seldom colonised by forest species—annual fires destroy the tree seedlings—have acted as a nurse crop for species invading from nearby natural forest.[11] This phenomenon of plantations 'catalysing' natural forest restoration on degraded lands has been documented for several types of plantation, including fast wood, in many countries.[12] The longer the rotation, and the less intensive the management, the more pronounced the effect.

Environmentalists dislike the term 'barren land'. They rightly point out that areas classified as barren land are often wildernesses which are slowly recovering from years of degradation by unsustainable farming practices. If left alone, they might well develop into valuable ecosystems that support higher levels of native biodiversity than would happen were they to be replaced by fast-wood plantations. However, such a recovery will be possible only if governments or others allocate sufficient funds and manpower to protect them.

Some plantations will support more biodiversity than others, and the same species will invariably shelter and attract more wildlife in its natural habitat than when it is planted as an exotic. Native Australian eucalypt forests, for example, support a rich diversity of animals and plants. These have evolved with the trees. However, when planted as a monoculture in other parts of the tropics, the same eucalypt species tend to have little or no undergrowth and support relatively few species.

Plantation companies could do much to protect biodiversity if they abided by a set of guiding principles. Biodiversity benefits most where natural corridors are retained between blocks of natural forest; where there are several layers of vegetation and a diversity of ecosystems; and where aquatic ecosystems are conserved.[13] CIFOR is currently undertaking research in Sumatra on the design and management of biodiversity corridors in a fast-wood plantation landscape. The aim is to retain and enhance the links between remaining patches of natural forest, and the research will assess the impact of such measures on the profitability of industrial timber production. Some companies already have active programmes to protect the remaining native forests in and around their plantations. For example, Aracruz in Brazil is protecting and enriching with native trees the remnants of natural forests left along water courses.

It is often claimed that industrial plantations in general, and fast-wood plantations in particular, have a compensatory effect: by providing timber and pulpwood they take pressure off natural forests, which can either be preserved as they are, or managed in such a way that they do not lose their biodiversity. The economic theory behind this claim goes as follows. As the area under plantations expands, the lower cost of plantation timber, relative to timber from natural forests, will gradually make the logging of the latter uneconomic. Markets will switch progressively to plantation timber, and plantations will expand to guarantee a sufficient and continuous supply.

In certain countries this may be happening. New Zealand is often cited as an example: 99 per cent of its current wood harvest comes from plantations.[14] However, one needs to remember that in the past the exploitation of natural forests contributed substantially to the country's economic development, just as it does in many developing countries today. Prior to Maori settlement, which occurred between 900 and 1350, natural forests covered roughly 75—80 per cent of New Zealand's land area. By 1840, when European settlement was already well underway, forest cover had been reduced to 53 per cent. Now natural forests cover 23 per cent of the land area.[15] True, plantations currently satisfy virtually all New Zealand's timber requirements, and generate considerable export revenues, but this is a recent phenomenon.

It would be wrong to assume that just because plantations seem to take pressure of natural forests in some countries, that they do so in others. Indeed, some observers contend that New Zealand is the exception rather than the rule, and there is certainly no simple formula linking plantation forestry to the conservation of natural forests.[16] Even in countries where the markets appear to favour fast wood over timber harvested from natural forests, deforestation may still be a serious problem. The fact is that the clearance of land for agriculture is a far more significant cause of forest loss in the developing world than commercial logging.

Furthermore, plantations devoted solely to the industrial production of wood are often a poor substitute for natural forests: in developing countries they never provide the great range of forest products—timber, fruit, fibre, resins—that local communities require and will continue to take from remaining natural forests. It also seems that where natural forests comprise a substantial proportion of the landscape, wood prices alone are unlikely to decline to such a degree as to render their logging unprofitable. In New Zealand, for example, the government had to intervene to stop logging in natural forests. It was legislation, not market forces, which protected the natural forests from further exploitation.

When the conservation of natural forests is seen as a national priority, it tends to be either a reflection of successful economic development, or an indication that natural forests have been seriously reduced in extent, or a combination of the two. This is illustrated by

Chile and Uruguay, where fast wood and other industrial plantations are by far the most important forestry activities, supplying over 90 per cent of the harvested timber. Deforestation caused by commercial logging has now been halted in Uruguay and drastically reduced in Chile. Both countries adopted strict conservation policies after a long period of deforestation had reduced natural forest cover to 3.8 per cent of the land area in Uruguay and 18 per cent in Chile. It was the realisation that little natural forest remained, rather than a market shift in favour of plantation timber, which encouraged the countries to protect their remaining natural forests.

Most people, though not everyone in the forestry industry and in government circles, would contend that it is hard to justify the further conversion of natural forests to fast-wood plantations, or for that matter to any other type of plantation. This is especially true when it comes to species-rich tropical rainforest, so much of which has already been lost to agriculture and other activities.

Water Matters

The hydrological effects of trees, and particularly the effects of plantations on water yields and flooding, have been the subject of much myth-making. Almost invariably, whenever there is a major flood the cry goes up that it has been caused, or aggravated, by deforestation. And this is generally accompanied by the claim that the obvious way to prevent a recurrence is to plant trees in the water catchment, the idea being that they will soak up excess water. There are often good reasons for planting trees, but plantations can seldom guarantee an even flow of water, whatever the climatic conditions.

The myth-makers have also perpetuated the belief that forests attract rainfall. This stems from a confusion of cause and effect. Mountains usually have more rainfall and forests than the adjacent lowlands, but this does not mean that the trees are attracting rain. This belief has been written into the textbooks, to become an article of faith for generations of foresters. However, like many myths, it does contain a grain of truth: in certain instances the presence of forests may lead to an increase in rainfall. Certainly, cloud forests can increase water collection by condensing the water droplets in mist and cloud, thus increasing the amount of water in the catchments. But this is the exception rather than the rule.[17]

Understanding the links between forests and water resources requires a basic knowledge of hydrology and plant physiology, not to mention an understanding of various environmental processes. It is a complex matter since the real contribution of forests and plantations to water regimes will vary from one site to another. Topography, soil type, local climate, the type of tree involved and a variety of other factors will exert their own particular influence.

The sites most commonly targeted for fast-wood plantations tend to be those with plentiful rainfall, as this promotes the highest

growth rates. However, some fast-wood plantations and many other types of plantation are established where water is in limited supply, at least during the dry season.

Environmentalists frequently criticise large-scale plantations on the grounds that they reduce the amount of water that flows through the water catchment. According to the World Rainforest Movement (WRM), fast-growing eucalypt and pine plantations have led to water shortages in Espirito Santo state in Brazil, in South Africa, southern Chile, north-east Thailand and many other places. These shortages are said to have led to the abandonment of farmland, a decline in fish catches, the depletion of groundwater reserves and the drying up of streams and wells.[18]

Before we assess the veracity of WRM's claims, it is worth describing precisely what happens when rain falls on natural forests or plantations. Some of it is immediately intercepted by the forest canopy and evaporated back into the atmosphere. The rest falls to the ground. The soil absorbs as much as it can, and excess water runs off on the soil surface. A portion of the rain that filters into the soil is taken up by trees and other plants, and some of this will be transpired back into the atmosphere through the pores, or stomata, on the leaves. The two processes of interception and transpiration are referred to collectively as evapotranspiration. Water which is not immediately evaporated back into the atmosphere, absorbed by plants, lost through run-off or retained in the soil will reach the ground water table and head for water courses and springs. Water lost to the atmosphere eventually comes down again. As it usually falls far away from where it went up, this process has little relevance to plantations, but in vast natural forests like those of the Amazon there is an important recycling effect.

Each type of soil differs in its water-retention capacity, which largely depends on its textural composition and vegetation cover. The organic-rich topsoil of most native tropical forests generally has a high capacity to absorb and retain water. Others soils—for example, those with high clay content—have much poorer capacity to soak up water, and are thus more liable to flash flooding at times of heavy rainfall.

Trees, too, vary in the way they intercept rainwater and consume and store it, and there can be considerable variations within the same genus. For example, one species of eucalypt may be capable of producing large quantities of biomass per unit of water consumed. Another may be unable to reduce transpiration in dry conditions. It will thus be less efficient when it comes to transforming water into biomass and more prone to water stress. In exceptional circumstances certain species may be able to put down rapidly growing roots in search of deep ground water

When a plantation is established, there will inevitably be a change in the water cycle. The nature of the change will depend on what sort of habitat the plantation replaces. When a natural forest is converted into a plantation, the greatest changes will occur during the first few

years following clearance and planting. In contrast, when plantations are developed on grassland, the initial change in hydrology will be slight, but will become progressively more pronounced as the plantation approaches maturity.[19]

Experiments conducted in French Guiana, following the clearance of lowland rainforest, provide telling evidence of the role different vegetation types can play in regulating water flows. When eucalypts were established following clearance of primary forest, run-off increased by over 60 per cent in the first year. Thereafter it declined, and by year six, run-off was some 10 per cent less than it had been under primary forest. When forest was replaced by *Digitaria* grassland, runoff increased by over 100 per cent in the first year, and was still some 30 per cent higher than under primary forest after five years.

This experiment suggests that when grassland replaces trees in a wet tropical environment such as French Guiana, water run-off increases: clear-cutting leads to more water downstream, not less. Run-off also increases dramatically when new plantations are established after clear-cutting, but plantations, especially those consisting of fast-growing trees, soon retain more water than primary forest, thus reducing the water available to those living downstream. This suggests that WRM's criticism of plantations—that they deprive downstream users of water—is valid in certain situations. However, if plantations are harvested after seven or so years, as many fast-wood plantations are, their water-retention qualities will be only briefly felt. Indeed, after the harvest, run-off will presumably rise, once again, to the post-clear-cutting high.

Climatic conditions also play a significant role in determining the precise impact of new plantations on water flows. A large number of studies and catchment experiments indicate that in wet conditions interception losses will be higher for forests than for shorter crops, while in dry conditions transpiration is likely to be greater. This means that in very wet and very dry climates, forested areas will experience lower levels of water run-off than unforested areas.

In drier climates the level of dry season stream flow is an important factor for users—during the dry season streams may provide the only source of water—and water retention by fast-wood plantations can cause serious problems, especially when plantations replace grassland. A classic example comes from South Africa. Large areas of riverside land were planted with eucalypts, black wattle and pine during the 1950s and '60s, and these led to a dramatic decline in the water available to users further downstream. As a result, in the mid-1990s, the South African government hired many thousands of people to remove the offending trees. Nowadays, obtaining a 'water licence' from the Department of Water Affairs and Forestry is a prerequisite to plantation development. Silvicultural measures that help reduce evapotranspiration—choosing species that use less water; thinning heavily—are also being encouraged.

It is frequently said that trees can regulate water flow by retaining water during the wet season and releasing it slowly during

the dry season. Many scientists see some conceptual validity in this. After all, root activity leads to better soil structure and increases the capacity of the soil to store water. In theory, these forest soils should release water slowly, rather than rapidly. However, this is rarely borne out by empirical analyses, and what little evidence exists to support this view is anecdotal.

It is often claimed by those involved in the forestry industry that plantations have the potential to reduce flooding. After all, plantations reduce run-off, so it would be logical, would it not, to suppose that they can prevent flooding by holding back water. The short answer is that we simply do not know for sure, although it is clear that we need to make a distinction between the way forests and plantations deal with modest amounts of water, and the way they behave during extreme events, when massive quantities of water fall over a very short period of time.

There is little or no evidence to suggest that forests or plantations can prevent flooding when an area is deluged with large amounts of rain. The apparent increase in flood damage over recent years in many parts of the world can often be attributed to an increase of human activity in the flood plains, rather than a reduction of tree cover in the water catchments. Far greater numbers die in Bangladesh when the Ganges floods today than in the past, primarily because far greater numbers now live in flood-prone areas. Furthermore, the canalisation of rivers, the drainage of wetlands and the building of towns and infrastructure in areas prone to flooding have increased the severity and regularity of floods. This is not to say that trees have no role to play in areas that experience torrential downpours. As the mountain dwellers of Nepal know as well as any hydrologist, trees can help to prevent landslides during floods, and they can help to stabilise terraces. However, they cannot prevent large-scale floods.

A failure to understand the relationship between trees and water has resulted in the misuse of both land and money. Investing millions of dollars on plantations that use more water than the vegetation they replace is senseless if water is already in limited supply for downstream communities. In other situations, a decrease in dry season stream flow, as a result of the increased demand for water in fast-wood plantations, may not cause significant water problems to other users. However, it is impossible to make generalisations about the relationship between fast-wood plantations and water flows, and each plantation, and each plan for a new plantation, should be assessed individually.

Plantations and the Soil

Soil degradation has become an increasingly serious problem, especially in the tropics and subtropics, where many soils are inherently poor in nutrients and at high risk of erosion. The main causes of soil degradation are poor agricultural practices, deforestation and overgrazing, but fast-wood plantations, when

poorly planned and managed, may also lead to an increase in erosion and a loss of nutrients. Fast wood is grown on a short rotation and harvested by clear-felling operations that often involve the use of heavy machinery. There is no doubt that a site managed for fast-wood production will be subject to more frequent disturbance, and possibly more soil erosion, than a similar site managed for slow-wood production.

Certain site preparation techniques—for example, contour planting on low ridges and the construction of micro-catchments—can substantially reduce water run-off, and therefore soil erosion, but these techniques, devised for exceptionally dry areas, are rarely used in fast-wood plantations. As a rule, erosion tends to increase during site preparation and the early years of growth, when the soil is exposed to wind and water. The amount of erosion depends on slope, soil type, rainfall, the duration of the barren phase when the soil is directly exposed to wind and water, and the nature of the tree canopy. Once the trees are established, erosion may still be an issue, especially where there is little ground cover, on sloping ground and in plantations where leaf size encourages the creation of large water drops. Short-rotation plantations will experience more erosion than long-rotation plantations when established under identical conditions.

However, in certain circumstances plantations may help to reduce erosion, and they are sometimes established precisely for that purpose. In New Zealand, for example, radiata pines have been planted on degraded farmland to reduce erosion, and they have helped to stabilise erosion-prone soils in the Waipaoa River basin on the east coast of North Island. After a cyclone in 1988, a study revealed that on sites with either no trees or trees of less than one year old, more than 20 per cent of the surface area was disturbed. As the age of the plantations increased, the amount of disturbance declined. In stands aged nine years or more, disturbance affected a mere 0.2 per cent or less of the area.[20] However, we should point out that fast-wood plantations are managed on too short a rotation to stabilise erosion-prone soils.

In natural ecosystems such as undisturbed tropical forests, nutrient cycles tend to be in balance. Trees take nutrients out of the soil, returning them later in the form of leaves, flowers and woody matter, which are then broken down by fungi, bacteria and other organisms and incorporated into the soil, where the nutrients become available, once again, for uptake by trees and plants. The ecosystem, in short, is more or less self-sustaining, though this is not a hard and fast rule. When fires occur on a regular basis, as they often do in Australia's natural eucalypt forests, they can cause a rapid loss of nutrients, and indeed some ecosystems will change and degrade naturally.

As a general principle, multiple rotations of fast-wood plantations will have a more significant impact on soil fertility than plantations that are harvested after a long period of time. The quantity of nutrients removed will be greater, and so, consequently, will be the requirements

for fertilisers. Nutrient recycling processes vary considerably from one soil type to another, and with different harvesting and replanting procedures. Nutrient losses are generally at their most significant during site preparation and harvesting. Some nutrient losses also occur as a result of erosion.

In recent years scientists have gained a much better understanding of the relationship between soil fertility, tree nutrition and productivity, and site management, and this has enabled them to measure potential nutrient losses and work out how to reduce them. Now that it is widely accepted that burning between rotations has been responsible, in part, for site degradation and a subsequent decline in yields, many plantation managers have changed their management practices. Increasingly, trees are debarked on site, and the unnecessary removal of leaves and woody matter is avoided, as is the use of fire between rotations.

It is important to stress that fast-wood plantations are generally much less degrading to the soil than many commercial agricultural crops. FAO cites a study that found that the amount of nitrogen removed by a cereal crop was two and half times more than the amount removed by a eucalypt plantation. In the case of phosphorus it was fifteen times more.[21] A study comparing fast-growing pine with grains, potatoes and alfalfa found that the latter removed 15 to 35 times more nitrogen (with the exception of nitrogen-fixing alfalfa), 80 to 250 times more phosphorus, and up to 10 times more calcium than the pines.[22] Acacia trees, like alfalfa, fix atmospheric nitrogen, so unlike eucalyts they increase the amount of nitrogen in the soil. It goes without saying that good management will help to minimise soil loss and declines in fertility, regardless of whether the land is devoted to fast-wood plantations or annual agricultural crops.

If fast-wood plantations are to produce high yields, nutrient levels must be maintained or improved, often with the use of fertilisers. The principle is precisely the same as it is for conventional—non-organic—agriculture, when crops are grown continuously on the same plot of land. It may not always be necessary to apply fertilisers, but on poor quality sites plantations may prove unprofitable without them. On soils that are naturally poor in nutrients—low phosphorus availability is one of the main factors limiting forest productivity—the use of fertilisers is essential.[23]

Fertilisers, whether used on arable or tree crops, impose certain environmental costs. In the case of nitrogen-based fertilisers, they are usually made out of natural gas, which is a finite resource. In the case of phosphorus, the raw material is mined. The use of fertilisers frequently affects water quality. Nutrient enrichment may be particularly damaging to the flora and fauna of nutrient-poor habitats, and often leads to a decline in species diversity. However, there is little evidence to suggest that the use of fertilisers in fast-wood plantations has caused significant problems as far as the pollution of wetlands is concerned. In contrast, the use of fertilisers on farmland has caused many well-documented problems. Fast-wood plantations require much

less fertiliser per hectare than many agricultural crops, and a single application per rotation will generally suffice.

George Bernard Shaw's dictum that 'The Golden Rule is that there are no golden rules' applies to the subject of plantations, soil erosion and nutrient loss just as it does to plantations and water flow. Although fast-wood plantations are more prone to increased rates of erosion and a decline in fertility, when compared to longer-rotation plantations, they can in certain circumstances have a beneficial influence on the soil and prevent or reduce erosion. In the People's Republic of Congo, plantations of fast-growing eucalypts cover some 45,000 hectares of very poor sandy soils. They have replaced degraded savanna grassland that was of little use, either for grazing livestock or hunting. Studies have shown that these plantations have improved the soils by building up organic matter.[24] They have also encouraged the return of natural vegetation and wildlife.[25]

Pests: Plantations' Achilles' Heel?

In *Pulping the South*, Ricardo Carrere and Larry Lohmann suggest that one of the great initial advantages of planting exotic trees—the absence of pests adapted to using them—can become an Achilles' heel in the long term, once predators adapt to the new species. 'At that point,' they suggest, 'the food desert becomes a feast for one species, which can expand exponentially and seriously damage or annihilate whole plantations.' The authors provide several examples to prove their point. In Uruguay, the depredations of the pine shoot moth meant that plantations of *Pinus radiata* had to be abandoned. The same happened when another pest attacked *Gmelina arborea* in Brazil. Not that events such as these were anything new. In the late 19th century foresters imported mahogany, a native of Central and South America, to many parts of the Asia-Pacific region. The plantations were attacked by a shoot-boring insect and abandoned almost everywhere except Java and Fiji, where the pest was brought under control by a combination of good science and astute management.

So, yes, in certain circumstances pests have wreaked havoc in plantations of exotic trees. However, *Pulping the South*'s critics are quick to point out that there is little *Pinus radiata* in Uruguay; that this species successfully supports major industries in several other countries where it is grown as a monoculture; and that, in any case, native forests are periodically ravaged by pests too. Furthermore, there is an equally valid opposing view that holds that exotics are at less risk of pest outbreaks than native trees, at least for a long initial period after their introduction. Those who hold this view contend that the safe period is generally long enough to justify their commercial exploitation. The plantations may eventually be attacked by pests, many of which can be dealt with, but the lack of pests in the early stages of introduction means that they may be much more productive than native species. As far as pests and disease are concerned, risk reduction has much

to do with the amount of knowledge gained by silviculturalists during the domestication process.

A recent study of pest outbreaks in tropical forest plantations, commissioned by CIFOR, posed the question: Is there a greater risk for exotic trees species than for indigenous tree species? The author, K.S.S. Nair, looked at the experience of nine species and genera widely used as exotics. As far as the planting of exotic species is concerned, Nair suggests that some species are at less risk and some are at greater risk: "No generalization is possible for exotics as a group, but more species seem to be at lesser risk, at least for a long, though uncertain, period of time after introduction." Intriguingly, Nair found that the common belief that pest problems are less severe among indigenous species than exotic plantations—the theory being that specialised natural enemies of the pest are already present in indigenous stands of trees—does not necessarily hold true. Although natural enemies play an important, and in some cases decisive, role in regulating the population increase of many insects, outbreaks also occur in natural forests and in plantations of native species.[26]

It seems that various factors determine the risk of a pest outbreak in exotic plantations. The shorter the distance between the location of the exotic introduction and the native habitat of the species in question, the greater the risk. If there are other closely related species in the vicinity of the introduction, the greater the likelihood that their pests will attack the exotics. On poorly chosen sites, trees are liable to suffer from stress, and this can promote pest outbreaks. And the greater the area under plantations, the greater the likelihood of the exotics being brought into contact with pests that can readily adapt to them. Poor silvicultural practices also increase the likelihood of pest outbreaks, and of course pests may be inadvertently transported great distance across the globe in shipments of timber.

It is worth pointing out that large-scale fast-wood plantations are a relatively new phenomenon. Many are still in their first rotation, and it is therefore unsurprising if there are some problems in matching species with sites in a way that reduces the likelihood of pest attacks. Agriculture has a long list of planting failures. Fast-wood forestry will inevitably have its failures too.

Plantation managers sometimes deal with pest outbreaks by spraying with chemicals. The environmental problems related to the use of pesticides have been well documented. Aerial spraying, a common practice for many agricultural crops, is used only in exceptional cases as a means of pest control in large fast-wood plantations. Suffice it to say that the aerial spaying of plantations would pose serious difficulties, especially when the trees had developed a canopy.

There has been something of a revolution in pest control strategies over recent years, and many plantation companies now practise integrated pest management, or IPM. This involves a combination of different measures, including preventative control of pests and accurate targeting of pests when pesticides are used. Much greater attention is now paid to finding the tree species and

provenances that best suit particular sites than was the case in the past, and they are chosen not just for their growth potential but their ability to resist pest attacks.

Genetically Modified Trees: Opportunity or Threat?

One of the fiercest debates in recent years has concerned the use of genetically modified organisms. GMOs are plants, animals, bacteria or other living organisms that have been genetically engineered by the insertion of a foreign gene. For centuries, farmers and plant breeders have improved crops and livestock, and to a lesser extent trees, by isolating and selecting for breeding the individuals with the most desirable traits. Everything has hinged on sexual reproduction: only by breeding within the same genus have advances been made. Genetic engineering has changed all this. It has enabled scientists to dispense with sex and cross the genus barrier. For example, a gene governing the manufacture of Vitamin A in the daffodil has been successfully transplanted into rice, which lacks significant quantities of Vitamin A. And a gene coding for cold tolerance in fish has been successfully installed in a strawberry plant, thus rendering it frost-resistant.[27]

Genetic engineering has opened up a whole new world of possibilities. However, it is a relatively new field and many believe that it poses a threat to both man and nature. So far the vast majority of GMOs have been developed as foodstuffs, but biotechnologists are increasing looking to genetic engineering as a means of 'improving' trees. The first genetically modified trees were produced in 1987, and by 1998 there had been at least 116 confirmed GM tree trials around the world.[28] Organisations such as Greenpeace and Friends of the Earth, which have long expressed their fears about GMOs in agriculture, have been joined in their campaigns against 'Frankentrees' by groups like the Native Forest Network, which claims that 'native forests ... are threatened worldwide by genetically engineered tree plantations.'[29] But are they?

There are a variety of reasons why biotechnologists are attempting to develop genetically modified trees. Around a third of a plant's energy supply is used in reproduction, and researchers hope that the introduction of sterility into transgenic—genetically modified—trees might help to improve growth rates. Biotechnologists are also looking for genes that code for the enzyme that breaks down lignin. Up to a third of a tree's dry weight is lignin, which must be removed at considerable cost when pulpwood is turned into paper. Plantations of low-lignin trees could help reduce pulping costs. It is claimed that this would also be good for the environment, as lignin removal is an environmentally hazardous process. The possibility of inserting herbicide-resistant genes into trees is also attracting considerable attention. There is the possibility, too, that genes could be inserted into trees to endow them with resistance to insect pests. This means that trees would manufacture their own insecticide, which would be good both for the bottom line and for the environment.

Those opposed to the development and use of GMOs are particularly concerned about the possibility of engineered genes escaping into the wild, where they might become established in natural populations of closely related species. Pollen can travel great distances, and transgenic pollution might introduce herbicide resistance into a wild species, thus creating a 'super weed'. In theory, this could be prevented by inducing sterility—again through genetic engineering—or by ensuring that the trees are harvested before they flower. However, this presupposes rigorous management, which is not always easy in remote locations. And what would happen if a plantation company foundered financially? Who, then, would take responsibility for the abandoned plantations?

Environmentalists have also suggested that genetic engineering of trees for reduced lignin content and for insect resistance might not prove to be as beneficial as the biotechnologists hope. Take, for example, lignin, which confers physical strength on trees and constitutes part of their defence mechanism against pests. Reducing lignin content could make trees more susceptible to pest attacks, and consequently more pesticides would be required in plantations. Insect-resistant genes, say GMO critics, might not only affect pests, but harmless insects too. On the other hand, insect pests might develop a resistance to the transgenic trees and become more difficult to control. Agricultural pests provide ample precedent for this: many have mutated to become resistant to sprays used on cotton, coffee and a range of other crops.

Another objection to GMOs is that they may be dangerous in foodstuffs. If there is a risk with GMO trees, and it is a remote risk, it would stem from humans eating domestic or wild animals that had consumed the leaves, fruits or seeds of transgenic trees. Animals might eat fast-wood leaves if no other fodder were available, for example during a drought. Animals will not eat the fruits or seeds of poplars or eucalypts, but they will eat those of acacia trees. However, even if humans were to eat animals that had consumed transgenic matter, there is no scientific evidence to suggest that their health would suffer.

A WWF scoping study surmises that the main impact of transgenic trees might not be genetic pollution, or the creation of super weeds, but 'the contribution that [genetic engineering] might make to unsustainable land use.'[30] The study suggests that trees engineered for enhanced growth will generally be voracious consumers of water and nutrients, and thus will have the potential to degrade land. However, similar objections could be raised for the non-GMO eucalypt clones, raised through tissue culture, which are delivering astonishingly high yields, most famously in the Aracruz plantations of eastern Brazil. Nevertheless, it is true that genetically improved or genetically modified trees will fulfil their true potential only when the right growing conditions are provided. They must be planted in suitable climates with adequate water and they will nearly always require the use of fertilisers. They may also demand relative freedom from weed competition when young, and this means that herbicides must be used.

Current objections to GMOs, like the defence of GMOs, are based on scientific theory. We lack empirical evidence. The jury is out still.

Plantations and Global Warming

Rising concentrations of greenhouse gases, in particular carbon dioxide released by the burning of fossil fuels, are leading to global warming. According to the Intergovernmental Panel on Climate Change (IPCC), if current trends continue, temperatures will rise by 1.4 to 5.8 degrees C over the next century. In the worst-case scenario, sea levels will rise by just under a metre, and coastal cities and deltas will be inundated. Already, global warming is thought to be causing significant climate change, and IPCC scientists predict a decrease in rainfall in Africa, Latin America and Asia. This could lead to a dramatic decline in food supplies in areas already plagued by shortages.[31]

There are two main ways of tackling global warming. One involves conserving carbon in its solid state; the other—and this is where plantations come in—involves its sequestration.

Carbon can be conserved by reducing the use of fossil fuels and slowing the rate at which forests are being cleared. Although industrial activities are responsible for the lion's share of carbon pollution, a fifth of carbon dioxide emissions come from the felling and burning of forests, mostly in tropical regions. The substitution of biomass fuels—for example, fast-growing trees—for fossil fuels is another way of reducing greenhouse gases. The theory is that biomass plantations will promptly sequester the amount of carbon released by burning biomass fuels.

Carbon sequestration involves locking up carbon in living trees and in durable constructions and furniture. The science is simple enough: trees convert carbon dioxide into solid carbon, in the form of wood, and they do so especially effectively when they grow rapidly. Huge amounts of carbon are stored in natural forests, but as they grow at a slower rate than plantations, they do not actively sequester as much carbon per unit area.

The science may be simple; the politics most certainly is not, as we have seen during the heated negotiations over the Kyoto Protocol, the aim of which is to limit the amount of greenhouse gases entering the atmosphere. Much of the debate has focused on the cumbersomely termed Clean Development Mechanism (CDM), which will allow companies to offset some of their emissions—and thus meet some of their pollution targets—by financing pollution-reducing projects in countries that are not subject to an emissions cap under the protocol. For example, coal-fired power stations in Europe will be able to fund plantation projects in Latin America and gain 'carbon credits' which can be set against their pollution at home. If it is cheaper to buy carbon produced in plantations than it is to reduce emissions at source, this makes good financial sense.[32]

Critics of carbon deals such as these—and many environmental groups opposed the inclusion of plantation projects in the CDM—argue

that these projects will exclude poor people from the land and cause the sorts of environmental problems described earlier in this chapter. While proponents of a carbon trade based on plantation forestry admit that these concerns are legitimate, they point out that well-designed and carefully managed projects could do much to improve livelihoods and restore degraded land.

Obviously, the nature of the plantation, its ownership and the uses to which its timber are put will determine whether or not it is beneficial from an environmental and social point of view. If plantations replace natural forests, or take over land previously used by peasant farmers, they might be considered a bad thing. If, on the other hand, they are sensitively sited on degraded land and managed by local communities, the opposite will hold true. If the timber is used to make high-quality furniture with a long shelf life, then the carbon produced by the plantations will be locked up for an appreciable period of time. If, on the other hand, they produce wood that is pulped to make paper, much of which will be burnt or quickly discarded, they will fail to serve their true purpose of carbon sequestration.[33] However, what seems to work on paper may well not work in practice. Research conducted by CIFOR has found that many local people involved in carbon sequestration projects simply do not understand how the deals they sign up to will work. Furthermore, some of the American investment companies involved in carbon deals have no forestry experience and little understanding of the complexities of land tenure, or the importance of forests and land for local livelihoods.[34]

Critics of carbon-sequestration deals fear that sequestering carbon in one area—by, for example, planting forests—could lead to pressure on forests elsewhere, thus neutralising the benefits of the scheme. They also suggest that carbon-sequestering plantation projects will have a very short-term impact on carbon budgets.

CIFOR, WWF, IUCN and Forest Trends have consistently maintained that whatever arrangements are made under the CDM, local communities should always be consulted when plantation projects are being considered. Ideally, they should be involved in their management and they should derive a range of benefits from the new plantations. For example, plantations could provide animal fodder, firewood and timber for building. However, if this is to happen, their nature and species composition will be very different from conventional fast-wood plantations.

Even those who champion the planting of trees as a way of tackling global warming concede that most of the cuts—90 per cent or more—will have to come from introducing cleaner fuels and improving energy efficiency. One estimate suggests that if 100 million hectares of additional plantations were to be established—this is the likely maximum over the next 50 years—the annual carbon fix would amount to 0.4 GT, or approximately 2 per cent of the annual carbon loading into the atmosphere.[35] This suggests that the planting of industrial fast-wood plantations will do little to counter the problem of global warming.

Farmer living in the neighborhood of a large-scale *Acacia mangium* plantation in South Sumatra, Indonesia

Chapter 3

Social Issues

Establishing large blocks of fast-growing trees has an impact not just on the landscape and the environment, but on local communities too. Critics of fast-wood forestry, and indeed tropical plantations in general, highlight the social conflicts sparked off by new plantations. They also contest the claim that plantations provide significant numbers of jobs. In this chapter we evaluate fast-wood forestry from a social perspective. In some situations plantations may prove a boon, both to the local economy and to those who work in the plantations and their associated industries. In others, the plantations and their associated industries may provide little in the way of jobs and social benefits and lead to severe conflicts between plantation owners and local communities. At times the army and the police have become involved in these disputes, and conflicts have occasionally led to the loss of lives.

Employment: A Contested Balance Sheet

In his critique of the plantations industry, *Ten Replies to Ten Lies*, Ricardo Carrere lists one of the lies as: 'Plantations generate employment.' He disputes this claim in the following terms: 'Large-scale plantations generate employment mainly during planting and harvesting. After the trees have been planted, employment opportunities fall dramatically. When the trees are ready to be harvested, workers are hired once again but, increasingly, these jobs are tending to disappear because of the growing mechanisation of this operation.' He goes on to say that the few jobs generated are usually of the unskilled, seasonal variety, with low salaries and labour conditions which are characterised by 'bad food, inadequate accommodation and non-compliance with current labour legislation.' The picture, as described by Carrere, is unremittingly bleak.[36]

Statistics provided by the International Labour Organisation (ILO) make no distinction between employment provided by fast-growing plantations and employment related to the harvesting of natural forests, long-rotation plantations and small-scale, farm-based forestry. Likewise, national statistics and industry statistics also tend to be presented in an aggregated format. This means that it is difficult, if

not impossible, to provide an accurate analysis of the local and regional impact which fast-wood plantations and their associated industries have on employment. What can be said is that longer-rotation plantations and wood industries that produce primary products like sawn wood and boards, and secondary ones like furniture and doors, make a significant contribution in terms of providing jobs. Fast-wood plantations and their associated industries—pulp and paper manufacturers, for example—are less significant in this respect. This holds true whatever the mode of calculation: jobs per hectare or jobs per million dollars invested. However, it is worth pointing out that Carrere's contention that much of the employment provided by large-scale plantations is seasonal does not apply everywhere: planting activities occur throughout much of the year in certain regions. Large plantation companies now find it much easier to conduct their planting, maintenance and harvesting activities on a continuous, year-round schedule, with less seasonal variation in manpower. They increasingly rely on contractors for the same reasons.

A brief glance at the figures provided by corporations involved in fast-wood forestry gives some idea of the contribution that fast-wood plantations and their associated industries make to local employment. Take the multinational company MONDI, which has a total of 407,000 hectares of plantations in South Africa, including fast-wood plantations and longer-rotation softwood plantations. According to data on its website, the company has 4,500 employees. This means MONDI generates just 1.1 job for every 100 hectares of plantation.[37]

Another major player, Aracruz Cellulose, owns over 180,000 hectares of fast-wood plantations in the Brazilian states of Espirito Santo and Bahia. According to the company, it employed 4,831 people at the end of 2001. Of these, less than 1,800 were employed directly by the company; the rest were outsourced. This means that the company created 2.7 jobs per 100 hectares of plantation, if outsourced jobs are included, or one job per 100 hectares if they are not. Aracruz Cellulose claims that its workers are relatively well paid and receive many social benefits. It also claims that its activities have generated 50,000 indirect jobs. However, the company provides no explanation of how it calculated this figure.[38]

Whether or not fast-wood plantations increase employment and benefit local livelihoods depends on the activities they replace and the way in which the wood is processed. If plantations are established on fertile agricultural land, the chances are that the number of jobs created will be considerably less than the number previously supported by farming, especially in developing countries. The replacement of small-scale farms on fertile lands by fast-wood plantations has been the exception, rather than the rule, but it has happened. For example, small farmers in some parts of Chile sold out to plantation companies. When they did so, many small businesses collapsed and rural towns went into decline.

However, if plantations are established on land that has either been abandoned or has previously been of little use to farmers or others, then they may bring new jobs into an area. This is precisely what happened in the People's Republic of Congo following the creation, in 1978, of L'Unite d'Afforestation Industrielle du Congo (now ECO S.A.). The organization was set up to exploit the poor savanna land in the region of Kouilou by establishing fast-growing eucalypts for pulpwood production. Besides making an important contribution to the country's balance of payments—a large part of the production is exported—this 45,000-hectare project has helped to create direct employment for some 1,400 people, equivalent to approximately 3 jobs per 100 hectares.[39]

Fast-wood plantations produce more than fibre and charcoal. In several parts of the world fast-wood plantations produce sawn timber from *Gmelina arborea*, *Paraserianthes falcataria* and other high-yielding species. With the recent progress in genetics and timber technology, fast-growing eucalypts and acacias are also being grown for their solid timber, and a new generation of eucalypt fast-wood plantations, dedicated to this purpose, is emerging, especially in South America. Increasingly, fast-wood plantations are being established to supply labour-intensive industries that manufacture furniture, flooring and joinery with knot-free lumber and veneer. As a general rule, plantations grown for higher value sawn logs have a much better chance of generating local jobs than plantations grown for low-value pulp.

All of this goes to show that when it comes to fast-wood plantations and employment, what holds true for one area, and one type of plantation, may not for another. Some plantations generate employment; others take jobs away. There are no global statistics that allow us to assess the overall impact of fast-wood plantations on the job market, but many governments have supported plantation development in the belief that plantations generate employment in rural areas.

Land Tenure and Conflict

Land means different things to different people. Modern societies, and their political and financial elites, tend to view land as something that can be owned, inherited, leased, bought and sold. Such a view will almost always be espoused by companies seeking to establish large-scale plantations. If they are to invest heavily in planting schemes, they need to be certain that they have sole rights to the land. However, to a community of hunter-gathers the very concept of land ownership—of land as a commodity—may be meaningless. Furthermore, shifting cultivators, nomadic pastoralists and settled farmers may all have different attitudes towards the use of the land and the issue of land tenure. Their understanding of land tenure often involves reciprocal-use rights,

rather than outright ownership. Attitudes, too, may vary from one part of the world to another.

In many countries, rural land was originally vested in communities that allocated portions to individual community members, and specified how communal areas could be used. On the death of an individual, his or her land reverted to the communal land pool and was then reallocated. However, governments have often disrupted these systems of communal ownership by appropriating land on behalf of the state. Forest dwellers often argue that governments have seized their land illegally, and indeed certain international laws recognise indigenous peoples' rights over their historical territories. Governments which have 'appropriated' forest lands frequently give or sell them to third parties—for example, to plantation companies—and this often leads to serious conflicts with local communities.

Many wood-based industries—logging companies, plantation companies, agro-industrial crop producers—have sought to gain control over land by actively exploiting it. This often involves destroying the forests or establishing plantations—and frequently both.[40] For example, during the late 1980s and early '90s, several Indonesian pulp and paper companies established fast-wood plantations on land that local communities considered to be theirs. The companies believed, rightly, that their close political ties to the Suharto regime would protect them if and when previous land users challenged their activities.

In 1997-8, over 11 million hectares of forest and land were affected by fire in Indonesia. Almost 1 million hectares consisted of forest plantations.[41] An investigation into the cause of these fires revealed that conflicts over land tenure were a significant factor, at least in Sumatra. Where land had been appropriated for acacia pulpwood plantations, oil palm and other agro-industrial crops, aggrieved communities and individuals often used arson as a means of fighting back.[42]

It is certainly true that some industrial plantation projects have caused considerable hardship for rural communities, especially where investors have taken advantage—often with government support—of their lack of political power. They have been deprived of land, and a means of garnering food and earning a living. Sometimes they have been forced to migrate to the cities. However, these problems often relate to poor governance, and apply to every sphere of economic development, from mining to agro-industry, manufacturing to forestry. Indeed, when plantations cause serious social problems, it is often poor governance that is to blame. In situations where good governance prevails, plantations, when well conceived and managed, can provide new opportunities for the rural poor.

Once again, we must avoid generalisations. As the Intergovernmental Panel on Climate Change points out in its analysis of land use, land-use change and forestry: "In the tropics, afforestation [can] enhance or impoverish local agriculture and increase or decrease employment and wealth, depending on specific circumstances."[43]

Chapter 4

Economic Issues

Just because an industrial plantation scheme makes good economic sense to a company, it does not necessarily mean that it makes good economic sense to the nation, the taxpayer or the local community. Clearly, if a privately owned company establishes a plantation, it does so with either a profit in mind, or to secure access to a resource that it can use in a manufacturing process, such as pulpwood for paper. As far as the company is concerned, the economic benefits must outweigh the costs. Sometimes the benefits may be more widely shared: exports may contribute to the balance of payments, taxes may flow to the national treasury, and plantations may generate jobs and prosperity. Indeed, the governments of several countries—most notably China, Japan and South Korea—have invested in medium- and long-rotation plantations precisely because they see them as a means of creating jobs and stimulating rural development.

However, plantations may also result in economic losses. Most industrial plantations have been established with financial support from the state. This often means that public taxes are used to subsidise privately owned ventures. If subsidised plantations fail to yield tangible public benefits, then taxpayers may feel they have been short-changed. The economic costs of development may also be borne locally, rather than nationally. For example, villagers may be deprived of agricultural land, and thus experience a decline in income, or a plantation might lead to hydrological changes which adversely affect downstream crop yields.

In this chapter we scrutinise the economic balance sheet for fast-wood plantations. But first, let us take a brief look at the economic imperatives that are driving the expansion of fast-wood forestry in the developing world.

Spiralling Demand

Several factors favour further increases in the area devoted to fast-wood plantations. First, there is rising demand. This is a function of two things: population growth on the one hand, and an increase in the per capita consumption of wood and wood-based products on the other. At present, the world population is some 6.2 billion. According to the International Programs Center of the US Bureau of the Census, it will reach 9.4 billion by the year 2050. Even if per capita consumption were to remain stable, demand for wood-based products would rise significantly.

However, per capita consumption of wood and wood-based products has increased dramatically, particularly in urban areas, over the past century, and will continue to do so. Since 1913, world paper consumption has increased 17-fold, while the population has increased by a factor of 4. According to FAO, world paper consumption will reach 443 million tonnes by 2010—an 80 per cent increase since 1990. It is especially significant, in the context of the fast-wood debate, that the increase in demand for pulpwood, used in the manufacture of wood-based panels and paper, has far exceeded the increase in demand for sawn logs. The ratio of sawn logs to pulpwood was 4:1 in the 1940s; today it is little more than 2:1. Consumption trends therefore favour a rapid increase in demand for wood produced by fast-wood plantations.[44]

The various technological changes experienced by the pulp and paper industry over the past two decades have been largely driven by the low cost of short-fibre wood from eucalypt and acacia plantations. Mill engineers were able to adapt their manufacturing process to suit this new raw material, which was significantly cheaper than wood from non-fast-wood sources. Subsequently they realised that other benefits—greater homogeneity and improved pulp opacity and moisture absorption, to name just some—were associated with fast-wood fibre. At the same time, and for the same reasons, developments in the manufacture of medium density fibreboard (MDF) enabled the industry to shift from using solid timber and plywood, both of which require high quality raw materials, to lower quality, short-rotation tree crops.[45]

Incentives and subsidies

During the 1990s, there was a significant increase in the rate at which new plantations were established. This increase could be attributed, in part, to the private sector's growing enthusiasm for industrial plantations, and its willingness to invest in them. Export credit agencies, the World Bank, regional development banks and development agencies such as the Japan International Corporation Agency (JICA) also played a prominent role in encouraging plantation development. In the case of Uruguay, for example, it was a combination of JICA/World Bank financial assistance that sparked off the plantation boom.

Governments, too, have played an important role in many countries, not least by providing private sector plantation companies with a range of incentives. These come in various guises and include afforestation grants, investment in transport and roads, energy subsidies, preferential tax treatment for forestry investments and tariffs that discriminate against imports.

When financial returns from plantations are lower than those from other land uses, private landowners are unlikely to plant trees. Incentives such as afforestation grants may tip the balance in favour of plantations. They can certainly help to reduce cash-flow problems

during the long period between planting and harvesting. But are they a good idea from the point of view of society and the taxpayer?

There are various reasons why governments intervene in the forestry sector. Incentives which make plantations a viable economic proposition, where otherwise they would not be, are often justified by invoking the benefits they yield to society. For example, plantations may be considered important in terms of carbon storage and soil protection. They may also, in the view of governments, have a role to play in stimulating and diversifying rural development and creating jobs. Incentives have often been used to establish a critical mass of plantations in countries that are seeking to establish a competitive forestry industry. They have also been used to encourage import substitution and create an export trade.[46]

Subsidies to the forestry industry in the developed world have far exceeded those provided by developing country governments. At present the average subsidy for plantation schemes in eleven EU countries is $1,421 per hectare, with an additional $761 per hectare for maintenance. This compares with subsidies of less than $400 per hectare for most plantation schemes in South America. However, most developing countries with significant plantation interests have used, or continue to use, incentives and subsidies as a means of encouraging the industry. For example, between 1974 and 1994, the Chilean government spent some $50 million on afforestation grants. In Brazil, subsidies and taxation incentives were used to encourage the establishment of plantations, and in recent years Ecuador and Colombia have adopted a similar incentives model to Chile. Ecuador currently provides planting and maintenance incentives amounting to $300 per hectare. Paraguay provides $350 per hectare for planting and $100 per hectare for maintenance for the first three years.[47]

The extent to which incentives and subsidies have fulfilled their purpose is hotly debated. Take, for example, the experience in Chile. During the 20-year period of the afforestation subsidy, the plantation rate was almost 80,000 hectares a year, compared to just over 11,000 hectares a year during the previous 35 years. This would seem to suggest that subsidies had a dramatic impact on planting rates, and indeed many observers believe that the Chilean subsidies helped to create a critical mass of plantations. The plantations attracted processing companies, which in turn created new markets for plantation products. Without subsidies, Chile might never have developed a thriving plantation sector.[48] However, this view is contested by a World Bank study which claims that the plantations would have been profitable without the subsidies; subsidies, according to this study, were unnecessary.[49]

The Chilean story of plantation development is complex. Rapid expansion initially occurred during the dictatorship of General Pinochet, when local opposition to plantations was brutally repressed. Plantation companies benefited from the support provided by the regime. Plantation companies continue to prosper in Chile, though for different reasons today. Chile now has a relatively efficient, democratic

government, largely untainted by corruption, and the macro-economic conditions that prevail appeal to private investors. Under these circumstances, subsidies may well help to create a viable fast-wood sector—if that is what governments (and taxpayers) actually want.

However, where such conditions are absent, plantation incentive schemes often channel large amounts of money to relatively few people and cause considerable environmental damage and social hardship. In Costa Rica, incentives were so generous that they enabled plantation companies to buy up natural forests, harvest the trees, convert the land to plantations and then take advantage of a tax relief scheme. Subsidies led to a greater concentration of land ownership and an increase in deforestation. On the other side of the world, programmes either sponsored or encouraged by the Indonesian government have accounted for over two-thirds of the country's deforestation in recent decades, according to the World Bank.[50]

There are many compelling arguments against the use of subsidies. They create distortions within the economy, both internationally and locally. Companies that do not receive subsidies find themselves at a competitive disadvantage to those that do. Subsidies may also have a profound effect on the allocation of land, making plantations economically viable when under free market conditions other uses—farming, conservation and sustainable management of natural forest, for example—would make more sense. By making the raw material for the pulp and paper industry cheaper than it would be otherwise, subsidies may well be encouraging an increase in consumption of pulp and paper products. In countries where revenues are raised through direct taxation, taxpayers may be subsidising private companies whose activities yield little in the way of public benefits. Most environmentalists would concur with an IUCN/WWF submission to the World Bank which argued that most of the grants and subsidies for industrial-scale plantation forestry have exerted a negative influence on biodiversity. "Large amounts of money that could have been better invested, either within or outwith the forest sector, have gone to support ill-conceived planting schemes," stated their report.[51]

Governments that provide plantation subsidies will contest this by maintaining, among other things, that the private wealth creation stimulated by subsidies leads to broader public goods. They may also argue that if plantation projects are successful, they will recoup the subsidies in the form of taxes at a later date. Furthermore, they can justly point out that the social and environmental benefits of plantation development are often difficult to quantify in financial terms.

None of this is likely to impress environmentalists (or, for that matter, neo-liberal economists) who generally argue that most subsidies to the plantation industry are 'perverse': they are bad both for the economy and for the environment. And it is certainly true that other factors may be just as significant as state aid—or development assistance—when it comes to promoting plantation forestry. The plantations sector is most likely to prosper in those countries where there is political and macro-economic stability; where there are open markets; where property rights are clearly established; and where

the government has the ability to enforce the law.[52] The industry also fares best in countries where there are good natural growing conditions and where companies have access to modern technology.

Economies of Scale

The pulp and paper industry provides a graphic illustration of economies of scale in action. The two largest mills in Indonesia, for example, represent a combined investment of around $5 billion and employ over 20,000 workers. Their plantations currently occupy around 350,000 hectares of land. When establishing a pulp and paper mill, it makes sense to think big, and pulp and paper companies nearly always expand their existing mills, rather than build new ones. The investment required per tonne of processed wood decreases with an increase in capacity, up to a certain level. Obviously, the larger the mill, the greater the amount of raw material required. This is why pulp mills are often served by large-scale plantations. To keep the two 2-million tonne mills in Riau province of Sumatra (Indah Kiat and Riau Andalan Pulp and Paper Corporation) in constant production will require over 700,000 hectares of fast-wood plantations once the company's access to natural forests runs out midway through this decade.[53]

Many pulp mills are finding it increasingly difficult to gain access to land where they can establish plantations, and they are also finding it harder to source wood from natural forests. At the same time, many feel under some obligation to provide local communities with new opportunities to improve their livelihoods; in doing so, they hope to demonstrate that they are good neighbours. As a result, many companies are entering into contracts to grow wood with local communities and small farmers. Of course, it may well be cheaper and less risky, both politically and economically, to plant trees on other people's land. Outgrower or joint-venture schemes, as they are known, have become a popular alternative to developing large-scale plantations in some countries.

The most recent analyses of outgrower schemes were conducted by FAO and the International Institute for Environment and Development (IIED). The former looked at 17 outgrower schemes in 11 countries;[54] the latter examined in detail a range of agreements in six countries, supplemented by a set of shorter examples taken from 17 other countries[55]. These studies covered a wide range of agreements. Those of particular relevance for fast-wood plantations included outgrower schemes on community land, as well as on private farmland; agreements on land leased from farmers; and joint ventures with communities registering as companies.

One popular form of outgrower scheme involves plantation companies providing local people with all the planting materials they need and the inputs required to maintain the plantations. At the time of harvest, the company buys the wood. Schemes operated by growers' unions or co-operatives, such as those studied by IIED in South Africa, have proved to be a viable alternative to the more common company-driven schemes.

In India company/ smallholder relationships have rapidly evolved, with wood being traded on the open market, and companies competing to meet their wood requirements. Outgrower schemes have benefited from a government policy that limits the area of land that can be held by a private owner. This has forced processing companies to buy most of their supplies from smallholders, and small-scale tree growing is increasingly seen as a viable land use. Companies must rely on farmers for their wood procurement as they themselves have limited access to land. The farmers have demonstrated their entrepreneurial capacity to produce wood products when the policy environment is favourable and appropriate incentives are in place. Farmers rely on companies to provide services such as research and development; in short, they benefit from the economies of scale enjoyed by the large companies which they supply with feedstock. There is a strong demand from participating farmers for improved planting stock, and several companies have understood that the best, and often the only, thing they have to do to support smallholders is to focus on tree improvement work and the commercial production, in local nurseries, of high-yielding clonal seedlings.

What all these schemes have in common is their capacity to provide the raw material, most commonly wood fibre, which would otherwise be unavailable, while still allowing the industry to achieve economies of scale in situations where land is scarce. Local involvement may mean there is less likelihood of conflict, a common problem for many plantation owners. As for local communities and landholders, they benefit in a variety of ways. Plantations provide employment and an income for some, and profits, as well as a way to spread risks between agricultural and timber crops, for others. From an environmental point of view, a large numbers of small wood lots may be preferable to a few vast blocks of fast-wood plantations.

Inevitably, outgrower schemes have had their teething problems. One of these stems from the fact that there is a long period—up to 10 years—between planting and harvesting, during which local communities and outgrowers receive no income from the planted land. In countries like India and South Africa, where there is a long history of company/ community forestry partnerships, companies have solved this problem by providing credit. This helps growers meet their immediate basic needs.

In some situations, both parties may become disenchanted with their relationship. Companies that purchase the entire output of wood from an outgrowers' scheme sometimes take advantage of their monopoly by driving down prices. Inevitably, farmers resent this. In places where several companies are competing for the same wood supply, some farmers may get credit and technical assistance from one, and then break their agreement to sell to another. Inevitably, companies resent this.[56]

Overcoming problems such as these requires good communication and a long-term commitment to make the relationship work. Experience so far suggests that outgrower schemes have considerable

potential, and can help to address some of the environmental and social problems that currently beset large-scale projects.

It is quite clear that many people resent fast-wood plantations partly because they disapprove of large corporations, especially those with multinational interests. These corporations are often perceived as being remote, authoritarian, undemocratic and exploitative. It could be argued that this is more of a value judgement than a rational analysis. Indeed, a recent study by the One World Trust found that multinational companies were more accountable, in terms of access to and disclosure of information, than most of the non-governmental organisations whose practices were investigated.[57] Clearly, some corporations behave honourably towards their employees and local communities; others don't. Some do their best to minimise the impact of their operations on the environment; others don't. Some manage their operations in a very transparent way; others don't. Whatever the situation, outgrowers schemes might well help to improve the reputation of large forestry corporations among those antipathetic to the fast-wood industry. That is one of several reasons why we will see more of them in the future.

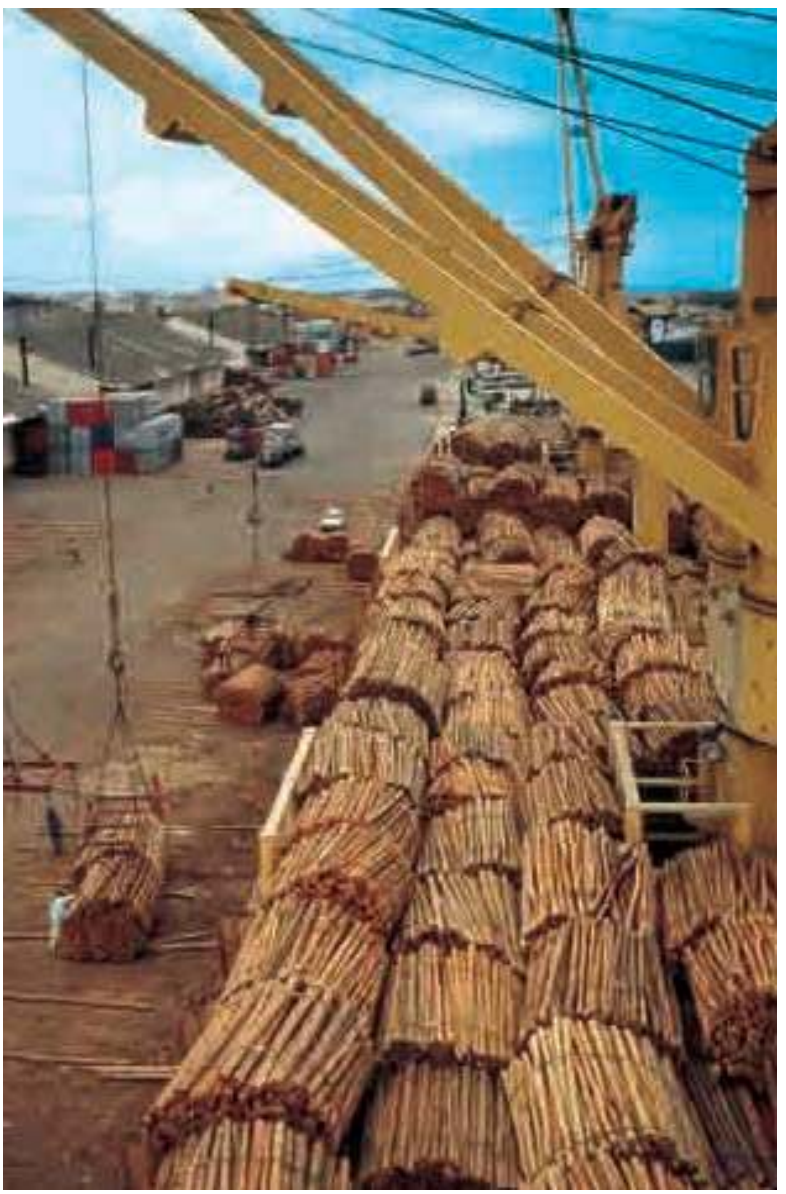
Costing the Earth

The majority of fast-wood plantations are owned or leased by private companies whose investment policies are dictated by a desire to make a profit, if not from the timber itself, then from fibreboard, paper and other derivatives. Planting large blocks of trees may make good commercial sense. But it does not necessarily follow that it makes good environmental or social sense; or that it makes good economic sense when these and other factors, such as subsidies and incentives, are taken into consideration. It is not hard to find examples of plantations which made money for their owners, but which made no economic sense when viewed from the perspective of the rest of the population. Of course, the same could be said for many other economic activities too.

Politicians, financial analysts, the plantation industry and plantation experts are now much more aware of the social and environmental impacts of their recommendations and decisions than they were ten years ago. CIFOR and other institutions have developed and promoted a system of Criteria and Indicators (C&I) which encourages plantation managers to adopt best practices when planning and managing forestry plantations. Nowadays, many projects undertake environmental and social impact audits at an early stage of development, although critics are right to point out that these are often perfunctory. At the same time, a growing number of buyers are insisting that their fast-wood products come from forests that are certified as well managed.

Many people believe that we need to establish a new means of appraising development projects, one which takes into account not just their immediate costs and benefits, but the economic losses and gains which flow from their impact on nature and people. In an ideal

world we would have a formula into which we could feed a mass of data when evaluating a plantation project: projections of jobs to be created; impact on wildlife; impact on hydrology and adjacent farmland; contribution to the national exchequer; benefits in terms of carbon sequestration and so forth. This would help us to come up with an answer that would tell us whether or not the plantation project should go ahead. But the world does not work like this, and the best we can do at present is to foster an open and well-informed debate that involves everyone, from scientists to local communities, plantation companies to civil servants, in a democratic decision-making process.



Bundles of eucalypt logs bound for a European pulp mill, Pointe-Noire harbour, Congo

Chapter 5

Conclusions

For many of those who believe that fast-wood forestry is an environmental and social menace, the solution lies in us consuming less and recycling more. If we reduced our consumption of paper and pulpwood products, goes the argument, then less land would be planted with short-rotation tree crops. However, unless there is a dramatic change in the way we behave, the area devoted to new fast-wood plantations will continue to increase.

This booklet has attempted to sort fact from fiction, truth from misinformation, as far as fast-wood forestry is concerned. Environmentalists have sometimes exaggerated the malign impact of fast-wood plantations, but there is no doubt that fast-wood plantations have caused environmental and social problems in some situations. Supporters of the industry often underestimate the damage done by fast-wood forestry, but this is not to say that fast-wood forestry is a bad thing. The truth is that in some situations fast-wood forestry is undesirable; in other situations, it can yield benefits not just for the economy, but for the environment and local communities.

Growing fast wood can be a very efficient way of producing timber and pulpwood, and fast-wood plantations can be a profitable investment, both for the companies involved and for society as a whole. Environmentalists dislike all large-scale monocultures, but they are especially critical of pulp mills, and the plantations that supply them. It is less easy to rail against plantations that supply sawn logs, not least because the world needs sawn logs and no other material—metal, concrete, plastic—is as environmentally friendly as wood. As it happens, a similar case can be made for paper, especially where recycling rates are high, and where mills depend for their raw material on woodchip residues from the sawn-wood industry, but plantation critics tend to ignore this. However, environmentalists are right to point out that there is considerable scope for a reduction in the consumption of paper and packaging, especially in the developed world. In principle, a reduction in consumption should lead to a reduction in the demand for fast-wood products.

We suggest that when economic assessments are made of future projects, greater emphasis should be given to the environmental and social costs of fast-wood forestry. If this were to happen, then the most damaging schemes would never get off the drawing board. We also suggest that the sooner subsidies to commercial plantations are

phased out, or at least dramatically reduced, the better. Subsidies create economic distortions and make plantations viable in situations where other land uses might make better economic and environmental sense.

A social audit of fast-wood forestry suggests that fast-wood plantations often bring far fewer benefits in terms of employment than is generally claimed by companies within the industry. This is not to say that in certain circumstances—for example, in remote, hitherto undeveloped regions—plantations cannot bring jobs, schools, roads and other benefits. Much the same, however, might be said of mineral development projects. There is certainly no denying that in many parts of the developing world fast-wood plantations have sparked off serious conflicts with local people, especially where they have deprived them of the land on which their livelihoods were based.

There are cases where fast-wood plantations have replaced habitats rich in biodiversity, although the claim made by some environmental groups that plantation companies deliberately target natural tropical forests is exaggerated. Some may, but many do not. Biodiversity is under threat from a whole range of activities, and there should be a general presumption against the conversion of species-rich tropical forests into any form of monoculture, including fast-wood plantations. Research currently underway on biodiversity corridors and plantation design should help to reduce the impact of fast-wood plantations on biodiversity.

In certain situations, plantations may help to enrich biodiversity. This is often the case when they are established on derelict or abandoned agricultural land. Many foresters claim that industrial plantations take pressure off natural forests and thus help to 'assist in redressing biodiversity losses in natural forests,' as the World Bank put it in its terms of reference for a study of plantations. This claim is highly tendentious. It may be true for a small number of countries—New Zealand and Sri Lanka are often cited—but there is little evidence to suggest that fast-wood plantations have taken pressure off natural forests elsewhere.

Foresters and environmentalists have often misinterpreted the role that trees play in regulating the flow of water through the environment. It is often claimed that forests—and plantations—can help to prevent major floods. They cannot. It is sometimes said that forests help to create and attract rainfall. With rare exceptions, they do not. Plantations frequently reduce annual water yields, especially when they replace grasslands and farmland, thus leaving less water available to other users, and large fast-wood plantations often reduce stream flow during the dry season. However, where there is abundant rainfall, the effect of fast-wood plantations on water yields may be insignificant.

The relationship between fast-wood plantations and the soil is extremely complex. Fast-wood plantations are more likely to experience higher rates of erosion and a greater decline in fertility than longer-

rotation plantations, but they are generally much less degrading to the soil than many agricultural crops. In some situations they can have a beneficial influence on the soil. Plantation soils are especially liable to erosion during harvesting and planting. Ground vegetation, with or without trees, is much more important than the canopy when it comes to reducing soil erosion.

In terms of nutrient cycling, fast-wood plantations behave like most agricultural crops, in that they remove minerals from the soil. These are transported off site when the trees are harvested. Leaving branches, twigs, leaves and other plant litter after each harvest will help to retain some nutrients, but fast-wood crops nearly always require applications of fertiliser if they are to prosper. There is nothing inherently wrong with this, and indeed fast-wood plantations remove relatively small quantities of nutrients when compared with most agricultural crops, and therefore require relatively modest doses of fertiliser. We now have a good understanding of the ways in which the burning of logging debris reduces soil fertility and increases erosion on sloping sites. In many places, this has led plantation managers to adopt more benign site-preparation practices.

The debate about the benefits of planting genetically modified trees, and the threats they may pose, will be long running and fractious. GMO technology potentially has much to offer. To cease all field trials, as some environmental groups urge, would be taking the precautionary principle too far. However, advocates of GMOs should acknowledge that real dangers attach to their development and use. This is one area where more research is urgently required.

It is sometimes claimed that fast-wood plantations are a pest disaster waiting to happen. In certain situations pests may cause massive damage, but the risk can be greatly reduced by choosing the right species for the right site, by careful management and by the adoption of intelligent pest-control strategies.

There is still considerable debate about the extent to which plantations can sequester and store atmospheric carbon. Even if one takes an optimistic view, establishing plantations to sequester carbon will be no simple matter. If plantations are to be enlisted in the battle against global warming—and even their champions concede that most cuts must come through more efficient energy use, and by reducing our reliance on fossil fuels—then they must be designed in a way that does not have an adverse impact on either the environment or local communities.

It is becoming increasingly clear that fast-wood forestry is set to become one of the most significant forms, if not the most significant form, of industrial forestry development over the coming decades, especially in the tropics and subtropics. Fast-wood forestry is neither inherently good nor inherently bad. It is a neutral technology which, when poorly planned and executed, can cause grave problems; and which, when well planned and executed, can deliver not just large quantities of wood, but a range of environment and social benefits.

We believe that it is essential that governments adopt a landscape approach to plantation development. Investment in plantations should not be considered, and permission for private companies to establish plantations should not be given, if it can be demonstrated that the plantations will prevent the delivery of a full range of forest goods and services at the landscape level. For example, if a plantation is likely to adversely disrupt the hydrological cycle or reduce water quality, then it should not be established. Likewise, plantations should not be established if they have an adverse effect on local communities; if, for example, they are likely to lead to a net loss of employment or to local communities being deprived of firewood, grazing land and other goods and services on which they depend. All these factors should be considered together, not independently, as there may be trade-offs that are acceptable. In any case, local communities, like other stakeholders, need to be involved at the earliest stage of planning and development. Finally, we must stress that there should be a presumption against any planting which would lead to the loss of primary forest, ecologically significant secondary forest or other important ecosystems.

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Fast-Wood Forestry—Myths and Realities provides a comprehensive analysis of the arguments for and against fast-wood plantations. It separates fact from fiction, science from speculation, truth from misinformation. Environmentalists have frequently exaggerated the malign impact of fast-wood plantations. At the same time plantation companies have underestimated the damage that fast-wood forestry has done, both to the environment and local communities. **Fast-Wood Forestry** explores in detail the impact of the industry on biodiversity, soil and water resources. It analyses the claims made by plantation companies that fast-wood forestry brings valuable social benefits jobs, infrastructure and wealth—to rural communities. And it assesses the merits—or otherwise—of the subsidies and incentives used by governments and international agencies to encourage the industry. **Fast-Wood Forestry** concludes with a series of recommendations that suggest how the industry could improve its environmental and social performance. Authoritative and comprehensive, lively in style and jargon-free, **Fast-Wood Forestry** will appeal to everyone with an interest in development issues, from environmentalists to plantation advocates, academics to non-governmental organizations, political decision-makers to resource use planners.

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Christian Cossalter and Charlie Pye-Smith