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Paper Cycle

Sub-Study Series

5 Paper Farming: The Role of Plantations in the Sustainable Paper Cycle

Stephen Bass, Ruth Nussbaum, Hugh Speechly, Elaine Morrison

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PAPER FARMING: THE ROLE OF PLANTATIONS IN THE SUSTAINABLE PAPER CYCLE

Stephen Bass, Ruth Nussbaum, Hugh Speechly and Elaine Morrison

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EXECUTIVE SUMMARY

The production of wood fibre for pulp has become contentious, whether it takes place in forests that are perceived as natural, or in plantations. The issues are complex, and highly dependent upon circumstance. Yet the transfer of analyses from some circumstances to others is misleading the debate about how to achieve greater sustainability in the paper cycle.

Plantations are increasingly significant as a source of pulp, and now contribute over 30% of global supplies. Their environmental and social impacts have been the subject of much strongly-held opinion, but rather less rigorous analysis. This study was therefore commissioned to examine the contributions of plantations to the sustainable paper cycle. Its particular emphasis is on obtaining facts from the field - principally from the major corporations which are responsible for so much of the plantation production. A special survey of corporate practice was conducted, covering most parts of the world. A regional review was made of issues, practices and government and public responses. This report is therefore a complement to the Sustainable Paper Cycle Report on smaller-scale, social forestry approaches.

To deal with the complexity of the plantations debate, the paper uses three typologies:

•The *definition of specific forest production systems* through key dimensions, rather than through often misleading general labels such as "natural forests", "plantations" and "monocultures". These dimensions are: external inputs intensity; biodiversity; structural diversity; use diversity; and user/rights diversity. This reflects the fact that there is a continuum of forest types, rather than a few uniform categories. It also reflects the fact that, through applying plantation silviculture and other management techniques, some natural forests have become like plantations in their structure and composition.

•The *definition of sustainability* in forest production systems by three key constituent objectives: maintaining sustained yields of goods and services including ecological processes, maintaining biodiversity, and optimising socio-economic impacts. Between them, these are consistent with the broad objectives of sustainable development, and cover more than the narrow "timber-and-ecology" definitions prevalent in the forest industry.

•The *distinction between key levels* at which the costs and benefits of forest production are experienced, and on which management objectives should be focused. These levels are: the individual forest stand; the total forest enterprise; the landscape; the province/district; the nation; and the globe. Sometimes it may be more appropriate to focus on the forest stand e.g. where multiple benefits need to be sought from the forest; at other times on the whole landscape, if zonation is possible.

It follows that there is no universal policy or technical guideline for *all* forms of forest which contribute fibre for paper production. The challenge is to seek sustainability, at specific levels, and this will mean evolving specific types of forest production system.

There is a simple explanation for the growing proportion of wood fibre coming from plantations. Huge quantities of pulp are in demand. 430 million m3 of pulpwood are harvested every year, and there is an imperative for this to be produced at the lowest possible cost. Plantations have several advantages for large-scale producers:

- the producer can use selected or improved genetic material which makes optimum use of land and growing conditions

- plantations can better produce large, regular supplies of uniform material than that can natural forests, and this suits the technology and demands of pulp mills

- plantations enable the use of labour-saving machinery, and efficient procedures and land configurations

- plantations are more flexible in their siting, thereby potentially being more efficient in transport use.

Furthermore, while until recently large areas of natural forest were available under policy and price conditions that encouraged their liquidation to pulp, these circumstances are comparatively rare today. Consequently, confined to given areas of land, the established producers of fibre require production systems which they can control best. With present forest management knowledge, the degree of production control which can be exercised over plantations is almost invariably greater than for natural forests. The exceptions are for some natural forests which are amenable to intensive management. They often behave similarly to plantations, or can be manipulated to become like, them.

The many productivity advantages of plantations have led to a variety of large-scale, intensive, simple forest systems that dominate the landscape. Certain large plantations have created negative impacts:

- loss of biodiversity
- soil erosion
- excessive water consumption
- loss of access by local people to forests and forest products
- loss of local control of land
- displacements of rural communities
- aesthetic uniformity

There is now strong concern about these environmental and social impacts. Just as industrial agriculture led to unprecedented levels of cheap food becoming available by the 1960s, and public worries turned away from food shortages and high food prices towards the environmental and social externalities of large-scale agriculture, so too the ethos of plantation forestry is now within an environmental era. This era is, however, populated by a wide range of demands and perceptions:

- *The public* is strongly concerned about plantations' apparent structural, aesthetic and biological uniformity ("monoculture"), the apparent dominance of corporate control, and loss of local access and control over land use. They seek social and environmental values which are becoming rarer in the landscape as a whole, and increasingly make demands that plantations should offer these values. Certification is being seen as a way of verifying that such values are being secured at the same time as wood production.

- *Plantation owners*, conversely, are concerned about public attitudes to plantations, as expressed through advocacy, political and planning systems and, increasingly, through the market. They are concerned with their own economic and financial sustainability, and with any social and environmental factors that may threaten this. They seek secure tenure of land, high productivity of trees and forest inputs, maintenance of site fertility, means to build resilience to adapt to the many changes taking place, means

such as environmental management systems to set and monitor targets, and good public relations.

- *Governments* tend to seek sustainability values for the forest estate as a whole. In the last five years, various national and intergovernmental attempts have been made to bring together the different sustainability demands being made of forests into sets of principles, criteria and standards, some of which are directed exclusively at plantations. There has been a growing emphasis on setting aside a Permanent Forest Estate (PFE) for protection and production purposes, the latter in particular including plantations. Some governments emphasise zoning in the PFE, with plantations being primarily responsible for production, and natural forests set aside for conservation e.g. New Zealand and Ecuador. Others have stressed the need for multiple objectives in almost all forests e.g. Sweden.

Findings on current corporate practice:

As this paper shows, major advances have been made in recent years in making the transition to sustainability. The general literature, reviewed in 1994 for the Sustainable Paper Cycle Project and updated in Appendix 1 of this report, still focuses very much on particular dimensions. It provides a catalogue of social and environmental failures. But it does not reveal advances that have recently been made to address these failures.

This study surveyed eighteen of the largest pulp producers in North and South America, Scandinavia, Southern Europe, Asia, South Africa, and New Zealand, using a detailed questionnaire based on the above typologies. Responses show that producers are reacting - generally positively - to three main trends. *Firstly*, the need to increase production efficiency and save costs (some such measures have also generated sustainability benefits). *Secondly*, growing concerns for environmental sustainability promoted by environmental pressure groups, and (as significantly) market demands for "green" wood and paper - demands which can often be traced directly to environmental groups' campaigns. *Thirdly*, the governmental and intergovernmental guidelines and codes of practice for plantations, which are sometimes perceived by plantation owners to be precursors of new legislation. In this governmental arena, corporations have generally been reactive, but have also been seeking ways to influence the debate.

Some main findings from our survey of corporate practice include:

External inputs intensity:

a Technical and economic reasons remain the most important criteria for plantation species selection, not environmental/multi-use reasons

b Mechanisation is increasing, but is becoming lower in environmental impact

c Fertilizer applications are routine, except in boreal regions. However, applications are much lower than for agriculture: over a tree rotation, they are about the same as for a commercial agricultural crop in a one-year cycle. Most companies have guidelines to match fertilizer needs with plant uptake and soil status

d Pesticide and herbicide use is, in general, low, not routine and decreasing. However, few intend to stop chemical use entirely.

Soil and water management:

e Most companies practice soil conservation measures, but few practice routine soil erosion or nutrient loss monitoring

f Half the companies have water management policies, focusing on water availability; but fewer than 10% monitor water quality e.g. chemical pollutants

Biodiversity:

g Although two-thirds of companies use clones, most currently make only limited (trial) use of them. But some are heavily dependent (up to 10,000 ha under a single clone). However, all clone users have clone replacement policies to avoid disease and other risks - mostly every 2 to 5 years

h Genetic engineering is not yet an issue, but may be contentious in the future

i The species range is still low. 25% of companies use only one species; and 40% only two species.

j Exotic species are planted exclusively in single-species blocks, but indigenous species are often mixed. All companies managing exotic plantations maintain areas of indigenous vegetation (2 to 27%) within the plantation matrix.

k All but one company have active programmes to protect and increase biodiversity - involving buffer zones, revised forest management and harvesting practices. 70% of companies maintain wildlife corridor strips. 70% also have programmes to minimise the spread of exotic species e.g. as weeds. However, as yet, no comprehensive costings for all such measures are available.

l Less than 1% of forests covered by the survey were old-growth prior to the current rotation. Plantations have frequently been planted on grassland and on land declared to be "degraded".

Use and user diversity; and stakeholder relations:

m About a quarter of the companies also produce fuelwood, meat, fish, oils and/or honey on a commercial basis from their plantations. A much larger percentage support subsistence or non-commercial use of forests for non-timber purposes (up to 80% for fishing and recreation).

n All companies report that they have agreements with local people regarding access to plantations or use of products. In addition, many provide local communities with facilities for education, health, and roads and transport.

o About 60% of companies either run an outgrower scheme or provide extension services to private landowners who grow trees.

p External pressures on companies have been greater from environmental groups than from consumers: 80% of companies have received local criticisms of their activities, and 60% from national groups - but very few customers have complained about operations. Most complaints concern biodiversity.

q Companies produce an increasing amount of publicity material, much of it extolling

their environmental virtues (an average $500,000 PR budget for each corporation). Some are conducting internal audits, and also publishing independent environmental audits (e.g. in Scandinavia) while others are pursuing verification through certification

Professional roles and planning approaches:

r Many plantation companies are hiring ecologists and sociologists; these people are playing an increasing role in structuring plans and operations. The new planning approaches include highly site-adapted planning and multi-species plantation systems at the site level; and ecological landscape planning on larger scales to ensure plantations link positively with, rather than impact negatively upon, surrounding ecology, and also nurture local ecological processes.

s Greater authority is being delegated to site-level workers, to ensure local environmental and social complexities are properly dealt with.

In summary, the major contribution of a number of corporations (and some state enterprises) is in the important task of *making practical trade-offs between different needs.* This emphasis on the practical and the possible - provided it is undertaken with wide participation of concerned actors, at pilot scales initially, and with good monitoring and learning - is preferable to theoretical lists of desiderata. There are many examples of this, from Brazil to South Africa to Sweden.

The overall trend is a reduction of forest management based on high levels of external inputs within rigid, simple structures; this is being replaced by more information-intensive management, based on more complex systems that allow the pursuit of more diverse plantation objectives than in the past.

Most attention has been paid to the *stand and enterprise levels* (perhaps because these are under the direct control of the plantation operator). Here, multi-purpose approaches dominate the advances. Some advances have been made at the *landscape level.* These do include some multi-purpose approaches, but tend to concentrate on zoning and making the most of the possibilities of site differences and neighbouring land uses. However, these have occurred more usually in landscapes with fewer interactions of owners and land use types, where there is less contention over land use, and where one owner (that of the plantation) covers a large area.

Areas for improvement:

More progress is needed on the practical processes, skills and internal incentives required to make the necessary transitions. The forest enterprise needs to be able to make a practical start by defining one or two key areas of improvement, monitoring them and "closing the loop". A lot is then learned whilst improvements are being made under local conditions; with a management system approach, this learning can be put to use in later stages. Key needs are, therefore:

- *Setting up enterprise management systems* to define key targets for sustainability, monitor their achievement, adapt targets and build up to more comprehensive sets of targets. Some major corporations have developed effective (environmental) management systems; now these approaches need to be modified to include greater public participation in defining internal standards, and to be applicable to small-scale enterprises.

- *Information-intensive management and forest technology.* Best bets for highly-mechanised systems include: computer- and GPS-aided forest assessment, inventory and mapping, linked to (mechanised) silvicultural and harvesting operations, to aid micro-site planning and local adaptation of input regimes and operational schedules. This can optimise chemical inputs, operational timing and determine the precise and rigorous location of e.g. biodiversity protection operations. But this is not to say that information-intensive management needs to be dependent upon high technology; at whatever level technology is available, a premium should be placed upon worker education and authority, and upon structuring forest plans and technology choice based on local site conditions.

- *Reducing uncertainty and increasing resilience in forest systems.* Forest systems face much economic, social and environmental uncertainty over their long rotation periods. The least diverse, most intensively-managed forest systems appear often to be the most vulnerable. Many plantations today are the result of anomalous objectives that no longer apply. Ways of building resilience and adaptability need to be sought. Best bets include: multi-factor monitoring systems to check that e.g. nutrient loops are being closed; shorter-rotation crops that increase opportunities for change; optimising clone replacement programmes; developing complex plantation systems to offer several goods and services; ecological landscape planning to minimise the risk of major plantation disruption of the surrounding ecology, and to keep ecological options open; examining the pros and cons of large- vs. small-scale forest systems.

- *Improving worker understanding and commitment to sustainable forestry.* Too many initiatives to improve forestry have come from the top down, and workers (beat foresters, machine crews, etc) have been invested with little knowledge, incentives and authority. Best bets include: means to encourage the bottom-up development of internal standards that best interpret external standards, and procedures to meet them; coordinated packages of courses, incentives and authority to ensure machine crews and local foresters plan and implement sustainable forestry procedures at the stand and micro-level.

- *Effective alliances of small private forest owners.* Small owners are capable of running plantations that produce very many secondary benefits other than wood. They need, however, to be equipped with the knowledge, and supported with technical advice and incentives, to adopt sustainable forestry approaches, and to be able to integrate their activities at the landscape level. Support is also needed so that they can compete with those operating at a large scale e.g, at present, certification currently operates like a "rich man's club", to which the smaller producer is effectively barred.

If management objectives are to both reflect, and be reflected in, the public's changing demands for sustainably-produced forest values, improved dialogue with different actors is required. Key improvements are needed in the following fields:

- *Communicating with the general public* about the nature of forestry systems (in general, as well as specific cases); and verifying the sustainability of plantations and other forestry systems. Best bets include: formal education and media activities on "tree farming"; certification, annual company audits and other independent means of verification. These are not just one-way "PR" means, but enable an informed dialogue with the public about the actual facts that matter.

- *Management agreements and other forms of "good neighbourliness"* with surrounding land users. Best bets include: local forest/land use round tables on a continuing basis; demonstration forests; opening forests for regular inspection by local people; managers trained in continuous consultation with surrounding land users and the public, and with incentives to do so; management agreements for certain non-wood products and services such as recreation - involving education authorities and local people in this work; and government policies and laws that permit these (government as broker).

- *Partnerships between the private sector and NGOs, communities, and/or local government* at field level, to help design, implement and monitor plantation activities that provide greater social and environmental benefits.

Comprehensive "toolkits" for sustainability assessment amongst different forestry (and other land use) options are not yet available. To date, analytical techniques and studies have focused on certain dimensions alone e.g. biodiversity or chemical input intensity. A key area for improvement would therefore be:

- *Practical means for assessing forest/land use sustainability* - bringing together information to explain how forests are meeting agreed sustainability criteria. Coordinated monitoring systems are needed for information-intensive management. Best bets include *certification systems* tied to environmental management systems at enterprise level (i.e. certification that allows stepwise improvement), and *forest resource accounting* systems at national level.

  Certification systems have been designed to assess sustainability, have focused on the stand and enterprise level, and have concentrated on environmental matters. Consequently they could be improved in terms of social, biodiversity and surrounding landscape issues. In addition, the specialised field assessment systems available for biodiversity and social issues need to be improved: indicators and procedures for assessing habitat condition and vulnerability are ill-formed, as are ways for assessing social impacts (many of which are based too much on "extractive" social science approaches).

Policy implications:

Policies have not always promoted sustainable forestry systems and their integration with the landscape. Very often, there is no policy on a permanent forest estate, or tenure laws for forests are weak. These do not give the long-term security required for forestry. On the other hand, some policy instruments have often provided inappropriate, short-term subsidies for plantation developments - which has mean that plantations do not take up an appropriate place in the PFE or in local landscapes. Governments can encourage plantations that play appropriate roles through:

- *Policies which declare Permanent Forest Estate, with a role for plantations, and which seek to integrate forest systems into the landscape.* A PFE needs to cover production, protection, and mixed-purpose categories, and cover forest land under any form of ownership. Where zonation is possible into strict production and protection forests (e.g. when a country still has large areas of watershed production forest and biodiverse forests available), then it should be permissible to manage plantations or simpler forestry systems principally for production - especially in sparsely-populated areas e.g.

the New Zealand approach.

If, however, demands for biodiversity and other social and environmental benefits cannot be met over the long term from "set-aside" protection forests alone, then multi-purpose forestry systems should become the norm; plantations and simpler types of forest then need to become more complex at the stand/enterprise levels e.g. the Swedish approach.

- *Greater participation in making decisions on land use.* Participation systems and methodologies are needed for stakeholders and government to decide on the PFE, and on sustainability principles, criteria and objectives. Sustainable forest management (SFM) is a civil society construct. Its achievement will be a civil society task. Future demands will not be predictable without such participation.

  Once the national PFE has been determined, forest planning and incentive structures are best set at sub-national level. Education and awareness activities will help to ensure that local participation is also informed participation.

  No matter how clearly-defined or solidly-agreed are the principles - e.g. FSC's principles and criteria or national legislation - there will always be demands for changing the details for individual circumstances. Participatory structures (and training in site interpretation of general standards) will be required.

- *Subsidies for environmental and social sustainability, not for fibre production.* If the above policies supporting productive forestry are in place, then it is rarely appropriate to subsidise the production of pulpwood (as a commodity with a large market). *Plantation subsidies may, however, be needed to cover the costs of generating local* social and environmental benefits, and should generally be directed at district/regional levels.

- *Reducing negative impacts abroad* - to stop "free-riding" on poor forest practices in other countries. In structuring its policies, a government may be tempted to improve the social and environmental management of forests at home, and to shift the burden of pulp supply onto other countries. However, this production may be unsustainable - and so decisions to depend upon imports need to be informed by analyses of the "ecological footprints" caused abroad by the production of pulpwood for import. Such analyses need to be made by major importing companies if they are not made by government. Plantations, at both home and abroad, have a potential role in reducing net negative impacts.

In conclusion: plantations can be an integral part of the sustainable paper cycle, if they are well-planned within the local landscape and wider national economic context. They provide a principal means by which this cycle can be fed from renewable fibre sources and fuelled with solar energy. This study focused on large-scale commercial plantations, where there have been substantial improvements in practice, due to the imperative of efficiency gains and to pressure group demands. Most managers accept the need to produce more goods and services other than pulp fibre, and some exciting and innovative schemes have begun. However, there is no room for complacency. Performance is patchy across the industry, and new issues arising will require sensitive treatment and a good programme of research, adaptation and monitoring. In addition, commercial success remains the priority, and so it is essential that governments create and maintain a climate in which environmental and social

performance, achieved in a step-wise fashion, is rewarded and is not put at a disadvantage.

While often disparate and inefficient in their advocacy, a major NGO advance has been made through the Forest Stewardship Council, where many of the NGO positions on plantations and forestry are becoming reconciled.

This paper presents a "forestry systems" approach to defining forest production practices i.e. describing the diversity of use, user and biophysical conditions and management intensity. This is somewhat analogous to farming systems. Plantations could be compared to a "hunter-gatherer" approach to producing pulp i.e. to logging (a comparison which is theoretically attractive but rare in practice today). But different plantation systems can be compared with each other using sustainable agriculture criteria.

1. Introduction

The pulp and paper industry, one of the worlds biggest users of wood fibre, has seen unprecedented growth in the demand for paper products over the last decades. With growing populations and increasing levels of consumption in many developing countries, it is likely that this demand will continue to rise. In response to this pressure, the forest products industry has invested considerably in raising the efficiency of wood fibre production through intensifying forest management, and developing plantations conducive to intensive management.

Over the same period forests and the way in which they are managed have become the focus of increasing attention and often criticism. They are no longer the preserve of foresters or industrial companies to be exploited for timber as efficiently as possible. Rather, there are now demands from a wide range of stakeholders including government, industry, consumers, environmental and social pressure groups, employees, and the general public, for forests to be managed for a multitude of products and services in addition to wood. These range from protection of soil and water resources through conservation of biodiversity to provision of social and economic benefits. In a way this parallels developments in industrial agriculture in the 1960s and 1970s[1].

The pulp and paper industry, as a major user of forests, has been one of the groups most directly affected by this debate about forest management. Naturally, there have been problems in the industry adjusting to changing requirements and this has sometimes resulted in criticisms from other stakeholders. Two of the more significant issues have been:

- the type of forest used to produce wood fibre; and
- the intensity of forest management employed.

Specifically, natural forests with a wide range of species and potential products are perceived to be preferable to 'man-made' forests, and low-intensity management seen to be better than high-intensity management. In particular, attention has focused on the use of '**plantations**'.

> *"Plantation forestry is an evolving concept, but most often interpreted as the relatively intensive management of monocultures for the production of a relatively narrow range of products. In this sense, the development of plantation forestry has paralleled that of agriculture generally."* (Kanowski, 1995).

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[1] With the unprecedented levels of food becoming available through large-scale, efficient means - in both temperate countries and in the "Green Revolution" developing countries - public worries turned away from food shortages and food price towards the environmental (and to an extent the social) externalities of large-scale production methods. In the same way, the ethos of the industrial forestry industry is extending to environmental and social services in addition to the efficient production of large quantities of timber and pulp.

Plantations can be productive, cost-effective and sustainable (Savill and Evans, 1986; Evans, 1992) and there are many examples of successes. For the pulp industry, there are two special advantages of using single species plantations:

- Planting allows the use of selected or improved genetic material which can substantially increase production rates.
- Plantations provide a very uniform source of wood fibre which is easier to utilise in pulp mills.

Although there are risks inherent in single-species plantations e.g. vulnerability in the event of disease or severe climatic events, their shorter rotations minimise the period of risk. As a result, the use of plantations to produce wood fibre has increased substantially over the last decade, and is likely to continue to increase.

For example, in New Zealand, where 85 per cent of plantations are under *Pinus radiata*, a policy of single-species plantation was justified because of: the good match of the species to the available sites; adequate financial resources available to combat an epidemic; no evidence of higher susceptibility than other species; a broad intra-specific genetic base was ensured among the *P. radiata*; and short rotations meant that revenue would be realised earlier, reducing the risk period (Burdon 1982 quoted in FAO 1992).

However, 'monocultures' have been the focus of intense criticism from environmental and social pressure groups. There is evidence that they can result in environmental and social problems beyond the enterprise. Perceptions of negative impacts relate to four basic situations:

1 the removal of natural forest or other habitat to make way for plantations (where this occurs);
2 the site preparation and management practices used in the plantation;
3 the form, composition and use of the plantation; and
4 who owns and runs the plantation

Some of the problems in each of the situations have been technical in nature - notably use of the wrong species, poor site preparation, incorrect management and so on (Sargent and Bass, 1992). Technical problems can be overcome by the use of rigorous planning and species trials and, as pointed out by Palmer (1986), by reference to the extensive knowledge already available in the literature. But failures have not always been technical:

> "... many more [failures of plantations] are characterised by a more fundamental limitation: the inadequacy of simple production systems in relation to the more complex needs of societies. Where - as in much of the world - land is scarce, time horizons short, or demand strong for the non-industrial products and services of forests, a broader range of plantation objectives and a more intimate integration with other land uses are essential if plantation forestry is to be maintained" (Kanowski, 1995).

This report investigates the role that the predominant forms of plantation - relatively simple, single-species "monocultures" - play in wood fibre production. It examines the advantages and disadvantages of this type of fibre production in relation to production from other forest types, and assesses the degree to which they can be considered sustainable. This is done through a brief review of the issues, followed by an assessment of the wider context in which plantations operate and an analysis of current practice in the industry through a survey of the larger companies worldwide.

In this way, we examine the responses to growing stakeholder pressures, and increasing scientific knowledge of plantation behaviour and impacts, and assess to what degree sustainability has improved. Many of the recent changes are very likely to have beneficial effects. However, the impacts of other recent changes in practice, especially those made to increase productivity, are not yet proven. Conclusive evidence of environmental sustainability is obtainable only after a minimum of two plantation rotations (Dawkins, 1988). However, very few historical time series of relevant data are available.

1.1 Types of forest used to produce wood fibre

1.1.1 Definitions

Wood fibre comes from a variety of forests, ranging across a continuum extending from clonal plantations to old growth forest. Wood fibre (and other forms of fibre for pulp) can also be produced in agroforestry and even agricultural systems. This is shown schematically in Figure 1.

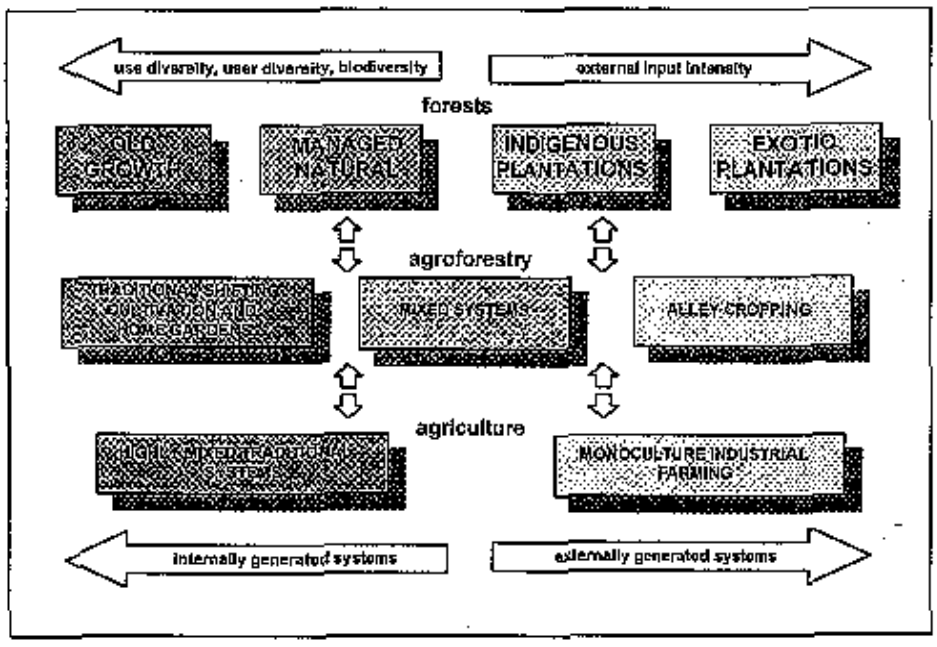

Figure 1. Land use spectrum

The distinction between man-made and natural forest is not always clear-cut. At one extreme, natural forests dominate the landscape through natural ecological processes of competition, succession and selection, while at the other, plantations of a single tree species are created by constant human intervention and manipulation. Between these two extremes lie a range of situations with varying intensities of management, varying degrees of reliance on natural processes and varying complexities of composition and structure. For the purposes of this discussion, four broad categories of forest have been identified:

- *Exotic plantation forests (exotic monocultures)*: Areas planted predominantly with a single, non-native tree species - often clonal.
- *Indigenous plantation forests (indigenous monocultures)*: Areas planted predominantly with a single native tree species. Such areas may be relatively similar to adjacent natural forests, especially in temperate and boreal regions.
- *Natural regeneration forest (secondary forest)*: Forest in at least the second rotation following initial exploitation, which has recovered naturally from resprouts, seedlings or seeds. The boundary between indigenous plantations and natural regeneration forest is sometimes blurred since in many regions forests are regenerated through a combination of natural processes supplemented by planting where natural recovery is poor, or takes too long for economic purposes.
- *Old growth natural forest (primary forest)*: forest which has not been significantly disturbed within historical memory.

Wood fibre for pulp production comes from all of these forest types (although in the latter case, not usually as a primary product but merely from sawmill residue), but there are differences in the relative importance of each type, both globally and within different geographical regions. A summary of the production of wood fibre from different forest types and different regions is given below.

1.1.2 The relative importance of plantations in wood fibre production

In 1993, plantations produced almost 30% of wood fibre for pulp globally, a considerable increase from the situation a decade earlier. Plantations of indigenous species produced 18% and plantations of exotic species 11%. However, the largest source of wood for pulp remained natural regeneration forest (54% of total wood fibre consumed), while old growth forests supplied the remaining 16%. (WRI Ltd, 1995)

Quantities of wood fibre produced varied considerably between continents with more than half of the total in North America, and another quarter from Europe (including CIS). The remaining 17% was produced in Asia, Africa, Oceania and Central and South America.

The relative importance of plantations also varied. Plantations produce almost 100% of wood fibre for pulp in Africa, Oceania and South America, and about half in Eastern Europe and Asia (Table 2). In North America, Western Europe and Russia a greater proportion of wood-fibre for pulp came from old growth or secondary

forests.

Table 1: Total production and consumption of wood fibre for pulp by continent (Source: WRI Ltd, 1995).

Continent	% global wood fibre production	% global wood fibre consumption
Asia	6.1	9.6
North America	57.5	55.9
Central and South America	6.4	5.7
Africa	1.8	1.6
Oceania	2.3	1.3
Europe	20.7	21.7
CIS	5.3	4.2

Table 2: Supply of wood-fibre for pulp production (%) by forest type for the whole world and by continent (WRI Ltd, 1995)

Forest type	Afr	Asia	Oceania	N Amer	C/S Amer	W Europe	E Europe	CIS	Global
Old growth: hardwood	3		3	2					1
Old growth: conifer	9			20		1		76	15
Secondary: hardwood	28		8	26		15	26	14	22
Secondary: conifer	10			33		58	13	10	32
Mixed tropical hardwood	8				3				1
Indig. plantation: hardwood	3					1			1
Indig. plantation: conifer	15			19	2	17	61		17
Exotic plantation: hardwood	17	51	2		52	5			6
Exotic plantation: conifer	7	49	87		43	3			5

1.2 Characteristics of forestry production systems[2]

This review aims to examine the 'sustainability' of plantation forestry. In order to assess the overall degree of sustainability of plantations relative to any other type of forest, it is useful to think in terms of four groups of characteristics. It is these characteristics which best describe any forest system in the land use continuum, in terms of its structure and function. Labels such as "monoculture", or even plantation, are too subjective and do not describe the wide range of systems that exist in practice:

1) **External inputs intensity:** the level of external inputs such as fertiliser and pesticides, degree of mechanisation, soil and water management, extent of intensive management techniques.
2) **Biophysical diversity:** genetic, species and habitat diversity; and spatial, age and landscape level diversity.
3) **Use diversity:** range of commercial products, range of non-commercial products, range of goods and services, role within a wider land use context.
4) **User diversity:** range of stakeholders involved in the plantation objective-setting, management, benefit-sharing; and range of their rights and responsibilities.

As external inputs intensity goes from high to low, the potential for sustainability tends to increase, in that an assured level of external inputs becomes less necessary. As biological diversity increases, the stability of the system and its long-term sustainability in general also increases. As use and user diversity increases, vulnerability - caused by the dependence on a single product by a single user - decreases. Any one plantation could be described with respect to these groups of characteristics (Figure 2, see also Figure 1).

In practice, these groups are linked, and extremes in one characteristic have tended to be associated with extremes in the others. For example, high management intensity has, until recently, tended to result in plantations of relatively low biodiversity, and low use diversity. In turn, such intensively-managed forests have not provided for many different users.

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[2] This section, and Appendix 1, are developed from the literature review included in the Sustainable Paper Cycle Phase I Review Report Second Draft (IIED, 1995)

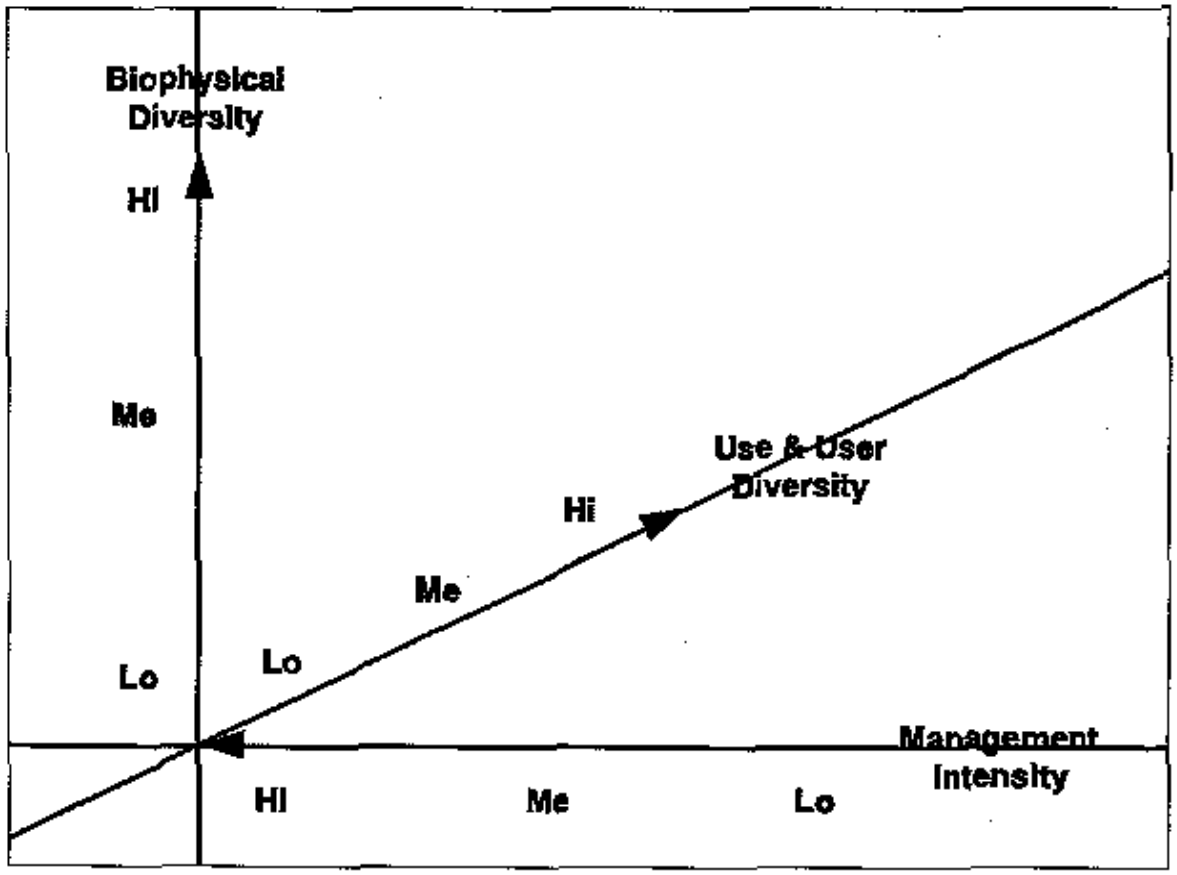

Figure 2. A method of characterising complexity or sustainability of a forest graphically.

Those who object to "monoculture" are often, in fact, objecting to specific characteristics, notably:

- high external inputs intensity ("*too much chemical and water use*"), or
- low use or user diversity ("*only pulp, and only for one large corporation*"), or
- low biological diversity ("*too sterile for wildlife*"), or
- a combination of the above.

These objections can easily become vehicles for expressing more general grudges, for example against multinational corporations. While extremes in one or more of these groups of characteristics have typified many plantations in the past, and have caused very real social, environmental or economic problems, some plantation operations are now turning away from extreme practices. Nowadays, highly intensively-managed, clonal plantations with simple structures under total corporate control are not always the norm. Hence labels such as "monoculture" do not accurately describe the range of ways in which plantations have become more complex to meet specific non-pulpwood needs.

Increasingly plantation management represents the integration of, and trade-off between, a wide range of requirements for the many benefits sought from forests.

The challenge which plantation operators are facing now is to achieve this integration more efficiently with respect to both economic and social costs. In practice, this may mean decreasing external inputs intensity, or increasing complexity, at one or more scales:

- making individual forest stands more complex (e.g. integrating biodiversity conservation into the management of all stands in a forest); and/or
- making whole forest estates more complex (zoning the intensive wood production parts of the plantation within an estate which also produces other benefits); and/or
- integrating complexity into the landscape level (co-ordinating better with surrounding land uses).

The overall effect of this is to make forest management more information-intensive, within more complex, adaptable structures. There is a limited extent to which the plantation operator alone can make changes at the landscape level, and even within the forest estate. The policy, legal and institutional framework within which the plantation operates can either encourage or discourage these trends towards complexity, particularly at the landscape level where, as we shall see, the challenges, and also some of the possibilities, tend to be greater.

In the following section, we review the implications of each of the characteristics of plantations in turn. Further technical details, taken from the literature, are given in Appendix 1. Policy trends in major plantation countries are summarised in Appendix 2. Corporate practices, based on our survey results, are discussed in Section 3.

1.2.1 External input intensity

This is a function of the degree of external inputs: mechanisation of operations, alteration of soil and water resources (fertilising, ploughing, irrigating and draining), alteration of the crop structure (weeding, pest and disease control, pruning and thinning, etc.) and tree improvement (selection, breeding, clonal propagation and, in the not-too-distant future, genetic engineering).

The major benefits of intensifying external input levels are: better control of the factors of production; economies of scale; increased yields and revenue per unit of land or labour; replenishing nutrients; and control of external forces (climate, epidemics, etc.).

Negative impacts of external input intensification are principally on the soil and water of both the forest and surrounding land; i.e. the periodic intensive use of chemicals can disrupt soil functions; soil fertility can be depleted by continuously high harvest volumes and whole-tree systems, although only on infertile soils; soils can be eroded through mechanisation and some types of forest canopy can increase rainfall erosivity; and nutrient cycling can be slowed under certain forest litter types. In addition, reliance on intensive techniques tends to reduce opportunities for involvement of local groups.

However, external input levels in plantations are low compared to agriculture. "Broadly speaking, a tree crop will require no greater input of fertilisers and herbicides during its life than will an agricultural crop... fungicides and insecticides, which are in regular annual use in many farm crops are reserved for only exceptional use in forestry. Blanket or prophylactic use of chemicals in forestry is rare" (Evans and Hibberd 1993). For example, 50 kg ha-1 of phosphorus might be used to establish spruce in northern temperate Europe (equivalent to 1 kg ha-1 per year of the rotation) compared to 50 kg ha-1 *per year* for a typical farm crop.

External input intensity can be optimised through the active identification, understanding and use of local ecological processes such as fire occurrences, and the employment of low-input techniques. Analysis of marginal returns and cost-benefit ratios (taking into account "external" costs and benefits such as environmental and social values) can help to define the optimal mix of management operations. So also can monitoring the flow of chemicals in the various nutrient cycles. For example, soil and foliar nutrient level monitoring can help to optimise fertiliser applications.

1.2.2 Plantation biophysical diversity

BIOLOGICAL DIVERSITY

The biodiversity of plantations includes the genetic composition of the plants and animals in the forest, the species diversity and the habitat diversity. Forestry's impact on biodiversity is a function of: original habitat and vegetation type and its sensitivity to change; the area of forestry activity; internal diversity of the forest and its configuration; edge to area ratio; road layout; the scale, periodicity and selectivity of felling and the accidental damage associated with it; other management methods especially thinning, fire management and chemical usage; conservation management provisions; and sequencing of operations (Blockhus *et al.* 1992, Good *et al.* 1993). Plantation management usually gains its efficiency from (and therefore aims at) keeping biodiversity within controlled limits.

The advantages of low biodiversity are to concentrate biomass production into the species (or genotypes or clones) which are most capable of producing the products required, and to control species that detract from production (weeds, pests and pathogens or other competitors with the "crop").

Negative impacts of reducing biodiversity are experienced both within the forest enterprise itself and outside the forest. Within the forest, the issues are: the vulnerability of a reduced biological base in light of possible changes in economic, social, environmental or climatic circumstances; and the reduction of certain ecological functions (e.g. nutrient recycling) that depend upon a broad biodiversity base. Outside the forest, the main issue is the reduced availability of the various values of biodiversity, especially rarer species that depend upon very specific forest associations.

A key aspect of the biodiversity debate concerns the tree species themselves - the argument of exotic *versus* indigenous (native) species, which carries on in different

forms throughout the world. *Native species* are adapted to local climate and site; their growth rate and habits in local conditions are known; their seed can be obtainable locally (but perhaps not in improved form); they have evolved resistance to local pests and diseases; they provide niches for local wildlife and dependent organisms; and their properties and potential uses are known by local people. However, they tend to become susceptible to disease in large blocks of single species; they may not exploit ecological niches as vigorously as some exotics; and many of them are difficult to establish in productive plantations - perhaps because their biology has been less well-studied (Zobel *et al.* 1987).

Exotic species are more usually chosen for plantations. Evans (1987) notes that 85 per cent of plantation forestry in the tropics is dominated by eucalypts, pines and teak. This prevalence is, amongst other reasons, because: their silviculture is known and their products widely appreciated in the market; they can exploit a previously underused ecological niche and hence grow much faster; improved varieties are already available; and there are no local pests and diseases for that species - at least to start with. However, they can become invasive, and can be very susceptible to epidemics if these eventually arise. The number of pests of an exotic species tends to be a function of the area under cultivation, rather than the time since its introduction. Major epidemics have included psyllid defoliation of *Leucaena* in the tropics, lodgepole pine defoliation in Scotland, and blight of *Pinus radiata* in Central Africa. In most cases where exotics suffered epidemics, it was because they were being grown in environments already causing stress, and breeding strategies subsequently overcame the problem. The overenthusiastic use of fast-growing "miracle trees" such as *Leucaena*, in areas which were not suitable and/or suffered disease, has given rise to much of the prejudice against these trees (Evans 1990).

Numerous ways have been suggested for optimising biodiversity in plantations, although many remain as theoretical guidelines and have not been implemented routinely or for long periods. At the stand level, more complex (multiple species) plantations have been established; native species have been grown in preference to exotics (not always a guarantee of improved total biodiversity); and varied ages and ecological niches have been created in plantation layout and during the process of plantation development. At the landscape level, increasing the edge:area ratio of plantations, and leaving different natural habitats to create a patchwork of plantation and natural forest has also become more common, particularly amongst large plantation developments in varied terrain.

Fragments of natural forest and other natural habitat have frequently been included in layouts along with a mosaic of different plantation types. There are many examples in the USA and Latin America (such as Aracruz). However, sometimes these areas have not been managed properly - rather, they may be treated as firebreaks and be subject to detrimental annual burning (Sawyer and Centeno n.d.). A final method of minimising net biodiversity losses through plantations is to compensate for plantations by conserving representative tracts of high-value natural habitats elsewhere ie not necessarily as part of the plantation scheme. In Queensland, 500 ha of native forest is usually retained for every 4000 ha of

plantation developed (FAO Paper 103 1992).

Good planning is key. However, there is currently little available in the way of detailed cost-benefit studies that analyse these approaches; indeed, whilst costs can be relatively easily calculated, there remains much discussion about methods to ascribe values to all the benefits.

There are good environmental arguments for using native species to minimise risks. A species may be considered to be native if it arrived unaided by man, and formed part of a natural ecosystem without completely dominating it. They rarely become invasive and generally support more insects and microorganisms at a low, background level. This both means general resistance to disease is built up (Zobel *et al.* 1987) and, because general support of other species is also higher than with exotics, greater conservation value is provided. However, native species do not necessarily support higher biodiversity. Exotic species may become naturalised over time without becoming invasive. In other words, the issue is whether a tree can support certain native species (in food webs, etc) without greatly suppressing others. Certain exotics may be able to play this role. For example, twelve-year old plantations of *Eucalyptus* in the Doon Valley, India were found by one study to support three times the number of understorey species as native *Shorea robusta* stands (Mathur and Soni, 1983).

Exotics can be just as valuable as native trees when it is only their architectural characteristics (as opposed eg. to biochemical) which are required by dependent natives. The ecological niches in plantations have been artificially augmented by e.g. providing bat and bird boxes (Lee, 1993). The planting of some *Acacia* and *Pinus* species now appears to provide a promising matrix for regenerating natural forests on anthropogenic grasslands, such as the *Imperata* grasslands that proliferate following extensive rainforest clearance (Evans and Hibberd 1993).

STRUCTURAL DIVERSITY

Structural diversity is closely associated with both *external inputs intensity* and *biodiversity*. High external inputs intensity (particularly of the type which depends upon mechanisation) and low species diversity in the crop are both associated with structural uniformity. Hence typical commercial stands tend to be uniform blocks of one or only a few age classes and species, and forest landscapes take on a large-scale, uniform appearance with standardised features such as roads, firebreaks and fences. Structural diversity can also be exaggerated or moderated by the natural landscape, notably topography.

The advantages of low structural diversity lie principally in the ability to run a forest enterprise in a financially efficient manner, being able to apply uniform operations using standardised machinery over the whole forest, without having to undertake special treatments for different types of area. In other words, the forest can be designed to operate as a wood-producing "factory".

The disadvantages of low structural diversity, on the other hand, reside precisely

in the fact that, even if the forest is principally devoted to a single product, forests do not best operate as "factories". Many ecosystem functions depend upon there being a variety of, for example, soil types, water tables, microtopographies and microclimates. In addition, many of the values sought by people from forests depend upon a high structural diversity, for example, landscape diversity (colour, texture, form, scale from human to grand, etc), and its associated recreational opportunities (one reason why forest recreation is so popular is that the different physical spaces in forests can absorb relatively high numbers of people). On the other hand, the argument that ecological stability depends upon high structural (and biological) diversity is not supportable in a universal sense. There are too many exceptions. Diversity is parallel to stability, and not a cause of it.

Various approaches have been employed for optimising structural diversity, at stand and landscape levels. These have addressed both biodiversity and structural diversity.

At the stand level, biodiversity and structural diversity have been increased through the development of *"complex" or mixed-species plantations*. The principal rationale is minimisation of environmental, economic and social risk, through the production of more goods and services (usually starting harvests earlier in a rotation and continuing on a more even basis for each stand than is possible with single-species approaches) and the involvement of more user groups. It is essentially a compromise, reached at the stand level; and it can still be very intensive in using inputs. There is much work still to do on this issue; interdisciplinary approaches are needed and some lessons can be learnt from recent initiatives in agroforestry and community forestry (which tends to be more polyspecific). The evidence for complex plantations so far shows that they are sustainable and productive in many circumstances (FAO 1992, Kanowski 1995). For example, one reason has been to improve soil processes and lead to mutual nutritional improvements between species, such as by incorporating nitrogen-fixers and trees with mycorrhizal associations. However, it does not warrant the universal substitution of simple plantations by complex plantations. For example, a major reason for considering them has been to reduce the risk of epidemics - something which is not always achieved in practice (FAO 1992).

FAO (1992) therefore concludes that mixed plantations are likely to be beneficial for biodiversity, soil conservation, and coping with many uncertainties such as climate and market changes, but not necessarily to reduce epidemics.

Solutions to the lack of structural diversity are also achievable at the landscape level, but here the involvement of more actors is required. Principal among these solutions is *landscape design*. Where it works well, this builds on the topography and on the natural and cultural landscape features considered to be of local or national importance, while incorporating operational requirements. Whilst aesthetic and cultural reasons for landscape diversity tend to be paramount, biodiversity reasons are also considered important.

A number of countries, such as the UK, now have forest landscape design

regulations and guidelines, with supporting advisory services. Varying degrees of public participation are included in order to generate a landscape which meets different stakeholders' needs. The usual approach is to entrust the work to professional landscape architects, who employ their own means of consultation with other professionals and interest groups, except in critical areas where, for example, rural planning inquiries may be used. Again, an interdisciplinary - and participatory - approach appears to be necessary for the full benefits of landscape design to be realised.

In other countries, such as Sweden, where population densities and recreational pressures are lower, a conscious aesthetic "design" solution is not routinely sought. Rather, *ecological landscape planning*, with its focus on forest management respecting natural features, is thought to generate an aesthetically-acceptable landscape, by mimicking and occasionally enhancing natural processes.

1.2.3 Plantation use and user diversity

In this section, we concentrate on the possible ways that plantations can provide benefits to groups beyond the commercial plantation owner or manager, in particular to local people living in and around forests. In large part, this will depend upon their ability to produce goods and services other than pulp.

USE DIVERSITY:

By and large, the main use of commercial plantations remains the production of industrial wood fibre, although there are increasing incidences of secondary uses being provided, often for groups other than the plantation owner. At the *local* level, secondary purposes of commercial plantations have included:

- fuelwood production (thinnings, prunings and deadwood collection)
- production of non-timber materials, some from the trees themselves (e.g. bark, nuts, resin) and others from other plants, animals and fungi (e.g. hunting, mushroom collection, beekeeping, thatch grass)
- grazing
- micro/local climate stabilisation (shade and windbreaks)
- watershed stabilisation
- shoreline/beach/slope stabilisation
- mine-spoil/quarry/contaminated land restoration
- recreation areas
- landscape enhancement

For some of these purposes, commercial income can be realised.

At the *national and global* level, plantations are also being established for:

- carbon storage and sequestration (usually to offset the carbon dioxide generation of power utilities)

Sometimes the above uses have become the primary objective. Carbon offset, for example, does look like becoming a predominant objective for plantation establishment in some cases, partly because the exercise (funded by electricity generation companies) could prove more profitable than wood production alone. In general, however, industrial wood production will remain the primary reason for large-scale plantations. While there are occasional examples of the above uses being of commercial importance, they are more frequently incorporated into commercial plantations for social reasons.

USER DIVERSITY:

The advantages of high user diversity tend to be:

- greater long-term social and political acceptance of plantations as part of the social landscape, and hence reduced vulnerability of plantations to change of land use;
- greater local, practical support for plantation protection in times of, for example, climatic or pest hazard; and
- increased skills base available for plantation planning and management.

The disadvantages of high user diversity are:

- the lack of an obvious hierarchy amongst subsidiary users[3];
- possibilities of conflicts in demands and approaches;
- legal and management difficulties in reconciling the problems of hierarchy and above conflicts i.e. in defining and coordinating roles and responsibilities;
- tenure ambiguities and conflicts becoming exposed through plantation development, sometimes resulting in marginal groups becoming excluded;
- difficulties in ensuring effective control over the whole forest enterprise, due to the spread of responsibilities; and
- difficulties in exploiting economies of scale.

Ways of optimising user diversity depend on providing information to interested parties; on means for consultation with parties; and, where appropriate, means for their active participation, sharing costs and benefits, and monitoring of developments. Sargent (1990) found that misconceptions and misunderstanding of a proposed plantation scheme arose largely from lack of information being made available to villagers. Hearsay regarding the project, and mistrust of the developer, developed rapidly, yet many of the local people's anxieties would have been allayed with the provision of comprehensive information regarding the developer's plans.

Round table mechanisms have been used, backed up by professional support to help reach compromises, such as landscape architects and (especially in North America) conflict resolution groups. Conflict resolution requires a good

[3] It is generally accepted that the plantation owner will determine the primary use, normally fibre production. The difficulties arise in setting priorities between other users.

understanding of the social organisation, including the decision making processes, the local political and economic power structure, and the systems and traditions used in cooperating and conflicting with other social groups, with government, and with business. Multi-user plantations are not really possible without these and other effective means for participation. These are capacities which are not yet fully developed in forestry.

Plantation management by multiple users is by no means a panacea. There are several legitimate approaches:

- single user regularly consulting with other interest groups and neighbouring uses;
- principal user with management/access agreements for other users; and
- various forms of multi-user partnerships (e.g. on zonation, temporal, and product differentiation bases).

Outgrower schemes are one form of multiple involvement in growing trees for fibre production, although this is not strictly multiple-use.

Most of the lessons on these approaches are being learned from non-commercial participatory forest management (Arnold, 1995, Hobley 1996), but some are being derived from the limited experience of corporate/social partnerships, such as outgrower schemes.

The need for consultation with, and participation of, local people in plantation development is acknowledged in much of the literature. Barraclough and Ghimire (1990) point to ample experience during generations of forest management attempts in Europe, North America, Japan and many other places which convincingly suggests that sustainable and reasonably equitable forest protection, management and land use planning requires genuine participation of those groups living in or near the forest and who depend on it for their livelihood.

However, it is also acknowledged that proposals for full consultation and involvement of local people in plantation forestry may raise delicate political issues in some countries (Shell/WWF, 1993), particularly since issues concerning socio-economic and political systems are raised. Barraclough and Ghimire (1990) contend that state or private property regimes alike can be relatively sustainable and equitable or can lead to tragedies for both local people and for the environment, 'but for any of these property systems to function well in the use of forest resources, there has to be popular participation'. In the literature, there are various examples of the degree of consultation being reduced, for example, the omission of stipulations regarding consultation with NGOs and individuals from the revised Russian forestry law (Grigoriev, 1993). Much of the current work of groups such as IIED involves bringing together forest 'stakeholders' and watchdogs - government, communities, private sector and NGOs - in dialogue on how to ensure that the many forest values sought by each of these groups can be integrated. This involves the identification of structures, institutions and methodologies for participation.

Single-user forestry is, however, sustainable in certain circumstances. This is where

lands have uncontentious tenure and are under no alternative claims and demands. Such lands are increasingly in short supply. The scope, therefore, for isolated plantation developments under the complete control of, for example, single corporations, is increasingly limited. In practice, the many single-user schemes that exist today are increasingly being forced to explore multi-user possibilities.

A first step is to examine the social implications of fibre production from plantations. These differ greatly depending upon:

- whether fibre is produced on existing forest land or on land specially acquired for afforestation;
- the plantation size, composition, management objectives, rotation period and layout with respect to neighbouring uses;
- the rate of plantation establishment;
- cultural perceptions of plantations generally, of exact species, and of the plantation owners/managers;
- the degree of lifestyle change that the plantation causes, particularly in terms of employment including the immigration of outsiders seeking work, local institutions and changes in social benefits, but also regarding basic needs provision;
- opportunity cost of land/tree values foregone;
- the precise forms of land and tree tenure, and who is responsible for which aspects of the plantation's operations;
- the precedent for, and extent of, local participation of different social groups;
- who controls the plantation: the relative economic, political and legal power of local people and the plantation developer, and the degree of lobbying and advocacy carried out by, or on behalf of, different stakeholders; and
- the extant of participation in the different tasks in the plantation cycle: site appraisal, objective-setting, species and management system selection, silviculture and management, harvesting, utilisation.

Typical social impacts, particularly where large plantations are involved, include:

- possible changes in land and resource tenure rights,
- household food, fuel and timber supply,
- employment and incomes,
- social structures, relations and equity.

Largely because many social impacts cannot be quantified, and because they depend upon different individual and group perceptions of the values of the forest or alternative land use, assessment of the impacts frequently depends on subjective judgement. There has been little systematic monitoring in plantation operations, or comparative analysis of the interactions of plantation management processes at local levels with different social groups. Yet it appears that social impacts differ widely according to the social group being considered, and the context. Hence, in developing social criteria and indicators for use in certification, CIFOR has been conducting detailed studies in local environments - working with local communities to determine what really matters in terms of tenure, other rights, cost- and benefit-

sharing, participation in the forest management cycle, etc.

Many of the social impacts vary according to whether the development is in tropical, or temperate and boreal regions. They are summarised in Table 3 below. This shows examples of positive (+) and negative (-) current and potential social impacts of fibre production: these are illustrative and do not apply universally across or within countries. Since, in general, land tenure tends to be more clearly defined, employment regulations better developed, and dependence on forest resources largely for recreation rather than basic needs, social impacts are often of a lesser magnitude in temperate areas.

In conclusion, social issues are complex, highly location-specific, and with no standard solutions. Yet most stakeholders acknowledge that the mitigation of negative social impacts is crucial to the successful long-term development of forestry operations: issues such as land tenure and equity are of great importance, and have caused numerous conflicts in forestry developments.

Table 3: Typical pros (+) and cons (-) of current social approaches to commercial plantations

	Tropical	Temperate and boreal
Rights and tenure	land and tree tenure often informal prior to the development + clarify ambiguous tenure - disregard customary rights - increase landlessness - formal tenure excludes weaker groups	tenure often clear and well-recorded + ownership established - development excludes weaker groups from traditional lands
User benefits (basic needs)	+ increase in employment - but employment may be temporary + joint management schemes supplement farmer income - species may not meet local needs - poorest social groups lose access to lands and associated services - loss of local food supply, decrease in nutritional status	basic needs generally not derived from forests + increasingly professional work force
Demographics	- expulsion of indigenous population from development area - immigration of migrant/ temporary workers into established communities	- impact on indigenous populations customary rights in development area + immigration to sparsely populated area - but dependent on forestry employment
Aesthetic and cultural resources and values	- conflicts between perceived values of plantation trees - loss of culturally important sites - loss of values of former land use	- conflicts between perceived values of plantation trees - tensions due to perceived reductions in aesthetic and recreational values - loss of/damage to important cultural sites
Community institutions	- sections of 'community' are favoured + lessons from joint forest management can be applied - small-scale producers unable to market produce because: - industry not organised to receive supply from diverse sources + farm production of non-timber fibre sources supplements farmers' income - lack of recognition of motivations of local communities	+ industry has led to establishment of co-operative organisations + relatively organised and effective unions, support for forest workers + effective campaigns to support indigenous populations, etc.
Equity	- subsidies favour control by large companies - marginalisation of the poor and landless from participatory schemes	- subsidies favour control by large companies

1.3 Definitions of sustainable forest management

In the previous section, we discussed the characteristics which contribute to, or detract from sustainability in plantations or other forestry systems. However, for management purposes it is useful to have a more specific definition of the requirements for sustainability.

As interest in forest management has grown over the last few years, a number of different stakeholder groups have attempted to define the essential elements of good forest management. These initiatives on forest management principles, criteria and standards are discussed and analysed in detail in Nussbaum *et al.* (1995). This review concluded that, although there were considerable differences between the initiatives, they all contain a common core of broad requirements. We can therefore assume that these broad requirements are essential to any current definition of sustainable, or at least good, forest management (although their further elaboration may be required at local levels):

The sustainable production of forest goods and services:

- the sustained production of timber products
- the sustained production of non-timber products,
- protection of soil and water resources,
- maintenance of ecosystem functions and natural biological cycles,
- continuing forest health and vitality
- contributions to local and global climatic stability.

Conservation of biological diversity:

- at the ecosystem level,
- at the species level,
- at the genetic level.

Positive social and economic impacts from forestry operations:

- the impacts on indigenous people,
- the impacts on local communities,
- working conditions for employees,
- contributions to the local and national economy,
- multiple use of, and benefits from, the forest.

This list, then, reflects the current vision of what constitutes good management of forest resources. 'Sustainability' can be seen to be related to the forest system characteristics set out in 1.2, notably *increasing diversity* and *decreasing external inputs intensity*. Table 4 shows the links that are generally observed between the SFM requirements listed above and levels of diversity and external inputs intensity.

There is a growing consensus among governments, NGOs, academics and industry that forest managers must consider these requirements if they wish to manage their forests well, but considerable debate remains about how the various functions should be implemented and which values have the highest priority. A particular difficulty for plantations is that they tend to provide a narrower range of goods and services than natural forests, making it difficult for a single plantation area to fulfill all the requirements above. This raises two very important issues which must be considered by those attempting to define 'sustainability' scale and participation.

- *Sustainability can and should be achieved at a number of scales,* e.g., forest compartment, enterprise, landscape, region, nation, globe. Within each level, there are many possible economic, social and environmental objectives, different possibilities to integrate these objectives, and trade-off options where integration is not possible. For example, it may not be efficient or even possible to conserve all local biodiversity within a single forest block, but it should be possible within the local landscape in which the block is sited. The question of which goods and services individual plantations should provide, and which could be provided from the wider landscape, is critical for a discussion of forest sustainability. It implies a far greater engagement of plantation operators with local communities and planning processes than is common today.

- *Sustainability needs to be negotiated between the different interest groups.* The choice, integration and trade-off of forestry objectives are questions of value. The national level (or state level where there is a federal system) is key for defining a forest estate which meets the demands of stakeholders. Various policy, planning, management and monitoring procedures are needed with appropriate participation. Without these, political pressures on any forest management organisation may very often result in unsustainable activity. At the corporate level, a sustainable forestry policy should include systems for consultation with local interest groups.

Against this background, this report now focuses on the degree to which plantations producing fibre for the pulp and paper industry provide the benefits of sustainable forestry. We look first at the context in which plantations operate, in particular external pressures and the changing institutional and policy environment (section 2) and then examine current industry practice in more detail (section 3).

Table 4: Sustainability values sought from plantations and other forests; and the forest system characteristics generally observed to provide the values.

	Inputs intensity	Biophysical diversity	Use diversity	User diversity
Sustainable production of goods and services				
Timber products	H	L	L	LM
Non-timber products	LM	LMH	LMH	LM
Soil and water protection	L	LM	LM	L
Ecosystems function/regeneration	L	MH	M	M
Forest health and vitality	LM	M	M	M
Climate regulation	LMH	MH	LMH	LMH
Sustained contribution to local economy	LMH	M	MH	M
Sustained contribution to national economy	LM	M	M	M
Conservation of Biodiversity				
Ecosystem and habitat diversity	LM	H	MH	M
Species diversity	LM	H	MH	MH
Genetic diversity	LM	MH	M	LMH
Social benefits				
Sustain indigenous peoples	L*	LMH	MH	MH
Sustain other local peoples	L*	MH	MH	MH
Employees' working conditions	LM	M	M	M
Landscape aesthetics	LM	MH	MH	MH
Recreation	LM	MH	LMH	LMH

Key: Intensity of the forest system characteristic (see Figure 2):

L (low) M (medium) H (high)

* (external management by non-local people)

2 The policy and institutional context for plantations

In this section we examine briefly some of the external pressures and institutional and policy issues likely to affect the sustainability of plantations. However, the context in which plantations operate varies considerably between regions depending on local climate, biogeography, history, culture and economy, so an overview of the major wood-fibre producing countries considered in this review is given in Appendix 2.

2.1 Government policies and plantations

Governments tend to respond to prevailing and often ephemeral pressures, and as a result policy towards plantations has often been inconsistent as different needs take precedence. For example, Dargavel and Kengen (1992) chart the flux in Australian plantation policy over the last century.

In general, governments have tended to promote the establishment of plantations when wood resources run low or when remaining forests are economically inaccessible. Strategic reasons, such as achieving wood security in times of war (e.g. UK earlier this century), or reasons of comparative advantage in being able to grow timber quickly and cheaply to meet expanding markets (e.g. Brazil, Chile and New Zealand) are principal among government pro-plantation policies. They may also promote plantations when a decision has been made to protect natural forests e.g. New Zealand. Conversely, governments tend to discourage plantation development when enough plantations are considered to have been established (e.g. UK in recent years), or when land is needed for other uses (e.g., in southern Brazilian states, it was perceived that widespread plantation development had driven land prices up). Finally, plantations tend to become disfavoured when secure and cheap wood supplies are available from other sources.

Pressures of growing significance are voters becoming dissatisfied with plantation practices, and international concern about plantation management. Indeed, there have been several new international policy developments recently, the most important of which have been the decisions taken at UNCED[1] and the subsequent follow-up initiatives. After UNCED, many governments joined in the drafting of sets of criteria and indicators of good forest management which cover the broad issues listed in Section 1.3. The first two sets to be published were:

- The Helsinki Process, developed by European governments and defining criteria and indicators for all types of forest in Europe.
- The Montreal Process, developed by 10 governments and defining national criteria and indicators for all types of boreal and temperate forests.

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[1] In addition to the Rio Declaration on Environment and Development, a non-legally binding set of 'Forest Principles' were produced, while Agenda 21 devotes Chapter 11 to 'Combating Deforestation'. Various aspects of forestry are also covered in the Convention on Biological Diversity and Framework Convention on Climate Change, both of which are legally binding on signatory countries.

These documents were produced mainly to define what aspects of forests should be monitored in each country, but they also provide the framework for developing national forest policy. Through these two initiatives, therefore, the participating governments have committed themselves to considering a wider range of issues in their planning and legislation for forestry.

Governments from tropical forest countries had already begun a process of commitment to improved forest management prior to UNCED, through the development of the International Tropical Timber Organisation (ITTO) guidelines and criteria. ITTO producer countries have committed themselves to implementation of the ITTO's guidelines and criteria by the year 2000. Unlike the Montreal and Helsinki Processes, the ITTO initiative includes specific guidelines for sustainable management of plantations ('planted tropical forests').

Governments are now in the process of translating these international initiatives for national use, with Canada the first country to produce a national set of criteria based on an international process.

Although all of these initiatives are somewhat general, and even vague, in nature, they are important because they set the agenda at the highest legislative level for the range of requirements which a forest must provide. The issue now is how far governments will encourage this in practice. There are three main ways in which governments can influence plantations within the overall forest context: through legislation, through incentives and through planning.

- *Legislation*: All countries have forestry laws, some of which work better than others. Detailed legislation does not guarantee good management, and there are many examples of countries with exemplary forest laws but very poor forestry practice. There are some areas where legislation is essential to ensure minimum standards, but it is essential that legislation is enforceable. Some countries are now enacting laws based on the new concepts discussed in the introduction: for example, Sweden has recently passed a new forestry law which places explicit emphasis on achieving both production and environmental benefits from "every hectare" of forest land. This marks legislative recognition of a transition from a plantation-type forest management developed in the 1970s to one of natural forest management.

  One area where legislation may be very important is the conservation of biodiversity. However well production forests and plantations are managed, there is always a need for sufficient, representative areas of forest to be set aside and completely protected, and their definition, organisation and management is usually the role of government. Other types of legislation aimed at conserving biodiversity such as specifying minimum areas of native vegetation to be left within exotic plantation estates (e.g. 20% in Brazil), or dealing with preserving special habitats such as wetlands can also be a useful tool in promoting sustainability.

- *Incentives*: Governments can use incentives to encourage or discourage

plantation forestry depending on current policy. There have been problems in the past with poorly thought out incentive schemes which have resulted in large payments for plantations which were never established. It has also led to competition for land, and disempowerment of local people. On the other hand, incentives from government to the private sector have formed the basis for very successful plantation development in many countries, such as Chile. Incentives used to encourage other types of land-use such as agriculture may act as indirect disincentives to plantation establishment.

- *Planning:* Although central planning is often ineffective, some land-use planning is essential for any country. A minimum requirement is the definition and agreement of a national Permanent Forest Estate (PFE), and within it, production, protection and mixed-use categories - for any one of which plantations may be appropriate. To ensure that plantations are as sustainable as possible, they need to be operating within a wider context which should be planned by national, regional or local government. A good example of this type of planning is New Zealand where, with enactment of the Resource Management Act, the government placed environmental legislation under a single umbrella and devolved interpretation and planning to the regional level.

2.2 NGOs and plantations

There has been a great increase in the number and the influence of environmental and social NGOs concerned with the way forests are managed, both reflecting and stimulating a significant increase in concern among the general public. It has been predominantly the NGO community which has voiced criticisms of plantations and helped to expose some of the problems that plantations can cause. Earlier concerns focused on the removal of natural forests for plantations. Particular concerns now are biodiversity reduction, poor aesthetic quality of plantations, social disenfranchisement and dislocation, and implications of large-scale producers (monopoly, monopsony, asset control and the exclusion of local interests). Although much of their advocacy has often been narrow and uncoordinated, NGOs have been instrumental in forcing some improvements in forest and plantation management.

One major recent NGO initiative is helping to bring together, and to rationalise, the many and disparate NGO concerns. This is the establishment of the Forest Stewardship Council (FSC) and the development, under its auspices, both of principles and criteria for good forest management, and of a system for accrediting different forest certification bodies. This initiative was a response to consumer concerns that wood-derived products were coming from badly managed forests, leading in turn to pressure on retailers of timber and timber-derived products to verify the management of the forests from which the timber comes.

To define its requirements, the FSC developed a set of ten principles and criteria of good forest stewardship. These cover the same broad areas as the Helsinki and Montreal Processes - sustainable yield of forest goods and services, conservation

of biodiversity and maximising the socioeconomic benefits of forestry - but with greater emphasis on social issues and multiple use of forests. The first eight of the FSC principles refer to all types of forest, while principle nine refers to the issue of converting natural forest to other uses. Principle ten is exclusively about plantations and represents the negotiated agenda of environmental and social NGOs with respect to plantation forests (though it had not yet been ratified by the full FSC membership at the time of publication of this report). The principle begins with the statement:

> *"While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's need for forest products, they should complement the management of, and reduce pressure on, natural forests."*

The principle contains seven criteria, which cover *inter alia*:

- Well planned and documented management strategies;
- Landscape planning to maximise both biological and structural diversity;
- Preferential use of native rather than exotic tree species;
- Control of pests, diseases and fire using the most ecologically sound methods;
- Minimising, or phasing out, the use of chemical herbicides, pesticides and fertilisers;
- Maintenance and improvement of soil and water resources.

In addition to principle ten, the requirements of the first eight principles also apply to plantations. Of these, four principles cover use and user diversity issues, three cover external input issues, and one covers biodiversity. At present, this last specifically prohibits the use of genetically engineered organisms in forests.

Although FSC's Principles and Criteria represent a more coordinated set of NGO ideals (rationalised with those of other interests such as industry), a difficulty with the FSC P&C is that they were developed without the full participation of industry, and as a result many companies remain somewhat suspicious of a process they are expected to implement yet feel they did not help create. The oft reiterated need for wide consultation works both ways: just as industry is expected to consult with NGOs, so NGOs have an obligation to consult with industry. One problem is that, although many NGOs are keen to work constructively with industry, there are some on the fringes who do not operate in a manner which contemplates compromise. These extreme few are suspicious of the less radical groups, leaving moderate NGOs torn between a desire for constructive dialogue and the need to maintain 'credibility' with the extreme fringe.

There have been examples of constructive dialogue between industry and NGOs over the issue of forest plantations. WWF and Shell International worked together to produce a detailed review of plantation management and, based on this, a set of guidelines for good plantation management (Shell/WWF, 1993). In New Zealand growing concern over plantation forestry resulted, in 1991, in representatives of

the forest industry and the main environmental and forest recreation groups[2] signing "The New Zealand Forest Accord". This document recognises that:

> *"commercial plantation forests of either introduced or indigenous species are an essential source of perpetually renewable fibre and energy offering an alternative to the depletion of natural forests".*

In the Accord the industrial groups undertook to exclude areas of naturally-occurring indigenous vegetation (as defined by area, size and canopy closure and ecological importance) from conversion to plantation, while the conservation groups acknowledged the importance of plantation forestry. The parties also supported the production management of natural indigenous forest, where such activity was carried out on a sustainable basis so that the forest ecosystem was "maintained in perpetuity".

Despite this agreement, plantation forestry in New Zealand has continued to receive adverse criticism from some NGOs, such as that summarised in the Greenpeace publication 'The Plantation Effect', (Greenpeace, 1994), which listed a range of 'unsustainable aspects' including:

> *biodiversity loss; soil and fertility loss; toxic pollution; excessive natural resource use; and increased risk and uncertainty.*

The New Zealand commercial plantation sector and New Zealand environmental and recreational organisations are now attempting to define what is meant by sustainable commercial plantation forest management and have produced a draft set of principles (Anon, 1995). This document includes a commitment to the 1991 New Zealand Forest Accord and also covers:

- *Ecological principles* cover indigenous biodiversity; soil, water and air; resource, energy and waste management; and agri-chemicals, biological control and pests.
- *Social principles* including public access; tenure and use rights; landscape, aesthetics and recreation; community consultation and social effects.
- *Economic principles* covering economic returns and costs and benefits of environmental effects.

In conclusion, there is growing pressure from both government and the NGO community for the implementation of sustainable management in plantations, and a considerable number of initiatives have been developed which aim to describe or prescribe what this means in general terms. However, neither governments nor

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[2] The New Zealand Forest Owners Association, the New Zealand Timber Industry Federation, the New Zealand Farm Forestry Association, the New Zealand Wood Panel Manufacturers Association, the Royal Forest and Bird Protection Society of New Zealand, the Environmental and Conservation Organisations of NZ, the Federated Mountain Clubs, Friends of the Earth, the Beech Action Committee, the Pacific Institute of Resource Management, Worldwide Fund for Nature (NZ), Japan Tropical Forest Action Network, Tropical Forest Action Group, and the Maruia Society.

NGOs agree on the detail of implementation and responsibility and it is likely that there will continue to be considerable confusion and disagreement. Plantation managers will need to learn how to operate within this rather uncertain climate and respond to changing requirements. Participatory structures and methodologies, for reaching agreement, and training in site appraisal and interpretation of general standards, will be required.

3. A Survey of Current Industry Practice

This section assesses current industry practices in relation to the forest system characteristics described in Section 1.3: external inputs intensity; biophysical diversity; and use and user diversity. The analysis is based on a combination of questionnaires sent to selected forestry companies (see Appendix 3 for a copy of the questionnaire used), together with material published by government, industry and industry associations (and coming from a much wider range of companies than those responding to the questionnaire). It focuses only on the activities of large pulp companies with tenure rights to forest land or harvest, and does not include management practices of smaller companies or private owners except where these are suppliers to the large companies. The survey did not cover activities involving harvesting large areas of old growth forest. All the companies surveyed harvest from natural regeneration forest or planted forest. The replies have been analysed in two categories:

- Companies harvesting from natural regeneration and/or indigenous species plantation forests (abbreviated to *'In'* in figures);
- Companies harvesting from exotic species plantation forests (abbreviated to *'Ex'* in figures);

A total of 30 questionnaires were sent out and 18 responses were received. Several reasons were given by the non-respondents. Some companies objected to the nature of the questions for being too directive, some felt it was too much work and one company refused without giving a reason.

Respondent companies managing natural regeneration of indigenous plantations were located in North America, Scandinavia and Asia. Those managing exotic plantations were in South America, New Zealand, Southern Europe and South Africa. For reasons of confidentiality the locations of companies are not given. Where precise cases have been cited, this material has been taken from published material in the public domain.

The forest areas managed by respondent companies range in size from just over 12,000 ha to 1,500,000 ha. Companies with large, diverse forest operations answered questions based on one region or forest zone - presumably perceived internally to be well-managed. The percentage of area in the first rotation ranges from 20% to 100%, while just under 50% of companies have forests in the third or subsequent rotation. These multiple rotation forests potentially yield more information on environmental sustainability. Annual harvesting rates of companies range from less than 1000 ha to more than 20,000 ha per annum.

3.1 Industry Priorities

The reasons offered for choice of species for industrial plantations give a reasonable indication of the overall priorities with respect to management objectives. Respondents were asked to score a number of possible reasons for species choice, with '1' meaning 'unimportant' to '5' meaning 'very important'. The results are shown in Figure 3.1.

- The four most important reasons for the choice of both indigenous and exotic species were the pulp quality, site suitability, pest and disease resistance and the growth rate, i.e. the factors considered most important are all technical and economic

- The three possible choices relating to a wider range of goods and services: *potential for multiple use*, *importance for indigenous wildlife* and *ecological benefit to the area* were the three least important reasons in the selection of indigenous species, and two of the three came bottom in the selection of exotic species as well, i.e. the factors considered not to be of fundamental importance are environmental and non-economic

These results suggest that, although companies are trying to deal with demands to incorporate a wider set of values into their management philosophies, the main goals in structuring forest plantations remain the efficient production of timber and wood fibre.

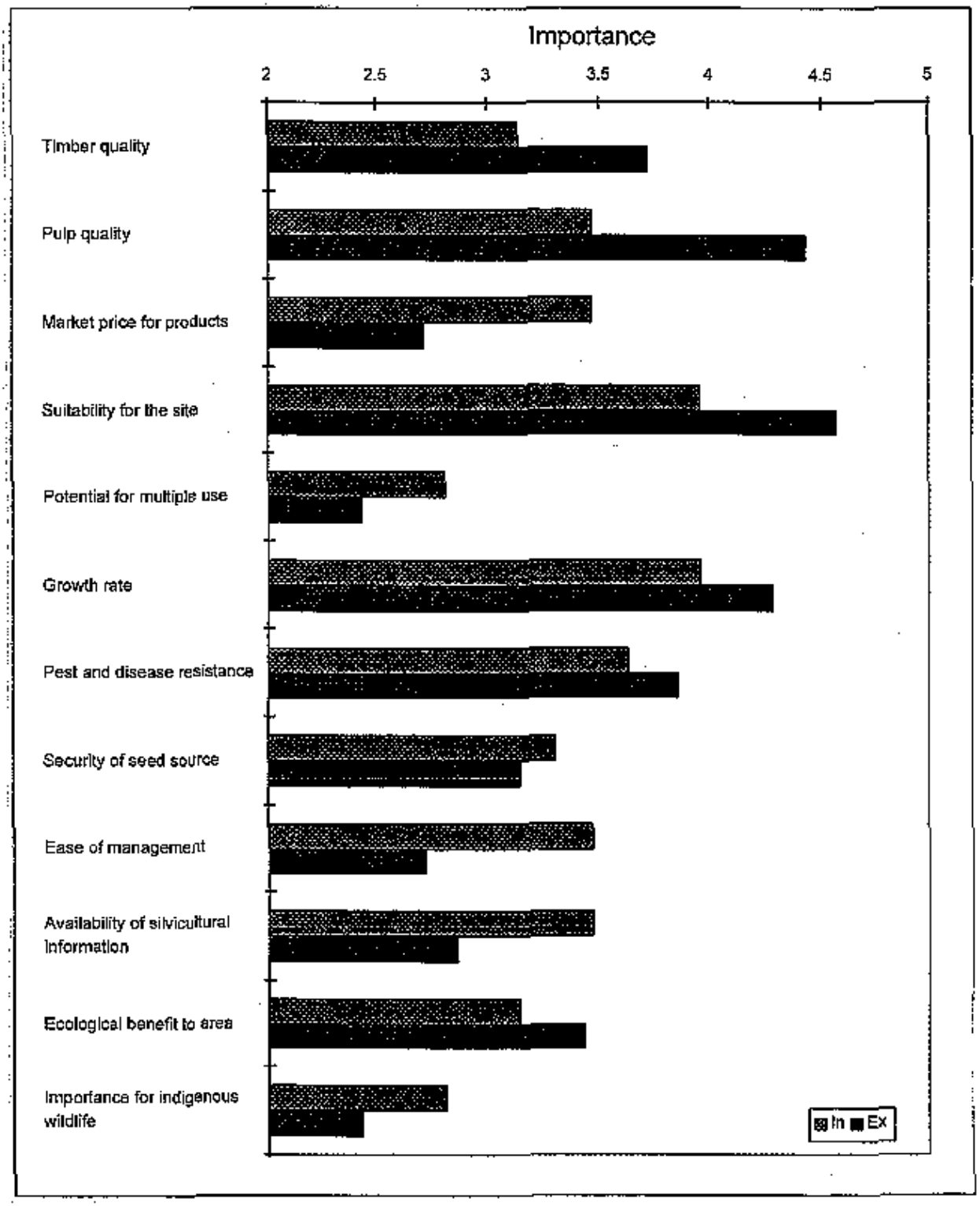

Figure 3.1 Importance of criteria for selecting the species for natural regeneration forest/ indigenous plantations (In) or exotic plantations (Ex), ranging from 1 = unimportant to 5 = critically important. (Each bar is the average for all respondents weighted to correct for total differences between the two groups.)

3.2 Industry Practice - External Inputs Intensity

A number of different aspects contribute to the overall intensity of external inputs in forestry operations. These include the degree of mechanisation, the degree of soil/site adaptation, the use of fertilisers, water management and the use of pesticides.

3.2.1. Mechanisation

The degree of mechanisation in natural regeneration and indigenous plantation forests is higher than in exotic plantations, perhaps reflecting regional differences rather than the species itself (Figure 3.2). This is particularly marked for site preparation and harvesting, an outcome strongly influenced by the high degree of mechanised practices in Scandinavia, and perhaps also the ready availability of low-cost labour for tropical exotic plantations. The only activity which is more mechanised in exotic plantations is planting, but the extent of mechanised planting for both forest types is very low.

All respondents alter the degree of mechanisation in relation to both soil and terrain (Figure 3.3). Managers of natural regeneration and indigenous plantation forests also adapt their mechanised operations for different vegetation and, in some cases, for different exposure to public view. Managers of exotic plantations, however, generally do not change their operating procedures with respect to public view. Again, this may reflect the currently lower demand for the visual integration of plantations in tropical regions. The trend in technology adoption is for low-impact, high-output machinery.

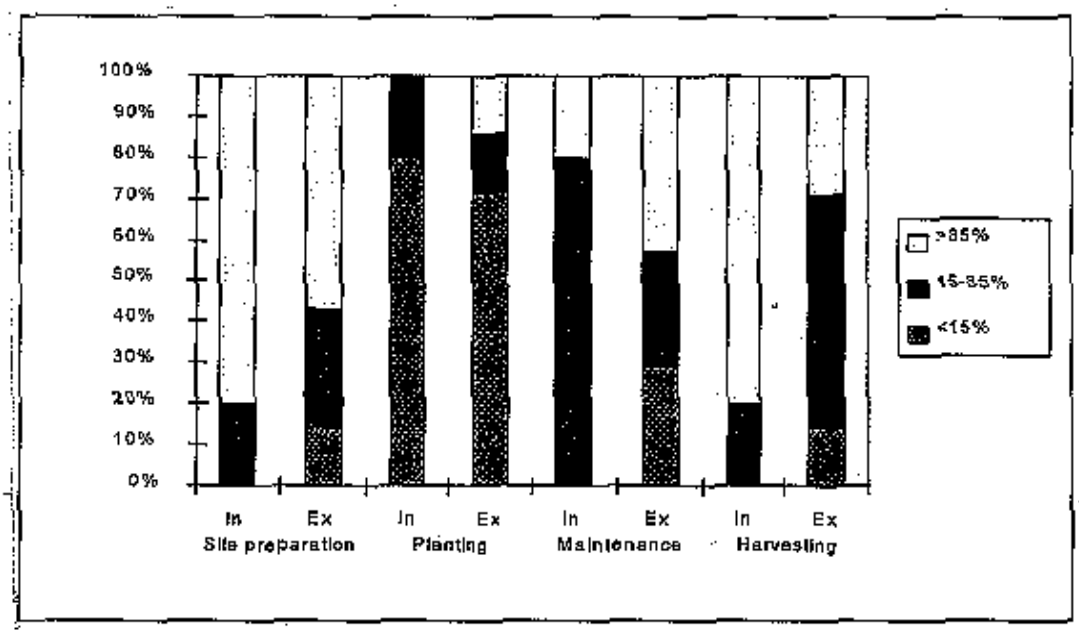

Figure 3.2: Degree of mechanisation in natural regeneration and indigenous plantations (In) and exotic plantations (Ex).

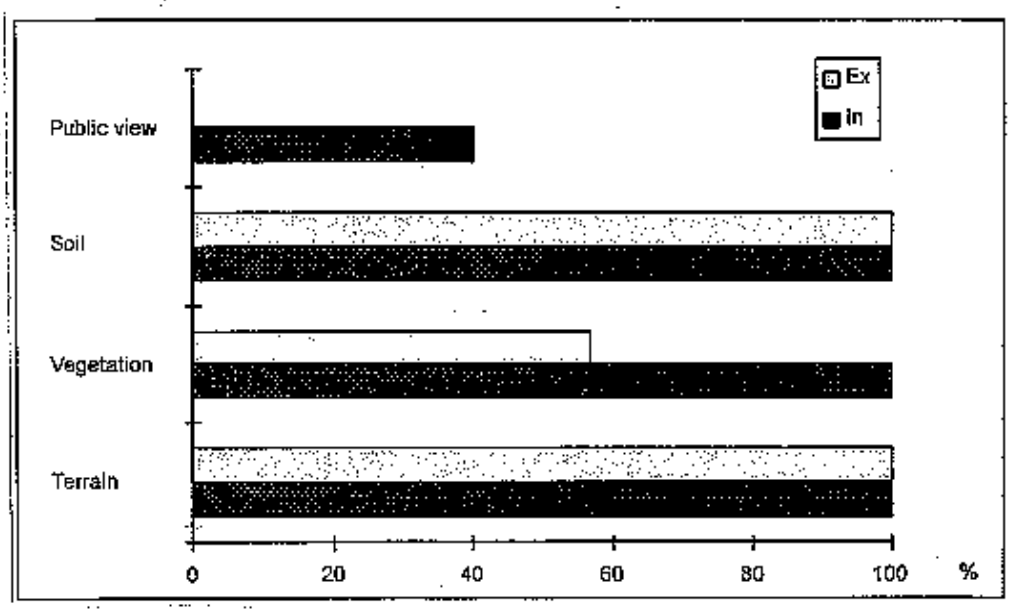

Figure 3.3: Percentage of companies which adapt mechanisation to suit different terrains, vegetation, soil and exposure to public view - in natural regeneration forests or indigenous plantations (In) and exotic plantations (Ex).

3.2.2 Soil use

Half of the respondents have areas with inherently fragile soil, including almost all those with exotic species. The area affected ranges from 2% to 40% of the total area. Most companies with fragile soils reported some degree of soil erosion as a result of their activities, but all of them have practices to minimise soil erosion such as buffer strips and contour ploughing. In addition, almost all companies planting exotic species practice some form of minimum tillage[1]. Several respondents commented that soil erosion now only occurs as a result of extreme events such as floods, or in isolated, vulnerable areas such as watercourses near tracks.

The main operations considered likely to cause soil damage in normal operations are ground-based skidding which can compact the soil, terracing (which few of the respondents use) and whole-tree harvesting (which again was seldom used as it may lead to reduced soil fertility). Almost all respondents, particularly those planting exotic species, have procedures in place to minimise the impact of operations on physical and chemical soil properties. However, very few have a monitoring system specifically to measure soil erosion or nutrient losses in harvested trees.

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1 Restriction of soil cultivation to the minimum possible disturbance, generally avoiding practices such as ploughing or soil scarification.

3.2.3. Fertilisers

Almost all respondents use fertilisers, the only exception being in some instances of boreal forest management. In general, fertilisers are applied at the time of planting, and sometimes again in the first two or three years after planting. However, there is considerable variation between different companies. Those with indigenous plantations or regeneration forests tend to apply nitrogen-rich fertilisers once or twice over a rotation. Sometimes specific cations such as calcium are also applied. In plantations of exotic species, there is widespread use of NPK (nitrogen, phosphorus and potassium) compound fertilisers, applied at average rates of 200 - 300 kg ha-1 supplemented by a wide range of other fertiliser types: superphosphate, urea, calcium and magnesium compounds and trace elements such as boron. This is not surprising given the choice of exotic species is often made in relation to their ability to grow fast and respond to good nutrition. Fertilisers in exotic plantations are generally applied at planting and again after two or three years, once roots have established and are able to make use of the fertiliser. All companies using fertilisers claim to have specific management guidelines to match fertiliser application to plant uptake in order to minimise losses through leaching and volatilisation.

The actual quantities of fertiliser used at any site are very dependent on rotation length. Therefore, sites in the tropics with rotations of less than ten years are receiving considerably larger quantities of fertiliser than boreal sites with rotations of 100 years or more. However, several respondents highlighted the fact that the levels used in the forest are considerably lower than those used in adjacent agricultural operations.

Asked about leaching to groundwater or streams, fewer than 20% of companies reported losses, slightly over 40% did not know, and the remaining 40% claimed that there were no losses. Most of these companies have measured the nutrient load of water leaving the plantation, at least on an experimental basis (Figure 3.4).

3.2.4. Water management

Half the respondents have water management policies, with others under development. Most of these companies also have some kind of monitoring programme in place, often experimentally (Figure 3.4). These programmes generally focus on changes in groundwater levels and streamflow, together with suspended sediment flow, i.e., measures of water availability and soil erosion. Companies less commonly monitor dissolved nutrient loads of streams leaving their forests and fewer than 10% have collected any data on the contaminant loads of stream water, i.e., measures of chemical pollutants. All of the companies surveyed maintain buffer strips along main watercourses during harvesting to reduce sedimentation.

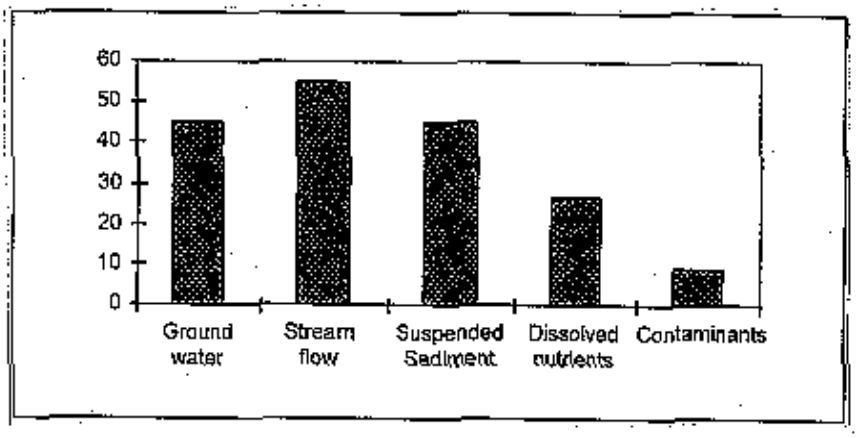

Figure 3.4: Percentage of respondents with water quantity/quality monitoring programmes.

3.2.5 Pests and diseases

Given a choice of 'high', 'medium' or 'low', all respondents managing areas of indigenous trees reported a low incidence of pest and disease problems. In exotic plantations, about 40% have medium levels, or areas with high levels. Most of these expect the situation to improve in the future and drop to low levels.

In indigenous species forests, 60% of respondents use pesticides, but these are mainly for seedlings in the nursery. Field applications are extremely low and in some cases are being phased out.

Pesticide and herbicide use in exotic plantations is much higher, with almost all respondents using them to some extent. The type and quantity of pesticide used varies considerably depending on site and company, with levels of use higher in tropical than in temperate sites. Several companies planting exotic species expect their use of pesticides to decrease in the future, while others predict no change in use. No company reports plans to increase its use of pesticides.

3.3 Industry Practice - Biophysical Diversity

The biophysical diversity of a forest is a combination of:

- the genetic diversity within each species in the forest,
- the species diversity which is both the number of different species and the relative size of each population,
- the ecosystem or habitat diversity which is the number of different types of habitat, and
- the landscape diversity which is the wider mixture of land use both in and around the forest; this latter category is a function of structural, age and aesthetic

diversity in addition to biological diversity.

3.3.1 Genetic diversity

Forest tree genetic diversity is reduced most by the use of clonal planting material. Two thirds of respondents made some use of clones, with a much larger proportion of companies that use exotic species also using clones (Figure 3.5). However, the majority of respondents make only limited use of clones. For some this is in the form of experimental and trial planting and may lead to greater use of clones in the future.

Generally the maximum area of a block planted with a single clone is 30 - 40 ha, although some companies planted blocks of up to 100 ha. The total area planted with a single clone ranges from 200 to 1,500 ha in most cases, although in one case it reached 10,000 ha. All respondents who use clones have a policy of clone planning (land use mosaics, based on clone/site compatibility) and replacement. Frequency of replacement ranges from every two to every five years.

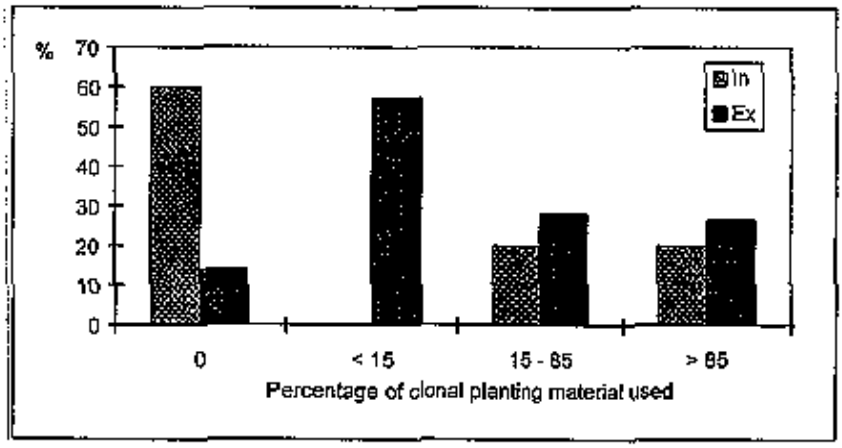

Figure 3.5: Percentage of companies using different proportions of clonal material in managed natural regeneration or indigenous planted forests (In) and exotic planted forests (Ex).

The genetic diversity of a forest can be eroded even if clonal material is not used. This happens mainly if a very narrow range of seed is used to produce seedlings for planting, or if regeneration is dependent on seed trees, and very few trees are left after harvesting. However, no specific information was provided on this issue.

A few companies have started experimental programmes aimed at developing genetically modified planting material (genetic engineering) with a view to increasing growth and disease resistance. These programmes are still in their early stages, but it is likely that the introduction of such material into plantations will cause enormous controversy, for example with concerns over 'leakage' of engineered genes, or monopolies by large companies over planting stock.

3.3.2. Species and habitat diversity

One quarter of the respondents use only one species for 95% of their forest area, while just over 40% use two species, and the remaining third use three or more species.

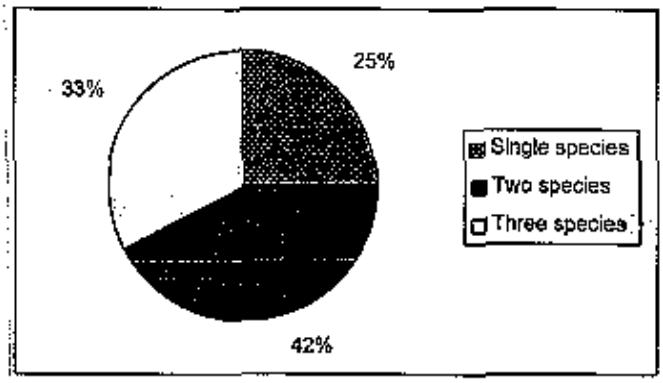

Figure 3.6: Proportion of companies with 95% of their total forest area under one, two, or three-plus species.

Exotic species are planted exclusively in single-species blocks, while indigenous species are planted in both single and mixed-species blocks. Single species blocks range from 30% to 100% of the total forest area with up to 70% in mixed species blocks. The maximum size of a block planted with a single species is generally 100 ha or less, although respondents reported areas of up to 45,000 ha. Mean block size generally ranges from 5 to 30 ha, but reaches 4,000 ha in some cases.

About 57% of respondents managing exotic plantations also have programmes of planting indigenous tree species, though these are aimed at amenity rather than production planting. Some companies do not plant indigenous seedlings themselves but provide seedlings for others to plant. Most have tested and planted a wide range of native species.

All companies managing exotic species maintain areas of indigenous vegetation within the plantation matrix. The area allocated for natural vegetation ranges from 2% to 27% with an average of 14%. In some cases, the proportion of indigenous vegetation depends on the property size with relatively bigger areas left in larger plantations. In all cases, the indigenous vegetation includes buffer strips left along rivers, and 70% of companies also maintain corridors to link protected areas.

All respondents with exotic plantations have access to studies on indigenous plant and animal species in and around their plantation areas. A decline in the number of species was reported by 28%, 15% reported no change and 57% reported an increase relative to neighbouring or previous land uses. In particular, species

numbers are said to be higher relative to adjacent agricultural land.

All but one of the respondents have active programmes to protect and increase biodiversity. The measures adopted include:

- Buffer zones along watercourses,
- Variation in clear-cut size and location,
- Old trees left unfelled,
- Specific management strategies for important habitats,
- Planting of indigenous plants,
- Control of the spread of exotic species,
- Reduction or cessation of hunting,
- Land reclamation with indigenous species,
- Re-introduction of indigenous animal species.

One of the ways in which a diversity of habitat can be maintained is by use of environmentally sensitive operating procedures, particularly during harvesting. An assessment of the relative costs of conventional and ecological harvesting carried out in Sweden is shown in Table 3. The results suggest that environmentally friendly operations are not inevitably more expensive. However, several of the companies surveyed consider that the loss of production resulting from leaving areas of indigenous vegetation, buffer strips and wildlife corridors is substantial in economic terms.

Table 3: Comparative costs (Swedish kronor) for a 38 ha clearcut in Central Sweden (Source: AssiDomän, Forestry's Green Revolution, 1995)

Year	Operation	Conventional clearcut	Site-adapted forestry
1985	Cleared	22,800	12,800
1986	Extra cost, felling		72,000
1986	Drained	38,000	13,000
1987	Patch-scarified	41,800	23,800
1988	Planted	159,600	67,600
1989	Surveyed	1,900	1,900
1989	Harrowed	41,800	0
1989	Replanted	112,000	0
1990	Replanted	19,800	0
Total cost		437,700	191,100

An important issue in the use of exotic species is prevention of their spread into adjacent indigenous forest or agricultural land. About 70% of companies planting exotic species have information on the spread of exotic plants or diseases, and programmes aimed at minimising this spread. The measures used included:

- buffer strips of native species around plantations;
- removal of volunteer plants from surrounding areas;
- monitoring of disease in the surrounding area;
- forest inventories;
- use of sterile or male only clones;
- control of non-native animal species using the area as habitat.

3.3.3 Landscape diversity

One of the most critical questions relating to the environmental impact of plantations is their role within the wider landscape. In judging the diversity of an area of forest, therefore, it is important to consider the previous use of the land.

Less than 1% of the forests covered by the survey were old growth prior to the current rotation (Figure 3.7). Overall, about one third were secondary, most of these being natural regeneration or indigenous plantation forests of which two-thirds was growing on land previously under secondary forest. Only exotic plantations have been planted on natural grasslands, whereas both exotic and indigenous plantations are planted on degraded land. Agricultural land also makes up a significant part of the area converted into both exotic and indigenous species forests. The high proportion converted from secondary forest to indigenous plantation might appear to be worrying in biodiversity terms, but in fact reflects an increase in the intensity of regeneration (with increased use of planting) to ensure full stocking, rather than a fundamental change in land use.

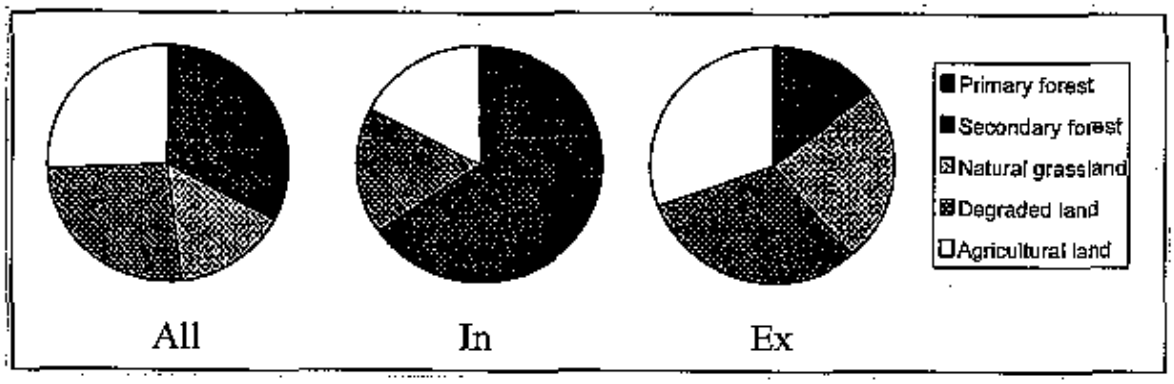

Figure 3.7: Land use prior to current forestry activities for all respondents (All), forests of indigenous species (In) and forests of exotic species (Ex)

A recent initiative in forestry has been the development of the concept of ecological landscape planning, which many corporations use, but have interpreted in different ways (Box 1). The concept behind this approach is that it is not possible or even necessarily desirable to try to produce the entire potential range of goods and

services listed in Section 1.3 from every forest. Rather, a complex mosaic of intensively managed production forest should be interspersed with areas intensively managed for other goods and services, such as protection of habitats such as wetlands and old-growth forests, agriculture or other uses. The mosaic arranges these uses in ways which optimise the connectedness of different habitats, and ensure a continuous supply of ephemeral components such as old growth trees and dead material. The total areas over which ecological landscape planning is applied range from 5000 to 25000 ha. Cost analyses between traditional and ecological landscape planning approaches are not readily available. However, in areas where current harvest levels are below annual allowable cut, there are fewer opportunity costs in moving to ecological landscape planning.

Box 1: Ecological Landscape Planning

'The aim of ecological landscape planning is to arrive at a long-term conservation strategy for a particular area. Its overall goal is sustained biological diversity in the landscape. Sustainable biodiversity means that species which naturally occur in the forest landscape today are given the opportunity to continue their existence there in viable populations within all landscape-areas in which we operate'.

(Source: Forestry's Green Revolution, AssiDomän, 1995)

3.4 Industry Practice - Use and User Diversity

3.4.1 Product diversity

The range of products produced by the forests managed by the respondents is shown in Figure 3.8. Commercially, the most important products remain timber and wood fibre, confirming the conclusions drawn in Section 3.1. However, a range of other products are produced commercially including fuelwood, meat and fish from all forest types, wood for charcoal from some eucalyptus plantations and non-wood products (mainly oil and honey) from regeneration and indigenous plantation forests. Recreational use is also a source of income for some companies.

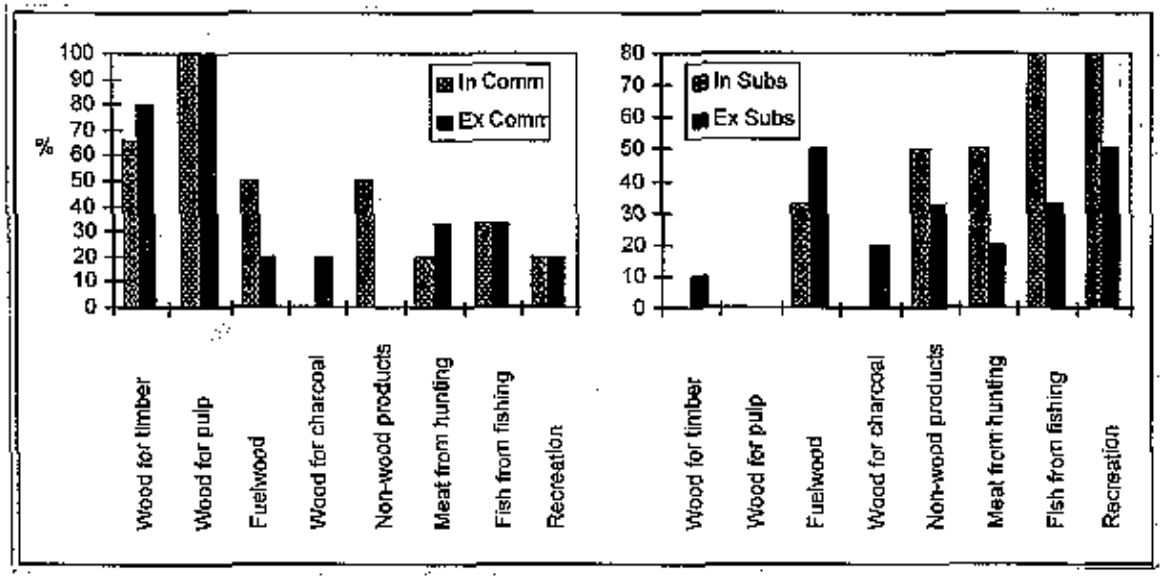

Figure 3.8: Percentage of companies reporting use of different products
a) on a commercial basis i.e. generating company revenue (Comm); and
b) on a subsistence or non-commercial basis (Subs).
Covers natural regeneration/ indigenous plantation forests (In) and exotic plantation forests (Ex).

Products produced on a subsistence or non-commercial basis form a mirror image to those produced commercially (Figure 3.8) with recreation, meat from hunting and fish from fishing the major subsistence products along with non-timber products (mainly honey and fruit) and fuelwood. The proportion of respondents whose forests provide a particular product or service is higher in natural regeneration forests and indigenous plantations, which may in part reflect geographical location - the demand for recreational activities in the forest, for example, is higher in temperate than in tropical countries - but could also be a function of the tree species grown.

3.4.2 Social impacts of forestry

The social impacts of forestry are complex. While almost every major forestry company now produces literature on its environmental performance, social issues are less widely discussed in public.

One of the most contentious issues worldwide is that of indigenous peoples' claims to areas belonging to, or being managed by, forestry companies. 40% of the respondents reported that at least part of their land was being claimed in some way by indigenous people. Some companies have responded by working with indigenous people, while others are awaiting the results of lands tribunals.

Many failures of plantations have been blamed on the lack of benefits for local

communities. However, all of the respondents in this survey reported that they have agreements with members of local communities about either access to plantations or use of resources. Freedom of access to the forest area is variable, but in general it is 'conditional' with the exception of companies in Scandinavia where forest access is essentially free to all under the law.

As discussed above some, though not all, forest areas provide a range of subsistence products. Many companies also provide a range of services for local communities, including education, health care and roads and transport facilities (Figure 3.9). In addition, companies reported providing sports facilities, donations to local cultural groups, a fire department and contributions to public TV.

About 60% of respondents either ran an outgrower scheme or provided an extension service for private landowners who grew trees, indicating that there is a degree of mutual interdependency. One example of an apparently very successful partnership between local people and a company growing exotic trees is the CEASA programme in Spain (Box 2). Another example of an apparently mutually beneficial project, which was set up between forest managers and local people in South Africa, is given in Box 3.

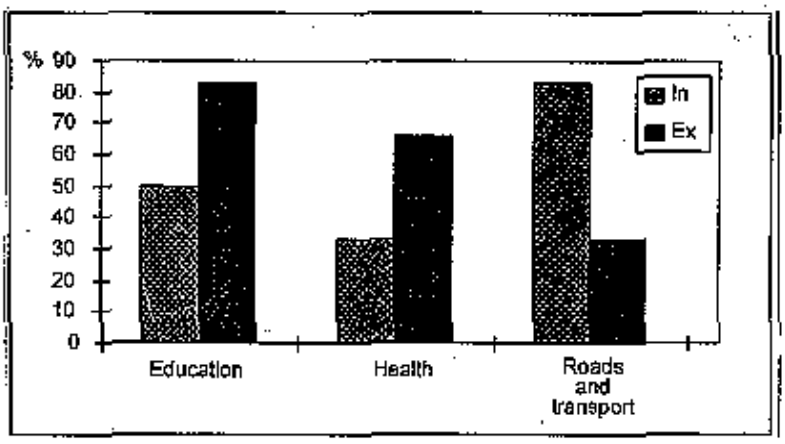

Figure 3.9: Percentage of companies providing education, health or transport facilities to local communities - those managing natural regeneration/ indigenous planted forests (In) or exotic plantations (Ex).

Box 2: The CEASA Rural Assistance Programme

CEASA (Celulosas de Asturias S.A.), located in Spain, has invested considerably in producing genetically superior eucalyptus trees to produce high quality pulp. In addition to its own plantations, it also embarked on a programme of rural assistance for the farmers in the region where it is located. Over 3000 farmers now participate in the programme which is bringing much needed cash to a region badly affected by the decline of agriculture in Europe.

Farmers are provided with genetically improved planting material and training which allows them to reap some of the benefits of the breeding and improvement programme carried out by CEASA.

Box 3: An example of synergistic multiple-use forestry in South Africa

In the eucalyptus plantations of HL&H Mining and Hans Merensky Holdings, landless local people, mainly women, are allowed to plant ground nuts in the newly clear-felled areas in return for weeding and preparing the land in preparation for planting. They are able to use the area for two years after the trees are planted, with one harvest per year, before moving on to the next clearcut.

However, examples of reductions in multiple use are also seen such as the ending of rights of local women to collect fruit from plantations for sale to juice manufacturers because foresters are 'anxious to tighten their controls'.

Source: Department of Water Affairs and Forestry, 1995

3.4.3 Employment

The forest sector is potentially a major source of employment. Companies responding to the questionnaire employ between 20 and 10,000 people directly, and between 75 and 9,000 as contractors. The average number of direct employees is 1,700 and contract employees was 1,800, suggesting that some companies preferentially use contract workers. Specific details of wages and conditions for employed and contract workers were not collected, but in general, contract workers usually have lower wages and often poorer working conditions than those directly employed. In addition, some countries have reported that an increasing trend towards contractors has led to some problems including poor

quality of work and failure to adhere to operating standards (Department of Water Affairs and Forestry, 1995).

Exotic plantations appear to provide a larger proportion of permanent jobs than indigenous forests (Figure 3.10). This may in part reflect regional differences since seasonal work is restricted mainly to temperate and boreal forests, while tropical forest managers are able to carry out most of their operations throughout the year.

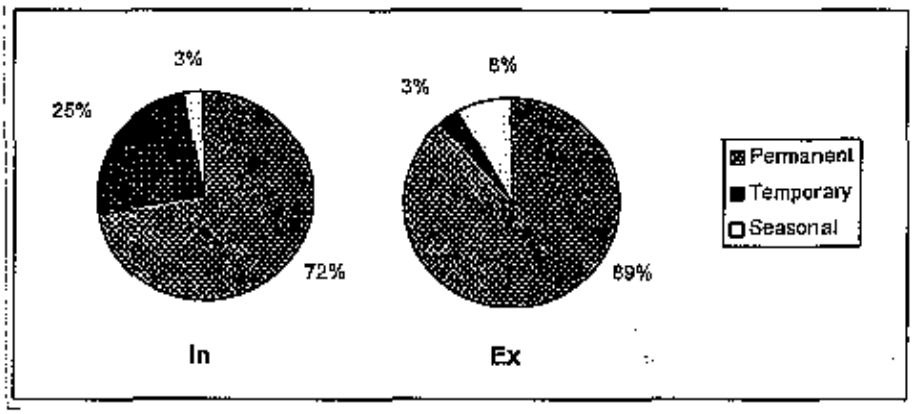

Figure 3.10: Proportion of permanent, temporary and seasonal workers in companies managing natural regeneration and indigenous planted forests (In) and exotic plantations (Ex).

The majority of people employed in forestry are recruited either locally or in the surrounding region for all forest types (Figure 3.11). Less than 2% of the total come from outside the region.

On average, less than one third of forest workers are unskilled, while half or more are skilled (Figure 3.12). However, the average figures hide a wide range of situations with some companies having up to 80% unskilled workers. There was no pattern relating to forest type in the level of skills, but some correlation with the degree of mechanisation since machine operators are considered more skilled than manual labourers.

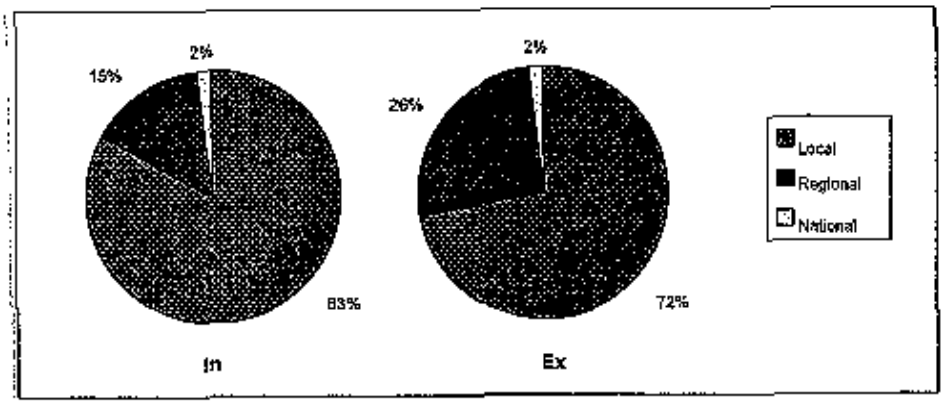

Figure 3.11: Origin of employees (local, regional or national) in natural regeneration and indigenous plantation forests (In) and exotic plantation forests (Ex).

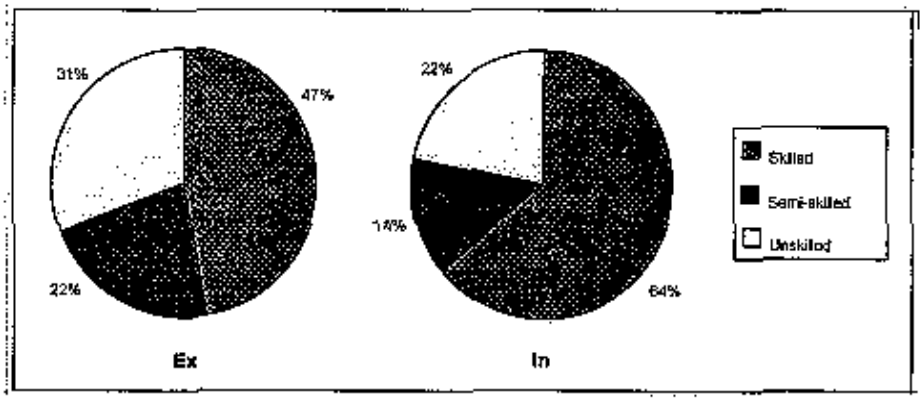

Figure 3.12: Proportion of skilled, semi-skilled and unskilled workers working in natural regeneration and indigenous planted forests (In) and exotic planted forests (Ex).

In South Africa, it has been reported that larger companies tend to pay 30 - 50% higher wages than smaller companies and also provide a wider range of benefits including pensions, housing, subsidised meals, medical facilities and schooling. This can cost up to one third to one half of the salary cost (Department of Water Affairs and Forestry, 1995). Similarly, reports from Brazil suggest that conditions of employment in plantations are putting pressure on large farms to improve the traditionally poor working conditions of agricultural workers.

3.5 Industry practice - stakeholder relations

It is clear from the survey that companies producing wood fibre on a large scale throughout the world are aware of the need to operate in a way which is environmentally friendly, and to be recognised as such. All respondents considered public relations to be 'very important'. All the companies surveyed produce some form of publicity material. Local and national audiences and customers are targeted by all respondents, and international audiences by more than two thirds.

The budgets for PR were not available for all respondents, but for those who were able to give a figure it ranged from US$50,000 to US$2,000,000 annually with a mean close to US$500,000. This enormous range and high average reflects, in part, that some of the figures are for entire integrated companies, rather than just forestry companies. Even so, an average of half a million dollars annually for each company is a very large sum, and until recently unprecedented in the forest industry. Several respondents added that these were direct costs and did not include all the costs of staff time.

Part of these budgets has been spent on the growing volume of publicity material which is specifically aimed at improving the image of forestry. Over the last five years, most annual reports of forestry companies have added an environmental section. Many companies now also produce a specific environmental report. Governments and industry associations in major forestry countries are also pursuing a greener image with the production of substantial amounts of publicity material. For some, these are by-products of introducing environmental policies or preliminary steps towards introducing environmental management systems.

Undoubtedly this PR effort is being accompanied, in many cases, by concrete efforts to improve management practices. One example is the Forestry Division of Shell which commissioned a comprehensive review of the effects of plantation forestry from which a set of guidelines for its own plantation operations was produced (Shell and WWF, 1993). Many other companies have hired wildlife biologists, ecologists and sociologists to help with development of improved management strategies, or formulation of new philosophies and policies of forest management. And increasing resources are being applied to dealing with stakeholder concerns.

Forestry has been the subject of considerable criticism over the last decade. All the companies surveyed had received criticism from at least one group of external stakeholders. Local groups have expressed concern over some aspect of forest operations to 80% of responding companies (Figure 3.13), with over 70% of companies reporting questions from regional groups and 60% from national interest groups. However, very few companies reported any criticisms from their customers. This strongly supports the contention that pressure from special interest groups rather than more general consumer concerns has led to modifications in practices leading to improvements in environmental performance. It may also reflect, in part, the length of the chain of processing, manufacturing and

distribution activities which separate forests from the general public.

The most frequent cause for complaints relate to reductions in biodiversity and concerns about the species planted. Few of these complaints are felt to be justified by the forest companies, particularly those concerned with species choice. This brings the discussion once again to the question of whether monocultures and exotic tree species are inherently bad, and different groups' perceptions of the values of these forms of plantation. This question is only partly resolvable through improved research and information; it is also a question of values.

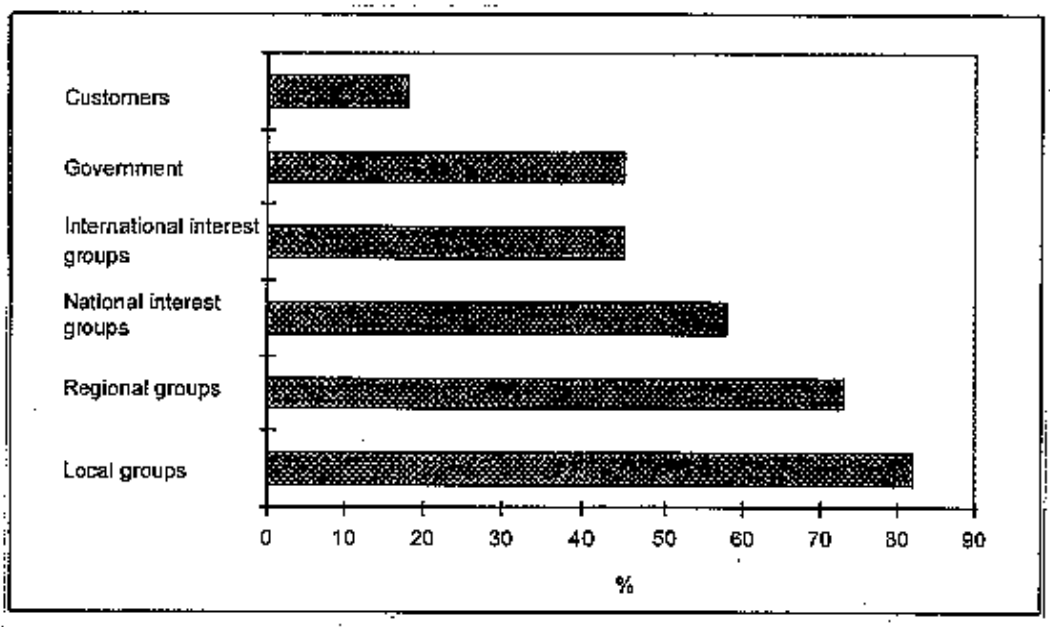

Figure 3.13: Percentage of respondents who had received criticism of their forestry activities from different stakeholder groups.

On the other hand, a higher proportion of complaints about a lack of local peoples' involvement, restricted access to forest areas, poor management practices and land rights and tenure were felt to be justified by companies. In some cases, respondents had taken actions which included:

- regular meetings with local people,
- initiating open days and educational trips in the forest,
- increasing the number of gates and tracks in the forest,
- improving operational practices as discussed in Section 3.2,
- improving safety precautions where operations impact upon local communities.

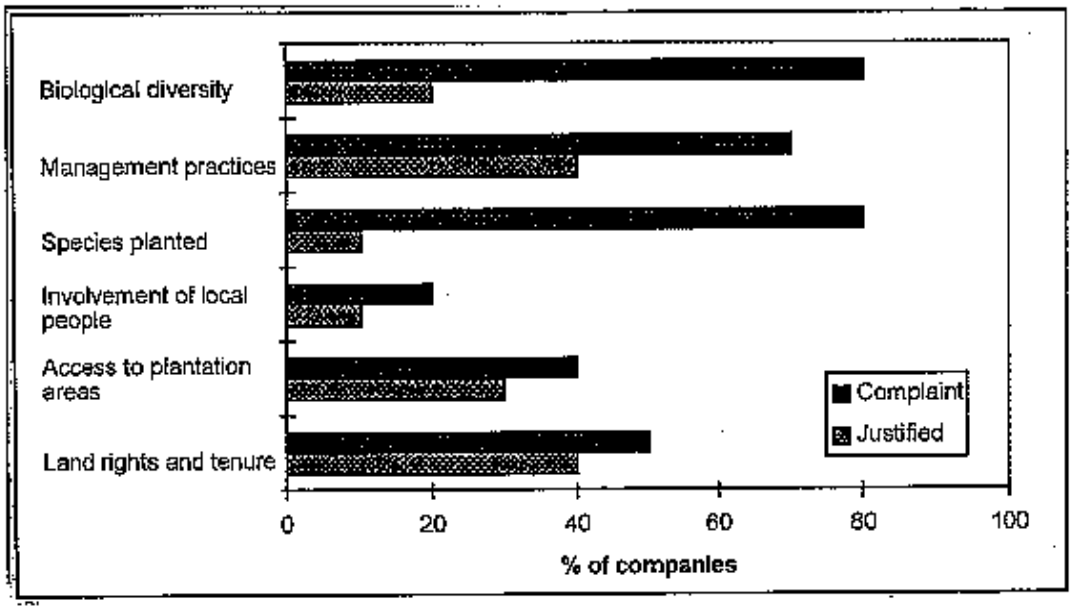

Figure 3.14: Main criticisms of forestry companies made by stakeholder groups; and the degree to which companies felt the criticisms to be justified.

One way in which forest mangers in Sweden are beginning to respond to criticism of forest activities is by providing more detailed information for the public. Instead of just producing an environmental report highlighting all the "good things" done over the last 12 months, some companies have begun a programme of internal audits of their performance which is analysed and published as part of the environmental report. An example is given in Box 4. It seems likely that forest companies will increasingly be asked to collect and publish information on their environmental performance, not only by pressure groups, but also by potential customers, investors and even employees.

One way of doing this is through certification of forest activities, which has been discussed in depth in Upton and Bass (1995).

Box 4: A report with more information - the Ecological Balance Sheet

'The purpose of the sheet is to show:

- How we respond to site conditions in our regeneration planning, i.e., if we are applying the correct regeneration measures with regard to local conditions.
- How the extension courses of recent years in site-adapted forestry have succeeded in permeating our organisation
- How we respect the need for nature and water conservation in our everyday forestry practices
- The extent to which we reach our production and environmental goals - i.e., high and sustainable economic returns, plus a healthy ecosystem over the long term, maintaining biodiversity.'

Evaluations are made based on 60 criteria and 390 sub-criteria, each of which are marked on a 5-point scale with 5 the highest. Average marks are reported for harvesting operations - site adaptation, conservation measures and water-protection measures for the current and previous year. Each work operation such as final-felling, tree-species selection and site preparation at a number of randomly selected sites was judged as: proper method, acceptable method, dubious method and improper method. Damage to sensitive biotopes such as rocky outcrops, springs, ravines and swamp and virgin forest were assessed as: completely undamaged, moderately damaged and seriously damaged.

(*Source: AssiDöman, Environmental Report 1994*)

4 Conclusions

We began this report by suggesting that forestry is entering a new era in which forest management must address a wider range of issues than simply the efficient production of timber or fibre. The ultimate goal of this new forestry is 'sustainability', and though much disagreement remains as to what this means, there are a set of requirements which have wide acceptance:

- sustained yields of goods and services *(timber products, non-timber products, protection of soil and water, maintenance of ecosystem functions, continuing forest health and vitality, contributions to local and global climate)*;
- conservation of biological diversity *(at the ecosystem, species and genetic level)*;
- positive social and economic impacts *(on indigenous people, local communities, employees and the local and national economy)*.

However, this list is very general and the challenge for forestry is to move from broad definitions to specific practices. In order to assess the relative 'sustainability' of any particular forest management system we suggested that it was useful to think in terms of the system's characteristics (described in detail in section 1.1.2):

- External inputs intensity
- Biophysical diversity
- Use and user diversity

As external inputs intensity decreases, sustainability increases in that an assured level of external inputs becomes less necessary. As biological and structural diversity increase, the stability of the system and its long term sustainability in general increases. As use and user diversity increase, the dependence on a single product for a single user decreases. This has serious implications for plantations since, in comparison to natural forests, normal practice tends to entail relatively intensive levels of external inputs, low biophysical diversity, and low use and user diversity.

We have also established, however, that one of the most important issues relating to the sustainability of plantation forestry is that of scale. It is necessary to establish, for each characteristic, the scale at which it should be applied: at the stand level, at the level of the forest estate or concession, or at the landscape level. Scale is particularly important in assessing the sustainability of plantations since they are less able than natural forests to provide the full range of sustainability requirements listed above.

- The *stand level* is the smallest operational scale. It might be a single clearcut area in a large plantation or a small private woodlot. Mixed-species or complex plantations provide one way forward, especially for small enterprises, but there are limitations. There are few large-scale examples of successful commercial mixed species plantations, especially in the tropics. In many cases, single species blocks are cheaper, more productive and easier to manage, especially

with mechanisation. Almost all the companies who replied to the survey plant in single species blocks and do not have plans to change this practice.

- The *concession or forest estate level* may cover a variety of forest types, topographies, land uses and forest stands and is the scale most applicable to long-term forest management planning. It is at this level that plantation managers can most easily address the issues of diversity i.e. build in the complexities required to produce the wider range of benefits desired, and to increase the resilience of the wood production system. Ecosystem forestry, landscape design and forms of partnership with local groups provide ways forward for large-scale plantation managers. Most of the companies responding to the survey were attempting to increase complexity at this scale. Some have made considerable progress, and the most innovative could certainly offer a great deal in the way of advice and ideas to those with less advanced management.

- *The landscape level* covers a much larger area including plantations, but also agriculture, national parks, urban areas and any other land use. Planning the integration of plantations with these land uses is highly dependent upon recognised systems of consultation and participation. In some countries, regional land use planning provides one means, but in many places, institutions and methodologies are yet to be developed. In this case, *ad hoc* or specially created systems for consulting with neighbouring land users are of help. However, ultimately, government policies need to be formulated to encourage the most efficient means of obtaining all required goods and services from the different land uses within the landscape. A better understanding of issues at the landscape level is vital to a real discussion about plantation sustainability. Many of the companies surveyed, particularly those with exotic plantations, repeatedly compared themselves to adjacent agricultural land rather than to natural forests. The analysis of the previous uses of plantation land justifies this view to a considerable extent since almost two-thirds of exotic plantations are located on land which was previously 'degraded' or used for agriculture, while less than 20% were established on forested land.

A second very important issue is that of who should be involved in defining and implementing sustainability at each of these levels: in particular, government, NGOs and industry. The question then is: at which of these scales should the forest manager and the wider range of stakeholders be seeking complexity and acceptable forest management practices? Must all areas supply all the goods and services required, or can different areas provide different services?

Taken on its own terms, a forest of high complexity in all dimensions is likely to be more sustainable than a forest of low complexity. But forests of low complexity (in one or more dimensions) are often legitimate because they are of high productivity. Such "legitimacy" can be conferred as a result of a mix of

professional assessment of economic and environmental sustainability, and a process of consultation with interest groups using accepted participation institutions and methodologies. In such cases, sustainability then needs to be "imported" into the system through good integration with surrounding land uses. In other words, it is the surrounding land uses which provide some of the complexity required to produce benefits such as biodiversity and recreation. This can be achieved through, *inter alia*:

- government planning to ensure that sufficient totally protected conservation areas or national parks are maintained;
- compensatory investments by plantation operators in surrounding land uses e.g. in wildlife management or recreation provision;
- plantations taking wood production pressure off surrounding land uses, especially natural forest;
- management agreements with surrounding land users.

The following discussion now examines how far government, NGOs and industry have responded to the issues of sustainability as they relate to plantations, and how far these responses are likely to be supportive of good practice.

4.1 Government response

Governments can intervene to influence plantation management in three ways: through legislation, through incentives and through planning.

- *Legislation:* In general, legislation tends to target the forest stand and the forest estate levels by encoding compulsory and for prohibited management practices. Very detailed laws are not always the most useful - there are many examples of countries with excellent legislated requirements for forestry and very poor performance in practice. Simpler laws to set benchmark levels for important requirements such as water quality or protection of rare species have often been more useful, although any overly prescriptive legislation tends to lead to difficulties. Some countries concentrate on prohibiting adverse effects, whereas others prescribe practices.

- *Incentives*: In the past, governments have sometimes provided a range of incentives such as tax breaks and easy access to land which have favoured big plantation companies and encouraged large-scale planting of monocultures. Such schemes rarely involved participation of any stakeholders other than the industry and the government, and many did not prove sustainable (see Appendix 1). There has been a movement away from such schemes in general. However, if governments consider that their production forestry needs are best served by large companies planting intensively managed plantations, then it is essential that there is a clear independence between members of the government and the

industry. This is not always the case and has led to suspicion from other stakeholders and poor decision-making by government.

A question related to sustainability, however, is whether subsidies are acceptable at all - in other words, if the subsidy were removed, would the plantation collapse? If the answer is yes, this would raise serious doubts about long-term sustainability. However, there may be circumstances under which it is reasonable, or even desirable, to use subsidies. For example to encourage the replanting of degraded land, stabilising watersheds or providing buffer zones around natural forests; that is, subsidies might be acceptable where private costs are incurred to produce public environmental or social benefits. The circumstances under which such subsidies might be acceptable, however, are likely to be very geographically specific, and care is always needed in the use of incentives, since differing priorities can lead to confusion. For example, incentives aimed at encouraging industrial plantation establishment implemented by one government department may conflict with the attempts of another to broaden the goals of forestry.

Incentives, particularly those available to large companies, are generally targeted at the forest estate level, though they may also target the forest stand in some situations, especially when aimed at small landowners who only own a single forest stand.

- *Planning*: If a government is to use legislation and incentives effectively, it needs to formulate a clear policy with regard to forests, particularly at the landscape level. Failure to think through a coherent forest policy can result in legislation, incentives and plans which are contradictory or inconsistent. However, detailed central planning is often not helpful. Rather, the most useful contribution the government can make is to define the *processes* which must be used to plan land use and forest management at a regional or local level, and to help outline the important aspects to be considered.

To maintain the wide array of goods and services required from the permanent forest estate, it is almost inevitable that some degree of 'zoning' will be needed, especially where it is clear that some forests are of distinct value for protection purposes and should be subject to no, or minimal, management for production. The government needs to:

- define the area and assess the condition of the permanent forest estate;
- protect certain areas as National Parks or similar to ensure that adequate conservation areas exist;
- assist in developing appropriate definitions of what constitutes 'sustainable forest management' at the national level and in disseminating this information to forest owners and mangers;
- define the processes by which regional and local land use plans should be made;

- define the processes by which stakeholder involvement in land use decisions is ensured;
- improve awareness and education of forest issues, and of different demands on forests, so that stakeholder involvement is well-informed.

Many governments are already involved in one or more of these processes, and as the agreements made during and after UNCED continue to influence policy-making, this is likely to increase. However, there is still, perhaps, too much dependence on prescriptive legislation and government 'policing', rather than on creating the necessary *processes* to encourage and maintain improved forest management.

- *Reducing negative impacts abroad:* Governments need to stop "free-riding" on poor forest practices in other countries. In structuring its policies, a government may be tempted to improve the social and environmental management of forests at home, and to shift the burden of pulp supply onto other countries. However, this production may be unsustainable - and so decisions to depend upon imports need to be informed by analyses of the "ecological footprints" caused abroad by the production of pulpwood for import. [1] Such analyses need to be made by major importing companies if they are not made by government. Plantations, at both home and abroad, have a potential role in reducing net negative impacts.

To sum up, Governments are influenced by international and national pressure whether direct *e.g.* due to campaigns, or indirect *e.g.* loss of markets or trade difficulties. Therefore, they need to understand their own forest resources in order to ensure optimal use and planning. However, beyond major decisions related to the PFE and the extent of reliance of foreign wood sources, central forest management planning by governments is rarely successful. More often the need is for regional or local planning and control within the context of overall government policy. This can provide better incentives for plantations to be integrated at the landscape level.

4.2 The response of NGOs

Plantations have been conceived and managed very poorly in the past, and some NGOs were instrumental in drawing attention to many practices which even industry now accepts were wrong (see Appendix 1). This will continue to be an important role. Early NGO attention tended to compare plantations with natural forests - since so many plantations were developed through deforestation. Nowadays, plantations are beginning to be accepted on their on terms, and NGOs

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[1] For example, the UK depends for its timber and pulp/paper upon foreign forests covering at least three times the UK's forest area (IIED, 1995). And, even though only 1% of global pulp supply derives from tropical rainforest (Hagler, 1995), there still remain opportunities for companies to "free ride" on the latest opportunity to take advantage of unsustainable rainforest logging.

are trying to improve their management.

External inputs intensity
Environmental NGOs are generally opposed to input-intensive management. One of the earliest issues raised by NGOs with respect to plantation forestry was that of soil and water disturbance by practices such as clearfelling, burning and ploughing. Many of the more destructive practices have now ceased, and there is wide agreement between all stakeholders that soil and water resources must be conserved.

More recently, there has been particular focus on the use of chemicals (pesticides, herbicides and fertilisers) in plantation forests, with many NGOs advocating significant reductions in, or even complete cessation of, chemical use. This is an issue which is likely to cause ongoing discussion between industry and NGOs, since the results of the questionnaire suggest that though most companies try to minimise the use of chemicals, very few intend to stop using them altogether.

Biophysical diversity
Biodiversity has become one of the major environmental issues of the 1990s. One of the main objections to 'plantations' is that since many are of exotic species their establishment represents a loss in biodiversity. However, an examination of the response of NGOs to this issue raises an interesting point: although there has been considerable opposition to exotic species in monoculture plantations by some NGOs, others have been promoting the use of exotic species in land reclamation or agroforestry. This highlights the need to explore how far plantations should be considered as a type of agriculture. It also serves as a reminder that there are huge numbers of NGOs and a great diversity in their views.

On wider issues of biodiversity such as the protection of rare species, preservation of habitats, and wildlife corridors, many NGOs have been instrumental in highlighting problems and providing information and ideas on best ways forward.

Use and user diversity
Social NGOs have been foremost in highlighting the plight of indigenous peoples and local communities in situations when forest operations have caused real suffering and abuse of human rights. They also provide valuable fora for less powerful groups to use to express their viewpoint. However, in some cases, part of the negative response of NGOs to plantations is more to do with the issues of large corporations and big land-owners than with plantations *per se*. It is important that the issues are clearly understood, and that objections in one area do not lead to blanket criticisms in others.

Overall, although there has been considerable concern about single-species plantations, some of the larger NGOs are trying to build a constructive relationship with plantation companies, for example:

- the WWF-Shell plantation guidelines which aim to set out a way to implement plantation forestry that maximises benefits and minimises the social and biological costs.
- Greenpeace's 'The Plantation Effect' which, though critical of some current plantation practices, does include details of the conditions under which plantation forests are acceptable.

Both of these organisations point out the importance of landscape level planning to ensure that the goods and services which are not provided by plantations are provided by other elements within the landscape. May of the continuing problems are a function of the industry's necessarily experimental approach to the many demands now being placed on them. For example, in attempts to improve social sustainability, some companies are running outgrower schemes. However, there have been incidences of outgrower farmers (and not the company itself) encroaching on natural forests. Corporate-NGO partnerships now need top extend from beyond the meeting room to key field activities, to help the transition to SFM. NGOs can be effective brokers between the private sector and communities, as well as advisors and watchdogs.

NGOs have led the way in developing independent international standards of forest management to allow independent verification of forest management. The Forest Stewardship Council, which co-ordinates this process, has outlined the conditions under which plantations are acceptable:

> *"While plantations can provide an array of social and economic benefits, and can contribute to satisfying the world's needs for forest products, they should complement the management of, and reduce pressures on, natural forest."*

FSC is of special significance as it has - for the first time - brought together many of the NGOs' disparate views and taken them through a negotiation process with forest stakeholders.

To sum up, NGOs provide a vital 'watchdog' role to prevent bad practice. In addition, some NGOs have been very proactive in promoting sustainable forest management through collaborative research and development with industry and through the establishment of independent definitions and standards. However, some extreme groups have shown a tendency to continue to attack companies which are attempting to improve their performance. This perpetuates a climate of confrontation, and serves as a disincentive to industry to change. Field-level partnerships are now called for.

4.3 Industry response

Overall, it is clear that the industry is aware of the need to incorporate a broader range of goals into plantation management strategies, and that some companies are already doing so. Many large companies appear to be innovative in finding ways to improve management practices at the forest stand, and particularly at the forest estate scale. There remains some disagreement about how or why this should be done, and some companies are still reluctant to change.

- *External inputs intensity* is generally fairly high in plantations, especially at the stand level, with use of mechanisation, fertilisers and pesticides. As all of these are dependent on fossil fuels, a finite resource, they cannot be considered sustainable in the broadest sense. The need to protect soil and water resources is more widely accepted and operations are adjusted accordingly, though not all operations monitor changes in soil and water quality. Overall, plantation management is less intense than agricultural practice in the same region, but appears to be more intensive than natural forest management. However, plantation management in the tropics is frequently much less destructive than adjacent natural forest exploitation. External inputs intensity is very dependent on region since the short rotations which are possible in warmer climates result in more frequent forest operations that are used in longer rotation plantations. In general, however, the quantity of chemicals used in a whole rotation is the same as that used in an annual farm crop i.e. from less than 1% to 10% of the agricultural levels.

- *Biodiversity:* The major issue at the level of genetic diversity is the use of clones. Most of the companies surveyed are using clonal material for at least part of their planting, and some use almost exclusively clones. Generally those using clones have programs to replace them regularly, and do not plant too large an area with a single clone. However, this is not always the case and it appears that improvements could be made in clone management by some plantation managers. Even where clones are not in use, few of the respondents are actively promoting increased genetic diversity at the stand level.

  At the scale of species and habitat diversity, there is considerable variation within the industry. Some companies are well-advanced with the implementation of strategies to maximise diversity and protect rare species or important habitats, while others have progressed little beyond the basic requirements for leaving strips of native vegetation along rivers or around plantation boundaries. However, almost all plantation companies have access to information about diversity in and around the plantation and many point out that, although plantations are less diverse that natural forest, they are usually much more diverse than adjacent agricultural areas. One point which seems clear is that large corporations are both willing and able to do more than smallholders to plan and implement conservation strategies. This is for a number of reasons, the most important of which seem to be: large companies can afford to employ biologists and ecologists and therefore undertake their own research; it is easier

to set aside a portion of a very large land base for conservation purposes than a significant proportion of a smallholding; in many countries strict legislation for companies is more acceptable than strict legislation for either government or privately-owned forests.

Very few of the respondents are at the stage of using genetically engineered material at this time, but this is clearly an area which is going to require considerable thought and discussion in the near future, since antagonism to genetic engineering is strong and widespread. Participatory and consultative processes will be essential, as will support to independent research.

- *Use and user diversity*: Most plantation companies produce several other commercial or subsistence products in addition to wood, but clearly management objectives remain predominantly about timber and fibre production, particularly in exotic species plantations. Most plantations are used by other stakeholders apart from the company, though such use is generally conditional. However, almost all plantation operations routinely provide a range of goods and services such as roads, health care and education for their work force and frequently to local communities as well. Many companies clearly feel considerable pride in the wider care provided for employees and local people.

  Pressure to change management practices comes from a range of sources (Figure 4.1). Almost all companies reported complaints by local communities which they felt were justified and to which they had responded. Most also had some means of communicating with local communities, although in most cases the methods did not appear to be very participatory. Complaints made by national or international groups were felt to be less justified, and far less information was given about what response was made to such complaints, suggesting that companies are more open to responding to specific complaints by local people rather than international groups.

  Communication with the outside world is important, however, and every company has a 'public relations/advertising' budget, often a very substantial one. Interestingly, costs of improvement in environmental management are often charged against this budget, emphasising the importance of outside pressure (particularly national and international) in improving environmental management. In future, a larger proportion of such budgets should go towards two-way collaboration (discussion, management agreements, monitoring, etc) as opposed to PR.

Overall, plantation managers are beginning to listen to and act on many of the criticisms made over the last decades. Several companies have become very proactive and, in particular, they are leading the way with designing and testing *practical solutions* for implementing sustainable forestry. This is an essential complement to those academics and NGOs which are attempting to define

idealised solutions.

Box 4.1 summarises what we believe are some "best bets" for large-scale plantation practice, bringing together the best of current approaches. However, in most companies much is still being done in a fairly *ad hoc* way. Some companies have formalised systems or procedures to ensure that management is improved, that environmental impact is reduced and that improvements are maintained and increased, but many others do not. Yet all companies are now operating in a changing atmosphere where it is becoming essential to be able to monitor shifting requirements and change rapidly. In particular, industry may face:

- changing concepts of good forest management;
- changing needs for land, timber or fibre;
- changing climate, levels of atmospheric CO_2, and ultraviolet radiation.

Therefore, industry must be flexible and responsive which is more likely to be the case if plantations are complex and management intensity is not too high.

To sum up, companies need to possess the internal *processes* and *expertise* necessary to achieve and maintain sustainable management of plantation estates within the wider land use context. (Environmental) management systems are usually the best options for guiding such processes. The recent strengthening of ecological expertise at high levels in companies needs to be complemented by environmental and participatory skills amongst forest workers. This will keep the impetus up for real changes in practice - and not just talk and planning - provided the right tasks, incentives and appropriate authority are accorded to field staff. Since definitions of 'sustainable management' are likely to change, demands on products/services change, and technical possibilities expand, companies need to be responsive and flexible. Such capabilities are needed throughout the organisation.

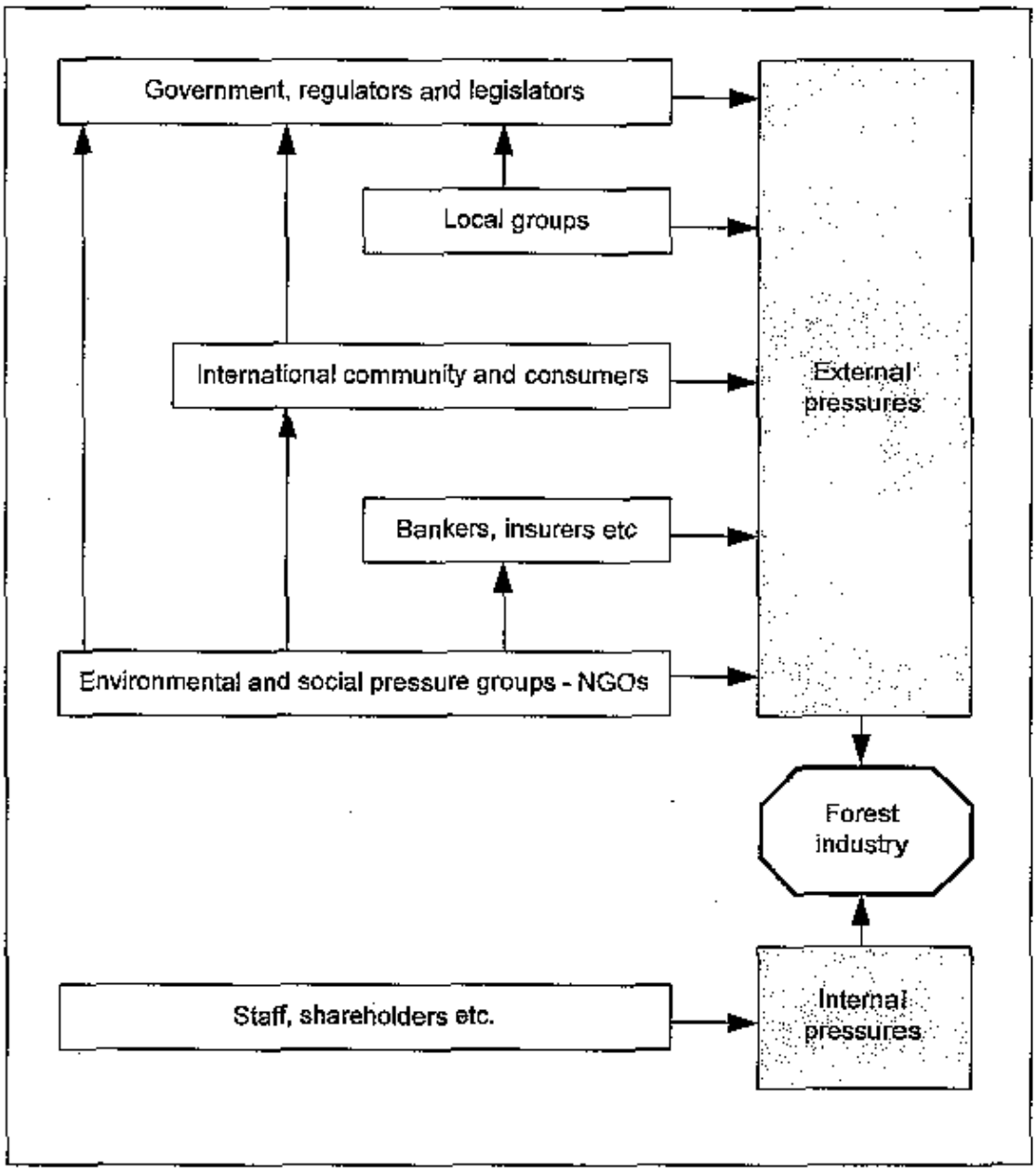

Figure 4.1: A schematic representation of the internal and external pressures on a forest operation.

Box 4.1 Some 'best bets' for sustainable plantation management

1. In acquiring land, be sensitive to population pressures to avoid competition for land in highly populated areas and to ensure positive inputs in areas with low population;
2. Plan management on a small-scale even within a large forest estate to ensure that the widest possible range of goods and services are obtained;
3. Maintain a diverse land use structure, especially in highly populated areas;
4. Use outgrower schemes wherever appropriate;
5. Use open, consultative planning processes;
6. Encourage comparisons between plantations and agriculture and learn lessons from agricultural successes and failures;
7. Maintain maximum internal flexibility as there will never be a 'final definition' of sustainable forest management, and therefore companies must be prepared to change;
8. Consider voluntary programs of independent monitoring and internal monitoring and auditing with public results.
9. With future developments, consider phasing in systems that are more information-intensive than external inputs-intensive, and that build in complexity and flexibility.

4.4 Areas for Improvement

Technology, management systems, skills and capabilities:

1. Plantation management is operating in a rapidly changing world, and many issues still need to be solved. Therefore, a very important concept in the development of plantations is that of *process*: what happens between the moment the idea of a plantation is conceived and the point where a stand of trees is ready for harvest. The better this is understood and controlled, the more likely it is that plantations will fulfil changing demands. Management system approaches are called for.

More progress is needed on the practical processes, skills and internal incentives required to make the necessary transitions to SFM. The forest enterprise needs to be able to make a practical start by defining one or two key areas of improvement, monitoring them and "closing the loop". A lot is then learned whilst improvements are being made under local conditions; with a management system approach, this learning can be put to use in later stages. Key needs are, therefore:

- *Setting up enterprise management systems* to define key targets for sustainability, monitor their achievement, adapt targets and build up to more comprehensive sets of targets. Some major corporations have developed effective (environmental) management systems; now these approaches need to be modified to include greater public participation in defining internal standards, and to be applicable to small-scale enterprises.

- *Information-intensive management and forest technology*. Best bets for highly-mechanised systems include: computer- and GPS-aided forest assessment, inventory and mapping, linked to (mechanised) silvicultural and harvesting operations, to aid micro-site planning and local adaptation of input regimes and operational schedules. This can optimise chemical inputs, operational timing and determine the precise and rigorous location of e.g. biodiversity protection operations. But this is not to say that information-intensive management needs to be dependent upon high technology; at whatever level technology is available, a premium should be placed upon worker education and authority, and upon structuring forest plans and technology choice based on local site conditions.

- *Reducing uncertainty and increasing resilience in forest systems.* Forest systems face much economic, social and environmental uncertainty over their long rotation periods. The least diverse, most intensively-managed forest systems appear often to be the most vulnerable. Many plantations today are the result of anomalous objectives that no longer apply. Ways of building resilience and adaptability need to be sought. Best bets include: multi-factor monitoring systems to check that e.g. nutrient loops are being closed; shorter-rotation crops that increase opportunities for change; optimising clone replacement programmes; developing complex plantation

systems to offer several goods and services; ecological landscape planning to minimise the risk of major plantation disruption of the surrounding ecology, and to keep ecological options open; examining the pros and cons of large- vs. small-scale forest systems.

- *Improving worker understanding and commitment to sustainable forestry.* Too many initiatives to improve forestry have come from the top down, and workers (beat foresters, machine crews, etc) have been invested with little knowledge, incentives and authority. Best bets include: means to encourage the bottom-up development of internal standards that best interpret external standards, and procedures to meet them; coordinated packages of courses, incentives and authority to ensure machine crews and local foresters plan and implement sustainable forestry procedures at the stand and micro-level.

- *Effective alliances of small private forest owners.* Small owners are capable of running plantations that produce very many secondary benefits other than wood. They need, however, to be equipped with the knowledge, and supported with technical advice and incentives, to adopt sustainable forestry approaches, and to be able to integrate their activities at the landscape level. Support is also needed so that they can compete with those operating at a large scale e.g, at present, certification currently operates like a "rich man's club", to which the smaller producer is effectively barred.

Participation and partnerships:
Perceptions of plantation forestry remain generally poor. People are slow to change their opinions and where poor practice has been widespread they are likely to be sceptical of claims that improvements have been made, especially if false claims have been made in the past. Therefore, industry may have to show sustained improvement for some time before it begins to regain the trust of the public. If management objectives are to both reflect, and be reflected in, the public's changing demands for sustainably-produced forest values, improved dialogue with different actors is required. Key improvements are needed in the following fields:

- *Communicating with the general public* about the nature of forestry systems (in general, as well as specific cases); and verifying the sustainability of plantations and other forestry systems. Best bets include: formal education and media activities on "tree farming"; certification, annual company audits and other independent means of verification. These are not just one-way "PR" means, but enable an informed dialogue with the public about the actual facts that matter.

- *Management agreements and other forms of "good neighbourliness"* with surrounding land users. Best bets include: local forest/land use round tables on a continuing basis; demonstration forests; opening forests for regular inspection by local people; managers trained in continuous consultation with

surrounding land users and the public, and with incentives to do so; management agreements for certain non-wood products and services such as recreation - involving education authorities and local people in this work; and government policies and laws that permit these (government as broker).

- *Partnerships between the private sector and NGOs, communities, and/or local government* at field level, to help design, implement and monitor plantation activities that provide greater social and environmental benefits.

Monitoring and certification:
Comprehensive "toolkits" for sustainability assessment amongst different forestry (and other land use) options are not yet available. To date, analytical techniques and studies have focused on certain dimensions alone e.g. biodiversity or chemical input intensity. A key area for improvement would therefore be:

- *Practical means for assessing forest/land use sustainability* - bringing together information to explain how forests are meeting agreed sustainability criteria. Coordinated monitoring systems are needed for information-intensive management. Best bets include *certification systems* tied to environmental management systems at enterprise level (i.e. certification that allows stepwise improvement), and *forest resource accounting* systems at national level.

  Certification systems have been designed to assess sustainability, have focused on the stand and enterprise level, and have concentrated on environmental matters. Consequently they could be improved in terms of social, biodiversity and surrounding landscape issues. In addition, the specialised field assessment systems available for biodiversity and social issues need to be improved: indicators and procedures of habitat condition and vulnerability are ill-formed, as are ways for assessing social impacts (many of which are based too much on "extractive" social science approaches).

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APPENDIX 1

THE LITERATURE BASE ON PLANTATION SOCIAL AND ENVIRONMENTAL IMPACTS

This Appendix synthesises the literature on the impacts of forest management, related to the main defining characteristics of forest management systems: (1) external inputs intensity; (2) biological diversity; (3) structural diversity; and (4) use and user diversity. It is drawn from, and builds on, the earlier Review Report prepared by IIED for the Sustainable Paper Cycle Project (January 1995). It should be made clear that the empirical evidence is not complete regarding the different impacts, and at best this is location-specific. Hence no universal applicability of the findings is implied. The Appendix seeks instead to provide some of the key illustrations of the types of impact associated with different forest (d especially plantation) characteristics.

1. Plantation external input intensity

There is a great deal of literature on the responses of plantations to individual elements of intensive levels of external input e.g. response rates to differential fertilizer application, particularly in terms of how this effects wood yield. There is less material on the environmental and social impacts of inputs, except in terms of some soil and water factors. There remain many unknowns, particularly with respect to the interaction of different management elements.

1.1. Impacts of Plantations on Soils and Watersheds

Up to 70 per cent of a tree's exchangeable (cation) nutrients are contained in twigs, leaves and bark; when these are left in the forest, the nutrient loss is not usually severe (Evans and Hibberd 1993). Nutrient loss is highest for whole tree harvesting and very short rotations, which reduce nutrient availability and acidify the soil, making fertilisation essential; whole tree harvesting removes 1.5 to 4 times more nutrients than harvesting the bole alone (Kimmins 1977).

Natural forest ecosystems can maintain themselves and consistently yield small amounts of produce with no inputs (natural weathering and atmospheric nutrients make up the losses from harvests). Plantations, on the other hand, result in larger net removals, which demand greater inputs and careful management to minimise accidental losses as a result of site preparation, access, silvicultural operations and harvesting. Knowledge of what inputs to provide, and how to protect ecological functions, is not yet systematic or based on a long enough period of observation.

Undisturbed forests also yield water of high quality (Good *et al.* 1993). Intensive plantation management, however, introduces many disruptive processes: draining, ploughing, burning, planting of (new) species and chemical treatment, felling and tree extraction, road-making and skidding. These can have both positive and negative effects. Ploughing and draining tend to increase sedimentation in drainage waters - which can be reduced by contour ploughing and the use of rippers rather than ploughs (Hornung and Adamson 1991). Burning, in site preparation, results in

a considerable loss of nitrogen and sulphur to the atmosphere, the degradation of surface soil structure and increased runoff, unless it is controlled.

Vegetation cover is a critical factor in determining soil erosion (a Vegetation Cover Index is included in most soil erosion models). Canopy height and the presence of an understorey to protect the soil from falling drops are significant elements of this. Plantations tend to provide less protection of the soil than natural forest, partly because of lesser understorey, fewer large roots and burning (for site preparation) which can degrade surface soil (Bruijnzeel, 1990). In a comparison of species grown in plantation in Karnataka, the erosivity of water droplets beneath a teak plantation was found to be nine times that of a Caribbean pine plantation, with Eucalyptus being intermediate (Calder 1994).

There are different opinions of the net change in soil erosion after afforestation. In Britain, there is a general agreement that afforestation in uplands increases erosion, because of the deep cultivation involved and the use of machinery during extraction (Moffat 1988, Soutar 1989). It is these areas - site preparation and harvesting, which need most attention if soil erosion with plantations is to be minimised. While a change of tree species can result in different water yields (temperate conifer catchments may yield 20 per cent less than a broadleaved catchment), it is the conversion process itself (clearfelling and site preparation) that is more responsible for severe effects such as erosion than the choice of species for the next rotation. (Hamilton and King 1983).

Tree roots create large soil pores which help soil drainage; this, together with the higher loss by evapotranspiration compared to most crops and the higher rate of interception of rainfall by leaves, usually results in a lowering of the water table and soil drying. The lower soil erosion under full forest cover is usually because of lower run-off. These phenomena are usual in both temperate (Pyatt, 1976) and tropical areas (Dunne, 1979). Hence conifers are considered to improve soil porosity and rooting depth on poor, wet soils of the UK (Good *et al.* 1993).

However, Calder (1994) shows that - under any rainfall regime in Karnataka, including in the monsoon - teak will not have a moderating effect on rainfall erosivity, unless an understorey is present.

The rate of soil processes (decomposition and soil formation) is reduced by soil drying under plantations (unless conditions were first waterlogged), by soil compaction, and by changes in the litter type (conifers usually having less degradable litter than broadleaves). The introduction of new species can change decomposition processes - if single species of conifers are planted, this greatly limits the resource base for soil organisms and tends to slow soil processes (Good *et al.* 1993). Muys and Lust (in Watkins (Ed) 1993) examined 50 physical, chemical and biological variables in meadowland, 20-year old plantations and 70-year old plantations in Belgium, and concluded that the decisive factor explaining soil biological activity and fertility was the litter quality of tree species - acid litter eg from conifers reducing soil quality greatly. Soil organisms responsible for decomposition etc. tend to reduce in number when plantations are both large and even-aged, and find it difficult to deal with the requirements of alien species (Cancela-da-Fonseca 1990).

Good *et al.* (1993) provide a very detailed review of the nitrogen, phosphorus and other mineral cycles under plantations and the implications for management. They note that management of cycling is much more critical in the tropics, where relatively more nutrients are held in the trees than in the soil and some nutrients are locked up in acid soils, where runoff and leaching are both higher, and where

temperatures increase the rate of biological processes. The site must therefore be prepared so as to transfer as many as possible of the nutrients, released when vegetation is removed, to the new crop.

Eucalyptus has gained a reputation as an excessive user of water (Poore and Fries 1985) but its canopy interception of rainfall is lower than other trees (Calder, 1986; Institute of Hydrology, 1990), and its transpiration rate is very little higher than other trees of similar fast growth rate, such as poplars. However, some studies (eg. Colquhoun *et al.* 1984 for Western Australia) conclude that certain *Eucalyptus* species cannot control water loss through their stomata; and that when such species get their roots down below the water table, they act as water pumps, using much water but not putting on proportional growth.

For Eucalyptus in Karnataka, research (Calder 1994) has shown that:
- in dry zones, water use of Eucalyptus and indigenous dry forest was the same
- this water use was equal to the annual rainfall
- but the water use of plantation or natural forest was twice that for finger millet
- and over three years, water use of forest was higher than rainfall (suggesting the trees were "mining" soil water, a potentially serious implication that is now being studied further).

One possible implication of this is that Eucalyptus plantations in dry regions (which can help bring up deep nutrients) should be rotated - or put in an intimate patchwork - with agricultural rotations (which can help to replenish deep soil water). Calder suggests that, in theory, it should be possible to grow the same volume of timber, using irrigation, on one-tenth to one-fifth of the usual land are, leaving the rest for rainfed agriculture.

1.2. *Changing Impacts on Soils between Plantation Rotations*

Because plantations tend to be higher-yielding than natural forest management in a given site, there is concern that successive rotations will exhaust the soil (as well as lead to pest build-up and other problems) in the same way as has been observed with continuous high-input agriculture. Dawkins (1988) notes that sustainability of plantations cannot really be assessed until the end of the second rotation. Moreover, as we note above, there are very many site, species and management factors - about which knowledge is limited but increasing - that could make a great difference between sustainability and unsustainability.

Adlard (1993) describes the salutary tale of 19th century production of Norway spruce in Saxony; here, for financial reasons, spruce was planted in pure stands in natural forest zones and worked over short rotations for pulp and mining timber. A decline in growth in the second rotation was first noticed in 1869; later studies showed how the litter of the monoculture conifers reduced soil fertility, and elucidated other complex factors.

Concern for declining yields is especially great for fast-growing plantations on poor tropical soils, especially with clear-felling which may lead to heavy soil erosion and the loss of mycorrhizal fungi which critically help nutrient uptake by some trees. There has been evidence for some time of declining yields in second rotation *Pinus radiata* plantations in Australia (Florence 1967), a phenomenon that appears to have complex causes, fertilisation making little difference (Boardman 1979). Hase and Foelster (1983) generated a nutrient budget for eighty years of teak (*Tectona*) cultivation following forest removal in Venezuela; removal of primary forest and subsequent leaching lost many nutrients, but even more were lost with teak bole

removal after the first rotation. Total nutrient losses over the rotation were much higher than additions from weathering or precipitation (especially calcium and phosphorus). Bruijnzeel (1990) shows that *Pinus caribaea* on infertile Brazilian soils is unsustainable within two rotations unless fertilised.

Many of the earlier studies were alarmist, stressing the very rapid rates of uptake of nutrients in plantations. However, nutrient demands should be assessed over the full cycle; while initial uptake is certainly high and inputs may therefore be desirable, later stages may include more interception of nutrients from the atmosphere, and recycling within the ecosystem and trees themselves. Management can maximise this - choosing a leafless season for the harvest and leaving nutrients in the forest (Miller 1981). Bruijnzeel and Wiersum (1985) show, for *Agathis* plantations in Java, that total nutrient inputs are adequate for cropping unless whole-tree systems are used. Such studies are rare, however, and have not been brought together. Research into plantation sustainability, including baseline studies and provisions for regular monitoring through Permanent Sample Plots, should be given increasing emphasis. Many larger forest corporations are now undertaking such work, sometimes in the context of environmental management systems.

In conclusion, it appears that serious productivity decline with successive rotations is in general highly unlikely *except* on infertile sites, especially with good choice of species for a site, subsequent soil management provisions (minimal cultivation and retention of organic matter) and silvicultural practices to recycle nutrients (Evans 1990; FAO paper 103 1992).

1.3. *Afforestation and Soil Acidification*

Acidification of soils and waters has been demonstrated in temperate forests (Forestry Commission, 1988). In Wales, a long-term study showed acidity from streamflow was 30-50 per cent higher from forested areas than from nearby grassland (Hornung and Adamson 1991), a phenomenon which has been shown to lead to reduced fish populations (Ormerod and Wade 1990) as well as nutritional imbalances in tree species. Draining may also increase acidity by increasing decomposition of organic matter following drying. The precise nutrient imbalance effects of acidification, however, depend upon the original soil type (Good *et al.* 1993). Single-species plantations, especially of conifers and nitrogen-fixing trees - the latter causing biological acidification - are suspected to exacerbate the effects of acid rain on catchments. Conifers have also been shown to intercept acid deposits from the atmosphere and hence to greatly increase stream acidity (Dudley 1992).

1.4. *Impacts of Mineral Fertilizers and Chemical Pesticides and Herbicides*

Unlike in agriculture, chemical use tends to be infrequent and for specific tasks. Total use per hectare over the life of a forest crop is about the same as that used in commercial agriculture over just one year. Fertilisers tend to be applied only at the beginning of a forest rotation, and pesticides only when required. Problems arise when very large areas have to be treated at one time, especially for pest control, although blanket and prophylactic use of chemicals is rare (Evans and Hibberd 1993).

The use of herbicides to clear weeds in plantations is common and beneficial to the crop in the tropics(Williamson and Lane 1989); eg. weed control in *Eucalyptus*

plantations is essential in early stages. No comprehensive review of studies of environmental impacts of forest herbicide use has been noted since Norris *et al.* (1981). Use in temperate and boreal regions is declining.

Pesticides in forestry tend to receive far less attention than they do in agriculture, even though some of them are much more toxic (and are not approved for agricultural application in many countries). For plantations, a great many studies were made in the 1960 and 1970s of the impact on watercourses of various pesticides used in plantation management (eg. Norris 1967, Overrein 1970, Cramer 1974, Ovington 1974). Recent comprehensive and global reviews of pesticide problems such as The Pesticides Trust's global health and environmental audit (1993) barely touch on forestry. However, concern about possible health and environmental problems has led to pesticide bans in forestry in Sweden (Dudley 1992).

Rodenticides have been used eg in controlling squirrels in broadleaved woodlands in Britain, to which there has been considerable public reaction; the Forestry Commission has detailed guidelines on careful targeting of hoppers to minimise broader impacts (Pepper 1990).

Insecticides are usually used only in an epidemic. But in some areas they have been sprayed every year: notably fenitrothion applications have been made for the last 40 years over large areas of the eastern Canadian forest, and many groups assert that large insect, aquatic and avian life has suffered (Dudley 1992). In tropical areas, problems arise when the more environmentally-damaging chemicals (some of them banned in industrialised countries and still "dumped" in the tropics) are used with poor supervision.

Research on biological pest control methods has been yielding promising results, and some (with insect predators, viruses or bacteria such as *Bacillus thuringiensis*) are becoming routine (Buckner and Sarrazin 1975). This is an area where the practice of forestry as environmental management is relatively advanced; yet guidelines on dealing with the possible problems arising from introduction of exotic biological agents are weak or absent.

Unlike pesticides, chemical fertilisers do not add new types of chemical to the ecosystem - they just alter the balance. Environmental impacts are therefore generally lower, unless the balance is affected so much that nutrients become locked up, or unless excessive quantities leach into watercourses, leading to acidification and eutrophication (Evans and Hibberd 1993).

1.5. Fire Management

Fire has several natural roles in many forest ecosystems; it is a natural part of the ecology of eg Australian *Eucalyptus* forest, the pine forests of south-eastern USA, and boreal forests. Forestry activities invariably alter the balance between these roles. Forest management may increase fire, by practising site-clearance burning, or reduce the potential size and heat of a fire, by controlled burning to reduce the incidence of catastrophe, or decrease fire incidence and severity overall, through suppression management. Dudley (1992) gives a good account of the benefits and costs of naturally-caused fires in forests, and the effects of forestry. Some ecosystem management forms of forestry are built around fire management where fire is a significant part of local ecological processes - for example the ASIO system in Sweden (see various references in Bull *et al* 1995).

Burning, to clear sites for planting, is a practice which now takes place mainly in the tropics. It frequently gets out of hand and results in very large fires. In general, such burning has too many negative impacts. It leads to loss of nutrients and much biodiversity and - if too hot - can lead to degradation of soil structure and hence erosion, especially in some tropical soils (Evans and Hibberd 1993). Extensive areas of forest were lost in this way in Kalimantan in 1982, Ivory Coast in 1983, Spain in 1987, and the Amazon in 1988 and 1989.

Many plantations are highly susceptible to fire; between 1983 and 1988 in Brazil, 200 000 ha of plantations (out of a total 6 million ha) were burned, at a total loss of US$200 million (Soares 1991). The most sound method for reducing the fire hazard in plantations is to increase their heterogeneity - through different species ages, and large clear areas, and through mosaics with natural forests. The potential for mixed species plantations to reduce fire risk, but to allow some fire, has not been documented (FAO paper 103 1992).

Controlled burning results in loss of some native vegetation in fire breaks, fire and soot kills some wildlife, and fire control uses chemicals. But it may also increase fodder for grazing animals. Fire suppression techniques may greatly alter the normal fire ecology. Some authorities practice fire suppression, and others do not, for cost and/or "naturalness" reasons; this is contentious, as the recent example of the great Yellowstone National Park fire demonstrated.

2. Plantations and biological diversity

Most literature covers the negative impacts of plantations on biodiversity, with some more recent material on the integration of biodiversity into plantation systems.

Forestry's impact on biodiversity is a function of: original habitat/vegetation type and its sensitivity to change; the area of forestry activity; internal diversity of the forest and its configuration; edge to area ratio; road layout; the scale/periodicity and selectivity of felling and the accidental damage associated with it; other management methods especially thinning, fire management and chemical usage; conservation management provisions; and sequencing of operations (Blockhus *et al.* 1992, Good *et al.* 1993).

Although the significance of each factor is known, the precise impacts of any particular factor cannot be predicted. This is because the interrelationships between them is poorly understood for any forestry activity, and because the requisite ecological and biological knowledge of the behaviour of species and communities is usually not available (Good *et al.*, 1993). Even if understanding were to improve, stochastic factors would mean predictions were rarely precise. In general, however, authors agree that the more intensive the forestry activity, the higher the impact on biodiversity (Essex and Williams in Watkins (Ed) 1993).

Forests, globally, are becoming simpler. Deforestation, natural forest management and afforestation have led to major transformations in the distribution of forest types globally; and, within each forest type, to loss of biodiversity in the tree stock, loss of other local biodiversity essential for forestry itself eg. pollinators, seed dispersers, predators of pests, soil organisms responsible for decomposition, etc; and loss of other local biodiversity that has taken often centuries to build up (Dudley 1992).

The loss of biodiversity is greatest when highly diverse systems eg. old-growth

forests, notably rain forests, and wetlands are replaced wholesale eg by monoculture plantations. Wetlands are very sensitive to afforestation, because they are usually drained, thereby also altering the conditions for other species. Rain forests are highly sensitive because of their complexity; it is not known whether they can be recreated following eg. the removal of a plantation established on previous rainforest land. Such ecosystems are rarely cleared for afforestation these days. However, semi-arid ecosystems are increasingly afforested, but there is little information on their sensitivity. Good *et al.* (1993) suspect that water competition may lead to the rapid demise of native species.

In Finland, 60 per cent of natural peatlands have been drained for forestry (IUCN 1992 cited in Dudley 1992). In Denmark, 66 per cent of forest cover is under conifer plantations; in Spain, there are 5 million hectares of pine and eucalyptus pulp plantations, and only 1.9 million hectares of hardwoods; in Ireland, 95 per cent of forests are now conifer plantations (Dudley 1992). In Sweden, where old-growth coniferous forests are being replaced by intensively-managed regeneration or by conifer plantations, it is estimated that 40 vertebrate species, and 50 fungus, lichen or flowering plant species are seriously endangered (Gamlin 1988). These losses may partially be made up over time, so that a mix of new and mature plantations, with different thinning treatments and cover percentages, ie where the number of niches is maximised, tends to be more diverse than just a newly-established plantation, or even of a mature plantation.

However, this diversity may be of a different quality; eg afforestation in the Scottish uplands has raised numbers of common animal species, but rare species have diminished. Different groups may have opposing views on this "balance sheet of gains and losses" (Tomkins 1989). The loss of endemic species, however, tends to be accorded high scientific, cultural and often economic value by most groups.

2.1. *The Impacts of Plantation Management on Forest Vegetation*

In general, the less intensive the management of the plantation or forest, the higher the species diversity, and the more likely that native woodland species regenerate (Essex and Williams in Watkins (Ed) 1993). For a young plantation, before canopy closure there may be a rapid development of natural vegetation (which is usually controlled by weeding). Full cover limits light and nutrients for other species soon after canopy closure (and toxins, or allelopathy, may add further effects [Poore and Fries, 1985]). If grazing animals are kept out to protect the young trees, tussock grasses and shrubs may be favoured over less vigorous plants ie biomass increases at the expense of biodiversity (Hill, 1979). As the plantation reaches maturity, more light again reaches the forest floor. In Britain, it has been shown that vegetation diversity will come to reflect the natural forest type of the area (Hill, 1986). Similar observations towards natural forest successions have been observed in the tropics (Lima, 1990) but this is not always observed (Poore and Fries, 1985). Rotation at economic, not physical, maturity means species that depend upon very old trees are absent - especially those that need a continuous availability of stable microenvironments such as epiphytes. Indeed, it is the continuity of habitat which is of importance rather than the age of particular trees (Good *et al.* 1993)

2.2. *The Impacts of Plantations on Forest Animals*

Phytophagous insects may depend critically on certain tree species. Exotic trees (initially) tend to support fewer insects - indeed, their freedom from pests is why

they are favoured. *Eucalyptus*, for example, has been found unpalatable to many insects. In Portugal, even mature stands of *Eucalyptus* appear to support very few higher fauna such as birds, mainly because few insects feed upon them (Kardell *et al.* 1986). However, it is thought that, in time, insects will evolve to depend upon *Eucalyptus* (Good *et al.*, 1993). Birds and mammals, on the other hand, depend more upon tree architecture; some animals can find a useful mix of nesting and cover from mixed age, exotic plantations - provided food sources are also secure. Those which depend upon ground/understorey nesting and feeding tend to do well in plantations, provided there is continuity in understorey provision over time. However, those which nest in holes or tree stumps, will not be well-provided for by short-rotation, even-age plantations. For plants and animals, the forest edge tends to be a richer habitat, and edge creation/management has been an important part of conservation provision; however, rare species are often excluded from edges (Bamford, 1986). Lavers and Haines-Young (in Watkins (Ed) 1993) note that bird populations may increase in plantation edges, but predators may increase also; they conclude that there is rarely adequate evidence for making predictions for specific situations.

In general "deficiencies in habitats associated with mature natural forests provide a major stumbling block to nature conservation in plantations throughout the world" (Good *et al.*, 1993). Some species cannot tolerate disturbance associated with forest management, even if the basic forest structure is little-altered. For example, in the North West of the USA, where logged forest may either regenerate naturally or be planted, ancient woodland-dependent species eg the spotted owl cannot survive (Barden *et al.* 1993). However, this is often a function of structural diversity rather than biodiversity, and structural changes can be introduced in plantation layout and tree architecture to suit.

2.3. *The Effects of the Size and Speed of Plantation Development on Biodiversity*

The *size* of plantations affects their impact on biodiversity - not merely in terms of amount of natural habitat removed, but also the chance for it to accommodate species from neighbouring areas. Lugo (1992, cited in Sawyer and Centeno n.d.) notes that small, 50-year old mahogany plantations show the same understorey richness as neighbouring secondary forest. The greater the edge:area ratio of a plantation, the higher will its total species count tend to be (edges are relatively diverse, although this will not usually reflect "natural" diversity). The *rate* of afforestation may pre-empt certain native species from keeping up, especially in the tropics, where very fast plantation rotations are completely out of step with the slow processes of eg. rain forest development (it is reckoned to take hundreds of years to recreate a rain forest). There are very few studies of the changing composition of species over the life of a given managed forest, however (Good *et al.*, 1993), and especially in the tropics for forests under management (Harvard University is involved in long-term forest management research sites in SE Asia). Chronosequence methods - studies of differently-aged plantations under otherwise similar conditions - have been used (Hill, 1986).

2.4. *Species Choice and its Effect on Biodiversity*

There is a general lack of native species associated with closely-planted exotics (largely because the species have not evolved together). Certain species used in plantations, often because they are colonisers of relatively poor land, have evolved

toxins which inhibit the germination and growth of other species; this is an issue which is frequently added to the list of *Eucalyptus* problems (Poore and Fries, 1985), as well as to *Leucaena* and *Casuarina, Acacia, Dalbergia, Morus, Quercus, Larix* and *Pinus* (Good *et al.*, 1993) but its effects in the field are poorly understood and are reckoned to be generally less significant than competition for light, water and nutrients.

2.5. *Invasive Exotic Species*

Plantation exotics succeed if they are well-adapted as colonisers of local sites, unconstrained by local pests; this may lead to their unwanted regeneration in neighbouring areas (eg. *Leucaena leucocephala* in many parts of the tropics (Barden *et al.* 1993), *Acacia dealbata, A. mearnsii, Melia azedarach* and *Salix babylonica* in the Transvaal (Henderson and Musil 1984)). Other exotics may hybridise with local trees eg. the hybridisation of native French and exotic subspecies of *Pinus nigra*, noted in Quezal *et al.* (1990).

2.6. *The Impacts of Biotechnology*

Very few references on the environmental impacts of transgenic forest plants (as opposed to biotechnology generally) have been noted. One volume on genetic engineering of woody plants includes details on the potential environmental impacts (Schuerman and Dandekar in Biswas and Harris (Eds) 1991). A good general volume covering agricultural applications of biotechnology is Hobbelink (1991). This emphasises the issues of developing countries and farmers' rights over genetic resources, and the social/power structure, rather than environmental implications. However, it shows that there can be alternative - low-input, sustainable agriculture - responses to every problem that biotechnology aims to achieve.

3. Plantation structural diversity

Two arguments are made against simple plantations: one, that simple plantations are inherently unstable; and two, that spatial diversity can reduce pest and disease epidemics. Both of these are over-simplistic, and there are many exceptions. The fact that epidemics can also arise in very many ways means that there are few universal laws available for minimising epidemics - at least in terms of proscribing simple plantations or otherwise. FAO (Paper 103 1992) provides an excellent review of these arguments, but notes that the evidence is highly confusing, lagging behind equivalent knowledge in agriculture.

The argument that stability results from diversity stems from the work of the earliest ecologists, and at one time became almost a maxim of the science of ecology. It matches with observations that eg natural forests containing a mix of species achieve a state of complexity in which vegetation is broadly in balance with pests and diseases - the latter tending to stop any one (tree) species from dominating (FAO Paper 103 1992). However, much ecological work of the last twenty years has revealed many exceptions to the rule, supporting van Emden's and William's (1974) relatively early hypothesis that diversity is *parallel* to stability, and not a cause of it. For example, some of the most devastating tree disease epidemics, such as Dutch Elm disease and chestnut blight, have occurred in natural polyspecific communities (FAO Paper 103 1992). However, narrow genetic diversity does seem

to be more of a problem than narrow species diversity in terms of vulnerability to extreme events (Zobel and Talbert 1984). The more mixed a population is within a species, the more likely it is to carry enough attributes to cope with epidemics.

Spatial diversity has been urged as a way of breaking up epidemic patterns. In Poland, blocks of *Pinus sylvestris* are broken up with highly polyspecific plantation to encourage birds and hence to reduce pests. However, in other circumstances, such blocks may provide eg. alternate host plants for pests. Hence spatial diversity is not a panacea, and establishing mixed plantations just to reduce epidemic hazard may be a misguided policy (Way 1977 cited in FAO paper 103 1992).

It has been suggested that mixed species plantations will improve soil processes and lead to mutual nutritional improvements (especially with nitrogen-fixers in the mixture and with a range of mycorrhizae encouraged) (Brown and Dighton 1989; Cote and Camire 1987). There is some evidence in Scandinavia of this synergy (FAO paper 103 1992). Mixed plantations would also tend to improve biodiversity. In practice, however, there is inadequate information on how to create the right mix for given soil and site types, and how to manage them to ensure mutual benefits, as opposed to competition between the species (Good *et al.* 1993; Sargent and Bass 1992).

Although a mix of species provides insurance against the risks of simple plantations, it usually also implies a reduction in profits because of the partial substitution of a valuable species by a less valuable one, or because of greater management costs (FAO 1992). However, evaluations of the risk have tended to account for the differential profitability, and the length of the rotation, but not so much the wider environmental risks beyond that of the individual enterprise - this, of course is inconsistent with claims by plantation owners that plantations bring wider social and environmental benefits. In New Zealand, where 85 per cent of plantations are under *Pinus radiata*, a policy of monoculture was justified because of: the good match of the species to the available sites; adequate financial resources available to combat an epidemic; no evidence of higher susceptibility than other species; a broad intra-specific genetic base was ensured among the *P. radiata*; and short rotations meant that revenue would be realised earlier, reducing the risk period (Burdon 1982 quoted in FAO 1992).

Although the management of mixed plantations has often been intensive, it could potentially be relatively extensive and (with adequate research - currently lacking) could adopt many of the low-input systems of sustainable agriculture. Intensive management, on the other hand, remains necessary for (the usually more profitable) simple plantations.

4. Plantation use and user diversity

4.1. Rights and Tenure Issues in Tropical Forests

In tropical areas, rights and tenure are frequently regarded as the most important social issue in forestry initiatives and management. Centeno (in Shell/WWF 1993) states that 'social conflicts have been mainly due to land claims by local communities, or to the lack of sensitivity to the needs and preferences of surrounding populations... Most of these conflicts can be avoided. They have been due to inadequate planning or defective management'. Much of the success of

social forestry programmes depends on land and tree tenure: 'without rights to the trees established, local and personal interest will evaporate' (Evans 1990). Sargent (1990) found that land tenure was of utmost importance in a proposed plantation area in Thailand: the high level of violence amongst the local population was attributed largely to conflicting claims over land. Failure to take account of customary rights would, in this case, have jeopardised the potential success of the plantation.

In the literature on forestry in tropical areas, much is written about the importance of land tenure, but legal forms of property tend to be confused with social realities. Property relationships have to be understood in specific socio-economic, political, cultural and historical contexts.

Furthermore, as well as the conflict of customary rights with those supported by law, tenurial matters in forestry are complicated by land and tree tenure often being separate from one another, and by changes in ownership over the long life of forest crops. Bass (1993) discusses particular problems relating to tenure in tropical areas. He points out that the establishment of plantations can have a positive social impact, by acting as a catalyst for clarifying ambiguous tenure, for redistributing land, and for securing usufruct rights for the landless. Such benefits are unlikely unless government, plantation developers and communities enter into well-organised negotiations.

However, negative impacts tend to be more commonly realised: clarifying a title without accompanying positive changes in tenure regulations (such as land registration, clear demarcation of boundaries) can also lead to land speculation and a growing proportion of landlessness. Less influential or politically weak groups and individuals who were formerly tolerated, under the informal system, may find themselves excluded from the new formal tenure arrangements.

Security of land tenure is generally regarded as a necessary precondition for the establishment of plantations, whether small or large. Sawyer and Centeno (nd) cite a guarantee of legal ownership of land to be a prerequisite for private investment in countries such as Brazil and Chile, where large scale industrial plantations have been established, due to the risk of serious encroachment where ownership is not clear. Saxena (1994b) describes the need for security of land tenure and a sound base of land records before Indian farmers will undertake small scale tree plantation.

4.2. *Rights and Tenure Issues in Temperate Forests*

In temperate regions, tenure tends to be relatively clear and well-recorded, with established titles. Frequently, plantations are established on land that has not recently been under forest cover. This land tends to be agriculturally marginal, ie. of a type which cannot make short term returns, but which can be devoted to longer term use. (For example, hill farm land, held by private farmers, or natural habitat - moorland and heath - often held by large landowners and government). Often in remote areas, the social impacts of afforestation have been positive - but in the short term only, such as the provision of employment in afforestation activities. The major impacts have been environmental - loss of wildlife and biodiversity, or the loss of broad social assets, such as recreation and landscape value.

However, in boreal regions, conflicts relating to tenure have also occurred. The Task Force on Native Forestry (1991) in Canada found that the issue of land claims was raised at every meeting held by the Task Force in British Columbia: "Native people

believe land claims will give them the control necessary to address and correct the economic problems and social ills resulting from a system which has excluded them from the decision-making process". The same reference cites examples of successful partnerships or agreements between native peoples, forest industry and government. O'Hara (1992) alleges that at least five groups of indigenous communities are facing threats to their traditional lands by commercial timber companies in British Columbia alone, and that some companies incorporate employment programmes for the local communities, who then find themselves clear-felling their traditional hunting grounds. She also describes how forest products companies have started legal proceedings against the rights of access of traditional inhabitants of forests in part of Sweden.

However, substantial progress in addressing such conflicts has been made: in British Columbia, an 'Interim Measures Agreement' was made between the provincial government and the indigenous communities in March 1994 (Interim Measures Agreement, 1994). This encompasses an agreement to establish a comprehensive joint management process dealing with resource management and land use planning, and addresses cooperative forest management areas and economic development opportunities. This type of agreement may provide a model for resolving similar conflicts of interest elsewhere.

4.3. Employment

The provision of employment is frequently presented (particularly by developers) as a positive social impact (Bass 1993). This is particularly the case when plantations are established on areas of marginal agricultural land, and bring employment and prosperity to a formerly depressed area where, because agriculture is failing, there is a need for cash income and especially employment that does not entail migration to urban areas (Sawyer and Centeno, nd). Commercial forestry may be of further value for employment if it is closely associated with local forestry processing industries. However, forestry employment is only beneficial to local people if it is structured such that the community does not become overdependent on forestry - but leads to job and skill creation in other sectors, too, or at least to some diversification of activities and long-term security of employment. Training is therefore an essential part of sustainable plantation development.

However, various authors contend that very often, plantation development results in a long term net loss of employment opportunities (Barraclough and Ghimire 1990; Bass 1993). An initial temporary increase in employment is often due to the need for clearing the land, constructing the infrastructure, and planting and initial maintenance: this may be met by poorly paid migrant workers. Some of them usually remain to fill whatever jobs are available later, but in the tropics many stay as unemployed squatters. Together with the displacement of rural labourers where forestry replaces intensive agriculture, this can result in a larger poor population in areas where the traditional inhabitants have lost their livelihood support systems and where there are few possibilities to find either jobs or secure access to agricultural land.

Increased mechanisation may further reduce the work force: for example at Jari (a hard- and softwood kraft pulp mill in the Amazon) the work force was cut from 8,000 to 4,500 between 1988 and 1993 (Higgs 1993). It has been calculated that in British Columbia, 27,000 direct forestry jobs were lost between 1981 and 1991 as a result of increased mechanisation (Paper August 1993). Lara and Veblen (1989) describe how, in Chile, the dramatic growth in plantations has not been accompanied by a significant increase in employment in the forestry sector. Due to

relatively low intensity silviculture, there is on average one job for every 39 hectares of plantation. The international average is one job for every 12 to 20 hectares of plantation.

This temporary increase in employment has also been observed in the UK (Bass 1993). However, in some temperate and boreal regions the reverse trend was observed in the 1960s, when the timber industry switched from part-time employment of small farmers to a professional labour force. This was due to mechanisation, requiring skilled labour; industrialisation and rural depopulation; and increased demand for labour in silviculture. In Finland, reductions in employment in the forestry sector have been observed over 20 years, such that only 6% are now employed in forestry (Karjalainen *et al*, 1993). Nevertheless, seasonal labour is still used. Also, intensified vocational training has improved the skills of forest workers and forest owners (Holopainen 1981). In other parts of the boreal region, extremely poor working conditions are alleged to occur (Grigoriev 1993b).

Employment may also be affected by concessions to pressures imposed by environmental interests: overall estimates of jobs likely to be lost as a result of efforts to save the spotted owl in the northwestern US range from 30,000 to more than 100,000 (ILO 1992). Adherence to sustained yield management can also lead to significant cuts in employment: in British Columbia, logging levels were found to be well above sustained yield, and recommendations were made to reduce the annual allowable cut (AAC). The Western Canada Wilderness Committee (1993-1994) estimate that such a reduction throughout the province would lead to the loss of 15,000 to 20,000 jobs; the Western Wood Products Forum (1992) estimate that there will be 11,000 direct, and 22,000 indirect job losses as a result of reduced AAC, and that in rural areas, where there is high dependency on the industry, the social and economic infrastructure is likely to be severely affected. During the recession of the 1980s, pressure to maintain employment levels allegedly persuaded the forest service to ignore some regulations, including some related to cut control, resulting in unsustainable forestry practices but sustained levels of employment. The reaction of the Pulp, Paper and Woodworkers Union was that 'the long term economic stability of the forest industry depends on a sustainable forest' (Stichting Greenpeace Council 1993).

However, Sargent (in Sargent and Bass 1992) points out that provision of local employment alone is not a sufficient social rationale for the establishment of plantations. To ensure success, the full spectrum of local needs and dependencies on the land and resources scheduled for conversion to the plantation must be taken into account. This includes ensured continuity of work, long term security, and provision of housing and amenities (or the means to enable private ownership of houses).

4.4. Income generation

Participatory commercial forestry schemes are widely recognised as having the potential to be mutually beneficial to both farmers and industry. The success of such schemes clearly depends on the provision of assured basic needs. For example, in Papua New Guinea, the criterion of success was identified as a balance between subsistence and cash economies, so that the standard of living is not jeopardised (Lagercrantz 1981 cited in Bass 1993). Spears (1991) reports that the cash income from pulpwood tree farming under the PICOP scheme has made a significant contribution to the income of several thousand farmers who were formerly classified as illegal 'squatters' on government owned forest land. The scheme also overcame the constraint of having to import labour and staff into a region. However, the introduction of a cash economy is only beneficial where it can increase net social

benefits.

The introduction of plantation forestry may hasten other processes of commercialisation, bringing secondary social impacts such as the marginalisation of the poorest, due to their inability to participate in the cash economy. In a proposed plantation in Thailand, it was found that the poorest sections of society were already cutting and burning forest to clear more land for cultivation: it is likely that, had the plantation scheme been implemented, destruction of nearby forest would have increased efforts to meet subsistence needs (Sargent 1990). In Ecuador, promotion of private forestry schemes, designed to reach communities and individuals, has involved only large and medium farmers and some organisations.

4.5. Subsistence - Alternative Uses of "Degraded" Land

For environmental reasons, and so that plantation land can be purchased at low cost, efforts have frequently been made to establish plantations on 'degraded land'. However rational this aim, it has frequently been found that local people's provision of basic needs may be threatened by the establishment of plantations on such land. This may be accidental or otherwise. Indeed, the allocation of such land may constitute a ploy to further marginalise some people. For example, Roychowdhury (1993) describes Indian government 'hints' that it would allow investment in plantations on degraded forest land in order to augment domestic supply of pulpwood and timber. He contends that, should this proposal be implemented, 'it will be at the expense of millions of rural poor, who depend on forests for fuelwood, fodder, building material and medicinal herbs' - since those rural poor would be denied access to vast stretches of forest land. So-called wastelands and degraded forests are the object of intense use almost invariably by the poor, and are used as a common resource (Down to Earth 1993).

In Spain and Portugal, farmers have been encouraged to destroy their olive groves in order to relieve EC surpluses of olive oil - resulting in more than 2 million hectares of 'marginal land'. According to the Women's Environmental Network, paper companies are now establishing pulp plantations on this land, despite protests at the loss of communal land (WEN 1990).

4.6. Food Availability and Nutritional Status

Where plantations are established on productive agricultural land, poorer food availability and nutritional status brings a general reduction in welfare: this has been well documented by FAO (1989a) in a report on forestry and food security. In developing countries, forests often serve as 'food banks' for the poor local communities, providing important sources of subsistence food as well as supplementary cash through sale of products in the market (Barraclough and Ghimire 1990). It is often argued that shifts from subsistence farming to cash cropping adversely affect stability and quality of food supplies and the nutritional status of children (Spears 1991). Furthermore, Barraclough and Ghimire (1990) point out that those depending on the forest are often ethnic minorities or other marginal social groups with little or no political influence in national societies. Baldwin and Bandhu (1989) describe how large scale afforestation took place in Karnataka, but with an overemphasis on the needs of commercial, industrial and urban markets, at the expense of food, fuel and fodder for the rural poor.

4.7. *Demographics*

If labour is imported for plantation schemes, there will be a significant impact on community structures. For example, in much of upland peninsular Malaysia, lowland communities have replaced traditional forest people in the vicinity of plantations of rubber, oil palm or fruit orchards (Bass 1993). In temperate regions particularly, the establishment of plantations may bring about immigration into a previously sparsely populated area, being one of the few providers of employment in marginal (hill) land. Such areas would otherwise be subject to worker migration. However, in other cases there is likely to be emigration from rural areas as the level of employment is reduced: in Canada, the Western Wood Products Forum (1992) recommends that a task force be set up to oversee the anticipated displacement of employees.

In Chile, the purchase of land from landowners in rural areas by timber companies for the establishment of plantations has meant massive expulsion of the rural population. Most medium or large estates sold to establish forest plantations were inhabited by campesinos on the basis of customary rights with no legal tenure of the land. Migration has mainly occurred to rural villages and small towns, but poverty, unemployment and lack of services are major problems (Lara and Veblen 1989).

4.8. *Aesthetic and Cultural Resources and Values*

A plantation may be run by single or joint interests. However, its impact of the landscape is generally agreed to affect society as a whole, or at least local people. Different groups, in different countries, have varying ideas about:

(a) the landscape and cultural values of plantations, forests and other land; and

(b) the responsibilities of forest owners (or other bodies such as forest authorities) to act on these values.

It is generally recognised, though not always apparent in the literature, that plantations and farm trees are perceived very differently by different people. Perceptions of the non-monetary values of trees and forests are perhaps the hardest to define and quantify, and are frequently disregarded. However, these issues can lead to some of the greatest conflicts.

In describing farm forestry in India, Saxena (1990) states that:

> *"farm trees mean different things to different people. Ecologists and environmentalists see it as a superior land use and land management system that integrates all components of a stable ecosystem, combining conservation with production. Foresters tend to look at it as a potential line of defence against unabated depletion of forests under pressure of population. Planners and donor agencies have viewed it as an answer to the rural need for fuel and fodder, and to the unsatisfied market demand for wood and wood products. However, the farmer who controls land and hence takes a decision is not always motivated by the above considerations. He adopts it because it is perceived as more satisfying to his needs, of either consumption or income, or provides him greater security against risks."*

In more developed countries especially, aesthetic values and perceptions of the quality of the landscape are considered important, and frequently raise tensions between different interests. Single age monocultures, such as extensive conifer plantations in western Europe, are frequently perceived to be 'visually monotonous'

(Crowe 1985); the creation of 'intrusive plantations... conflicting with the natural irregularity of the original landform... upset many people' (Campbell and Fairley 1991). The importance placed on aesthetic values in such areas is demonstrated by the UK Forestry Commission's willingness to encourage broadleaved species 'particularly where they will enhance the beauty of the landscape and the wildlife interest' (Low 1986) and in its Forest Landscape Design Guidelines (Forestry Commission 1989). These guidelines do not include local consultation; they are entirely about professional judgement. However, the Commission's Community Woodland Design Guidelines (Forestry Commission 1991) includes a very brief section on "involving local people" without suggesting how to go about the process.

Similarly, tensions are raised concerning the various recreational values provided by plantations, or foregone in developing plantations in temperate areas (rambling, hunting, fishing, etc.). However, the creation or conservation of forests specifically for recreational purposes - for example, community forests around British cities - serves to offset some of the recreational values foregone in plantations dedicated to timber (Countryside Commission and Forestry Commission 1989); this is a compensation approach, at a regional scale.

The large area preferred for integrated plantations and mills is often incompatible with landscape values. In addition, respect for past traditions, customs, and beliefs about land such as sacred groves, or ground claimed to be inhabited by spirits, are easily overlooked when great tracts of land are acquired (Evans 1982). As well as the size, the limited range of species in plantations usually excludes those which are identified as important by local communities for cultural (and subsistence and environmental) reasons. Such losses are rarely costed in investment analysis. Particularly in cases where natural forests are cleared for plantations, the cultural values lost may be as important as the more commonly cited losses in biodiversity, soil fertility etc. (Bass 1993).

It is acknowledged that the multiple functions and perceptions of values of trees can rarely be replaced in their entirety by uniform plantations (Morrison and Bass, in Sargent and Bass 1992). Labelling land or forests as 'resources' through economic activity removes the protective identity established through myth and custom, and opens them to exploitation. Sensitivity to the possible impacts by the plantation developer is essential - there is a sudden introduction of a new set of circumstances, ie. large scale afforestation, which local people perceive in relation to existing belief systems and values.

In particular, the use of exotic species (such as Eucalyptus) demonstrates a marked contrast between the esteem in which they are held by commercial growers and the vehement antipathy often expressed by local people, or by agents representing them. The local perception may be strongly influenced by myth, and may attribute false properties to an exotic species - and there may be wide differences in perception by different social groups at the local level (Sargent 1990), or according to context. For example, Eucalyptus is very popular in some parts of India, but despised in other parts. The conflicting perceptions of such species has become a social syndrome of plantation forestry worldwide, sometimes resulting in destruction of the exotic, perceived to be harmful, by the local people. Conversely, developers may clear natural forest which the developers perceive to be valueless (Morrison and Bass, in Sargent and Bass 1992).

4.9. Equitable Distribution of the Benefits of Fibre Production

The development of plantations or farm forestry can have a major impact on equity: some social groups will benefit, others will lose out. CODEFF (1991) illustrates a

very uneven distribution of benefits in Chile, where, after ten years of government subsidies for forest plantations, it was determined that just three Chilean corporations accounted for seventy per cent of the planting grants, plantation area, and timber exports. In British Columbia, the concentration of control of forests by a few large corporations was perceived to be a major problem by the Forest Resources Commission in 1991, whilst alleged obstruction of 'woodlot licenses' to individuals contributed to less than one per cent of timber harvested coming from forests owned by local small landowners (Western Canada Wilderness Committee, 1993-4). [However, British Columbia has a very low population density; other provinces with higher population density in eastern Canada have higher degrees of private ownership].

Barraclough and Ghimire (1990) show how public policies reflect the contradictory interests and influence of different support groups: powerful interest groups, including corporate transnational corporations, are seen to be very influential in shaping development policies and often more so in their execution. But this issue receives relatively little attention in most of the literature on forestry (Palo 1990, in Barraclough and Ghimire 1990). The promotion of forest industries in the drive for economic growth and greater national self-reliance has often taken place at the expense of deteriorating livelihoods for local populations using the forests, who are seldom consulted.

Employers may be selective in the appointment of a work force: Rasmusson (1994) contends that, in the case of Indonesia, "traditional populations do not tend to get many jobs associated with industrial forest estates... the jobs are filled by persons coming from elsewhere, often transmigrants".

Within the local community, the traditional division of work often changes as a result of forestry developments. Where women may have been the major cash earners through selling food or non timber forest products, employment on a plantation or provision of a contract to grow timber shifts the cash earning power to men (Evans 1982). Such issues are addressed by researchers, such as in a reported workshop on forest regeneration through community participation, where the means of meeting the needs of different user groups, especially women, were considered (Malhotra and Poffenberger 1989), but are commonly subsumed in the overall approach to the collective 'local people'.

Other aspects of inequitable benefits are considered: for example, in a proposed plantation site in Thailand, Sargent (1990) found concern - significantly, voiced by the village leader - that employment would be given to resident villagers in preference to landless migrant workers. Poorer farmers will be less likely to be able to take advantage of farm forestry schemes, since the long gestation period requires a supplementary source of income or support during the period when trees are not generating income (Barraclough and Ghimire 1990; Saxena 1990).

4.10. Conflicts of Interest

Given the generally inequitable distribution of benefits of fibre production, conflicts inevitably occur between stakeholders with differing interests. A commercial development thus needs to incorporate techniques of conflict resolution.

The literature on forestry in developing countries cites countless examples of conflicts between local forest users and powerful exploiters of their forest habitats who are ultimately backed by, or even help to form, state institutions and policies (Barraclough and Ghimire 1990). Less common are documented examples of how

different social groups are affected by changes in the forestry systems, how they react individually or collectively, the internal contradictions within the groups and what role is played by the state. Poffenberger (1990) describes disputes that have arisen over the allocation of territorial management rights and responsibilities in Bengal, disputes which the Forestry Department currently lacks the capacity to arbitrate. He suggests possible means of dispute arbitration, suitable to the particular region. Aside from competing claims on land tenure, one of the most common reasons for conflict is the use of exotic species such as Eucalyptus, described above.

In temperate and boreal regions, conflicts between conservation interests and logging companies have been the subject of international campaigns and the division of communities. A well known example is the conflict in northwestern US, where conservation groups attempt to protect species such as the spotted owl; forest workers, already suffering unemployment due to timber supply reductions, blame conservationists for further hardship (Western Canada Wilderness Committee, 1993-4; Devall 1993). Mills have been threatened with economic boycotts if old growth cutting and 'clear felling' practices continue. In Scandinavia in 1992 five major Swedish manufacturers agreed to a voluntary one year moratorium on felling old growth forest for fear of losing market share.

APPENDIX 2

BRIEF REGIONAL REVIEW: PLANTATION ISSUES, AND GOVERNMENT & INDUSTRY RESPONSES

This section gives a brief overview of forestry in the main regions producing wood fibre for commercial pulp production. It includes a historical background of forest use, forest ownership patterns, the types of forest typically used for pulp production and its management intensity, recent stakeholder pressures on management and the responses of government and industry to these pressures. We concentrate on plantations, and on forests which are under plantation-like silviculture and management. Additional details on forest types, compositions and silvicultural practices are in Bull *et al* (1995), a separate substudy of the Sustainable Paper Cycle Project.

Many forest managers are now having to address a wide range of issues that they did not consider to be their concern in the past, and any discussion must occur in the light of these changes. In general the forest industry world-wide is going through a period of enormous change in its philosophy, and this is being followed by changes - largely improvements - in its working practices. Many significant changes are comparatively recent and are not covered in the literature as reviewed in Appendix 1.

1. *The Nordic Countries*

History

The Nordic countries have a long history of forest management. Already by the end of last century forest legislation had been enacted and higher education in forestry established. By the mid 1970s, forestry had become highly mechanised and the accusation was being made by NGOs and the public that the forest base existed mainly of plantations. This has led to a radical change in the approach to forestry with the appearance of 'the New Forestry' based on more ecological principles.

Forest cover and ownership

The Nordic countries have more than 50% of their land covered by forests, mainly *Pinus sylvestris*, *Picea abies* and *Betula* spp. In Sweden, a large proportion of the forest (48%) is owned by small landowners and a further 40% is owned by large corporations. These corporations are often highly integrated vertically, which has enabled them to treat forests within the context of a paper cycle (indeed, the Swedish forest industry body is the only group apart from the Sustainable Paper Cycle Project, that we know of, to have examined the concept of the cycle in terms of local practice). Finnish forests are 63% in small private ownership, 24% owned by the state and 9% by corporations. A large proportion of forests are managed for pulp; most of these have single-species canopies, although broadleaves are increasingly (re) admitted to the canopy for biodiversity reasons.

Types of pulp-producing forest

Most wood fibre comes from managed natural forest in its second or subsequent rotation. Such managed forest has, through silvicultural manipulation, come to resemble plantations - even in areas where natural regeneration was employed. Plantation and artificial seeding account for 80% of all regeneration in the region today. Although it has been shown that other species (principally *Pinus contorta*, American Lodgepole pine)

may be substantially more productive than *P. sylvestris* (Hagner, 1983), there has been strong pressure against the introduction of such exotics (Savill and Evans, 1986). Despite this, considerable areas in Sweden have been planted with *P. contorta* in the last two decades.

Main management issues
Changes in management approach have occurred over recent years. As a result, the simple, plantation-like characteristics created earlier in the century have now become moderated. Management has moved away from large clearings, the elimination of birch, and draining of bogs. One-third of the private forest owners in Finland (100,000 people owning more than 300,000 ha) have recreational or other non-commercial use as their primary objective of forest ownership. In both Finland and Sweden, management recommendations given by the forest owners' associations include many activities that mimic or stimulate natural processes. There is a strong emphasis on diversity at both stand and landscape levels, and suggestions are based on the precautionary principle. Operations are highly mechanised, and emphasis is placed on low-impact machinery e.g. tree harvesters, rather than chainsaws and skidders.

Stakeholder pressures and debates
Industrial forest land has come under increasing pressure from the environmental lobby over the last decade. The main pressures have been against chemical use, large clearcuts and the draining of wetlands. Large corporations in Sweden now take environmental issues very seriously, with substantial changes in both philosophy and practices over the last five years.

Several forestry companies have been supporting the idea of certification of forest practices through the Nordic Forest Certification scheme and through involvement in the development of criteria for environmental certification of Swedish forestry by the World Fund of Nature (WWF) and the Swedish Nature Conservation Council (Svensk Naturskyddsföreningen) based on the Forest Stewardship Council's Principles and Criteria. Although, in Scandinavia, NGOs and industry are used to being more collaborative than antagonistic, the development of a Nordic certification programme will be a challenging test of this.

Government response - policy and legislation
Both in Finland and Sweden, forestry legislation is being adjusted to provide a framework for acceptable forestry practices according to 'the New Forestry' based on more ecological principles. In Finland this means the government is committed to reviewing the forest management practices employed in commercial forests according to guidelines as set out by the resolutions of UNCED and the subsequent Helsinki Process. In Sweden, a new Forestry Act came into force on January 1, 1994; this requires production nd environmental protection to have equal priority in each hectare of production forest. It includes several measures to ensure this, such as environmental impact assessments. Subsidies are reportedly only for social/environmental purposes. In addition, there is a strong emphasis on educating small forest owners e.g. the "Richer Forest" campaign reached a majority of private forest owners with group learning sessions and forest visits; this was followed by the "Forest for all Times" course.

Industry response - policy and practice
It appears that both large industrial forest managers and small private forest owners in Sweden and Finland are increasingly committed to forestry with a broader remit than just the production of timber. At the heart of the new

corporate approaches are micro-level multi-use planning, ecological landscape planning, and investing knowledge of the new approaches at all levels - including the all-important local foresters and machine crews. In addition, new approaches are developing based upon the natural fire occurrence and its effects in boreal forests. Such forests are classified according to whether they burn "Almost never", "Seldom" i.e. every 200 years; "Infrequently" i.e. every 100 years; or "Often" i.e. every 50 years. This ASIO system of classification is used in defining fire management models. Because there are few extensive areas of old growth conservation forest in the Nordic countries, biodiversity is now being nurtured in all production forests. However, there is still a significant use of exotic species, both of which are of concern to some environmental groups.

2. The Iberian Peninsula

History

The area of forest in Spain grew by 3.3% between 1975 and 1987. Over the 1980s reforestation rates averaged 96,000 hectares per year. The production of processed wood also grew. The component of paper and paperboard in this growth was a significant one; in the period 1980-1988 the rate of growth (volume-wise) was approximately 4%, resulting in a total of over 4 million metric tonnes for the Iberian Peninsula (Sharma, 1992).

Forest cover and ownership

The productive forest land of the Iberian Peninsula is 9.5 million ha, which is about 20% of the total land area of Spain and 30% of Portugal. In Portugal the ratio of conifers to broadleaves is 50:50. In Spain the ratio is about 75 to 25%. Industrial plantations are estimated to have a total growing stock of about 642 million cubic metres in 1988 (Sharma, 1992), 40% hardwood and 60% softwood. In Portugal 15% of the forest area is protected in a national system, while in Spain it is only 3%.

Types of pulp-producing forest

There is some pulp production from managed, naturally regenerated conifer forest and plantations of indigenous conifers. However, the most important source of wood fibre for pulp production in both Spain and Portugal is hardwood plantations, mainly of exotic eucalypts. The species most commonly used are *Eucalyptus globulus* and *E. camaldulensis*. Pulp and paper companies produce wood fibre from eucalyptus using a combination of industrial plantations and small woodlots grown by farmers.

Stakeholder pressures and debates

Originally, the development of plantations met with much public discontent, as it was associated with the fascist governments, and with considerable rural unemployment and social dislocation. Today, a big issue is fire. In Spain 235,000 ha annually suffers from fire damage of which approximately 88,000 hectares are forested. The area affected by forest fire has frequently exceeded the area planted with trees in any one year (WWF, 1992). The fires cause significant environmental losses; besides the loss of timber, rare species such as the Spanish Imperial Eagle are severely affected. During the 1980s, the severity of the forest fires has increased. Reasons that have been suggested for this are: neglect of forest management leading to dense and dry, often monospecific, stands; and the choice of pyrophytic conifer species instead of native fire resistant species (WWF, 1992). There is also contention over the development of pulp plantations on large areas of communal land from which olive groves have

been removed under EU incentives.

Industry response - policy and legislation
There is a growing awareness within the fibre-producing industry of the need to broaden the focus of forest management away from simple wood production. Social issues are important in both Spain and Portugal where rural lifestyles have changed rapidly in recent decades. Some companies have tried to work closely with farmers, encouraging growth of pulp species in woodlots by providing planting material or management advice. In some, though not all cases, this has resulted in an improvement in the local economy.

3. USA

History
There was a decrease in forest area following arrival of European settlers in the US, but this trend has been reversed in the last 50 years. Natural regeneration on abandoned agricultural land has increased the area of forest cover from 30% in 1920 to 33% by 1992. Management of these forests has often resulted in uniform, plantation-like forests, or their replacement with plantations. In other words, the use of plantation silvicultural techniques has become more widespread, even on forests that were not originally plantations.

Cutting in the federally-owned national forests has been drastically reduced in recent years due largely to the pressure from environmentalists, epitomised by the debate over the fate of the spotted owl, a species which needs large areas of old growth forest for its habitat.

Forest cover and ownership
Total timberlands in the USA cover just under 200 million ha. Currently softwoods constitute 57% of the US growing stock volume, and hardwoods 43%. The pulp and paper industry uses 30% of the hardwoods and 27% of the softwoods. Hardwoods are mainly found on the East Coast, while douglas fir is dominant in the Northwest and southern pines in the South. Thirty-four million ha is set aside for non-production uses.

Sixty percent of the forest area in the USA, producing half the timber, is owned by approximately 7 million, private, non-industrial owners (individuals, trusts and corporations). Small private landowners in the US do not form co-operatives and associations in the same way as forest owners in Nordic countries, due to differences in social behaviour combined with the influence of US anti-trust laws. Private industrial ownership accounts for about 15% of the total area, and one third of the total timber production. Federal and other public ownership (state and local government) covers the remaining 26% of timberland areas (approximately 53 million ha) and produces about 20% of the timber.

Types of pulp-producing forest
The US South (16 states stretching from Florida to Texas) is the most important region for production of wood fibre; over 67% of the total volume. Another 12% comes from the Pacific Northwest (Washington and Oregon) which is 90% softwood, mainly from privately-owned land in its second or subsequent rotation. The remaining 20% of wood fibre comes from the lake states, the Northeast and the rest of the US (WRI Ltd, 1995). Overall, 65% of US fibre production is from softwoods, of which a little

under half comes from plantations. Pine plantations are increasingly significant in the South - now making up 14% of production forest area; two-thirds of such plantations are on industry-owned land.

Main management issues
There are enduring tensions between environmental groups who wish to regulate the management of private forest land and defenders of private ownership rights, which has resulted in only limited movements to implement improved forest practices on private forest land. However, there is considerable variation between states, with some states offering tax breaks to forest owners who have a certified forest management plan.

Stakeholder pressures and debates
NGOs in the USA tend to act against private forest owners through litigation. Campaigns tend to be directed at public forests. There is currently less pressure for certification than in Europe. The main controversy over forests in the US has been in the Pacific Northwest due to the logging of old growth forest. This has clashed with tourism/recreation interests, and increasingly with environmental interests such as those concerned with endangered bird species, notably the spotted owl and marbled murrulet. This has led to withdrawal of large areas from production and has cost thousands of jobs in forest industry-dependent communities.

Forests in the South are being managed increasingly intensively with tree breeding producing ever faster-growing, more disease resistant trees which are planted in single-species blocks. Prescribed burning is widely practices, to reduce the hazards of uncontrolled fires and disease, and to prepare seedbeds, maintain grazing quality, and keep hardwoods out of the pine crop. Developing a balanced approach to fire use is critical to achieving SFM in the south-east. Considerable effort is going into ensuring that good management practices are in place. Also of concern in the South is plantation establishment in wetlands, which entails draining, and the conversion of established wetland (pine) forests to plantation-like structures (currently, such activities are legal under Federal law, but are being challenged by NGOs).

Government response - policy and legislation
Although Federal Forestry Laws *per se* do not exist, there are several important environmental acts which have an impact on forestry operations. Two of the most important are the Endangered Species Act and the clean air and water acts and amendments.

Forestry law in the USA has been enacted mainly at the state level, and differs considerably between states and regions. Although considerable legislation has been enacted over the years, the Endangered Species Acts, which is one of the mainstays of environmental protection in the US is "under increasing threat from Conservatives in congress, who think it protects endangered species at the cost of economic development and the rights of landowners (New Scientist Vol. 146, No 1974 p9).

Industry response - policy and practice
With the increasing pressure for forests to meet defined goals of management, an industry association, the American Forest and Paper Association, has led the way with the production of a set of criteria for sustainable forest management. Conformance with this standard, which covers good working practices, consideration for other people impacted by forestry, research and education, will be a pre-requisite for membership of the Association from January 1996.

In the south-east, management is relatively intense, but well-planned. There are strong emphases on: soil mapping and site capability assessment; site risk assessment; controlled chemical use regimes (there is a resistance to notions of banning herbicides and pesticides); controlled burning; breeding programmes; and objective-oriented management planning. Larger companies are making more progress in environmental factors than social factors, because there is a perception that social needs are often taken care of through other means. Large forests tend to be zoned rather than multi-use, but often such zoning is subtly designed to create a shifting mosaic of different forest types within a natural forest framework. Smaller landowners are much less aware of the different imperatives for SFM. The American Forest and Paper Association is attempting to turn the loggers, who harvest for small landowners, in improved forestry.

4. Canada

History

The development of Canadian forestry has been characterised by an early, unregulated, exploitative stage, followed by a centralised administrative stage that failed to reflect the variable and ever-changing ecological character of the resource, and therefore failed to achieve sustainable resource management. This led very recently to a stage in which forest management has become increasingly ecologically-based, including ecological site classification, ecologically-based tree crop species selection, and conservation of the tree crop gene resource. There has also been an increasing concern for wildlife, fish, recreation and landscape aesthetics (Kimmins, 1991). However, there remains a significant proportion of exploitative forestry.

Forest cover and ownership

Canada has 417.6 million ha of forest (45% of land area) of which 56% is considered 'commercial forest'. Softwoods make up 63% of forest cover, hardwoods 15% and mixed hardwoods and softwoods 22%. Most forests are even-aged due to cyclical disturbances such as insects or fires. Approximately 12% of forests are protected by policy (sensitive sites) or legislation (heritage forests).

Forests in Canada are 94% publicly owned, with provincial ownership the most important at 71%, while combined federal and territorial ownership is 23%. The remaining 6% is privately owned by 425,000 owners.

Types of pulp-producing forest

The main wood fibre producing regions are British Columbia and Alberta, and Ontario and Quebec, which together produce about 87% of Canada's total. Most of the wood fibre in Canada will continue to come from old growth coniferous forest until well into the next century when significant areas of second growth regeneration will have reached rotation age. Most pulp production is from coniferous species with hardwoods contributing less than 15% of the total volume. There is little plantation forestry in Canada, especially with exotic species and plantations of faster growing species for pulp production are relatively recent in most of Canada. However, there is some use of improved varieties of species such as *Populus*, which is generally planted on private land, particularly through leases of privately-owned farmland.

Main management issues

In the past, due to the extent of the forest resource little thought was given to management and areas were left to regenerate naturally following harvest. More recently, with the advent of mechanisation and the continued growth of markets, forest exploitation has become more rapid. Consequently, there has been increasing regulation and control of the forest industry with emphasis on ensuring adequate regeneration following harvesting. One form of forest tenure is the allocation of volume-based cutting rights on public land to companies who then have responsibility for regeneration and care of the harvested area until the trees are 'free to grow'. However, with no automatic rights to the next harvest, companies have little economic incentive to invest in optimising regeneration beyond what is required by regulation.

Stakeholder pressures and debates

Recently, there has been strong criticism of Canada's forestry practices from both within and outside the country. This is largely because of the dependence on exploitation of old growth forest with extensive clear-cutting being the main form of management (for economic reasons - to cover the costs of access, and for biological reasons - to control windthrow, pest and disease risks. The issue has been epitomised by the strong and sometimes violent campaign to prevent harvesting in Clayoquot Sound. This debate eventually led to the establishment of a scientific panel which has proposed stringent guidelines for future logging activities.

One serious issue in Canadian forestry is that of land rights. Indigenous people claim large portions of the country and although there is an on-going process of investigation into land claims, it is extremely slow, so that many areas are exploited before land claims are settled.

Government response - policy and legislation

Some provincial governments have responded to public pressure with the introduction of tough forest practice regulations. The annual allowable cut in British Columbia is now being reduced, with some forest areas to be withdrawn from production. The Federal Government has been involved with the development of criteria and indicators for sustainable forest management through the Montreal Process, and industry has been prominent in efforts to develop an international standard of forest management through the International Organisation for Standardisation (ISO). In 1994, the Canadian Council of Forest Ministers produced 'The Canadian Approach' which is a set of criteria and indicators of forest management, a national interpretation of the Montreal Process, to act as a basis for the assessment of forest practices.

Industry response - policy and practice

Industry in Canada has been mixed in its response to environmental criticism. Some companies have attempted to improve practices and consult to a greater degree with NGOs:

> *'We at MacMillan Bloedel are acutely aware that our company's environmental performance is by far the most intensely scrutinised of all forest products companies in BC, if not in the world. We accept the profile and the responsibility ... we are taking extraordinary steps to ensure that our operations respond to society's changing environmental expectations'* (MacMillan Bloedel, 1994).

Companies have great difficulty, however, in keeping up with the speed and uncertainty of market changes in environmental demands. For example, in

spite of the above, MacMillan Bloedel have very recently lost their contract to supply the New York Times. While other companies remain somewhat antagonistic, there is a general trend towards greater openness and involvement in environmental initiatives.

New practices in western temperate Canada include: the creation, at younger ages, of old-growth structural features in second-growth stands; modifying clear-cutting and leaving older and dead trees; different thinning regimes to result in more complex stands; and other changes to result in more uneven-aged forests. Such "New Forestry" practices emphasise multiple use in forests, rather than zonation.

5. Brazil

History

Eucalypts were first introduced in Brazil in the early 1800s as ornamental trees but already in 1906 afforestation started to provide fuelwood and sleepers for railways. Besides Eucalyptus, exotic pines were introduced from Southern USA, the Caribbean and Central America, to replace the depleted Araucaria forest (Suchek, 1991). In 1965, a Brazilian Forest Code allowed the development of new forests by giving fiscal incentives for man-made forests, thereby providing the key to the growth of this sector. As a result, planted forest area in Brazil grew from 470,000 ha in the 1960s to 6.2 million hectares in the 1990s, of which 3 million hectares is in eucalypt plantations. Plantation development has continued since the major government incentive program was eliminated in 1987, at a rate of some 100,000 ha per year, mainly supported by the pulp and paper industry (Suchek, 1991). But opposition to "monoculture" plantations and intensive use of herbicides and insecticides has caused them to be prohibited in some areas.

Forest cover and ownership

The Amazonian forest, for which Brazil is best known, used to cover 40% of the 850 million ha of land, but today it has dropped to 36%. The Atlantic forest, which once covered 10% of the land area now covers less than 1%. Similarly, 90% of the temperate Araucaria forests have disappeared. The Cerrado, a low-density savanna forest region has been reduced from 20% to 12 % of the land area. The entire plantation area, 6.4 million hectares of pine and eucalypt, is privately owned and less than 1.5 million ha belongs to the pulp industry on which Brazil's pulp and paper industry relies almost exclusively for its raw wood fiber requirements (WRI Ltd., 1995). However, little of this plantation area was developed on land previously under natural forests.

Types of pulp-producing forest

The most important pulp producing plantations are of exotic hardwoods, primarily eucalyptus. There is some use of mixed tropical hardwood but it is a minor contributor. Brazil is now the world's biggest supplier of eucalyptus pulp and, as a result of very successful breeding programmes, has some of the highest yields in the world. In particular, investment in breeding and clonal propagation by companies like Aracruz Celulose has been extremely successful in increasing the yield of plantations. Yield improvements of up to 700% have been reported (Sunder, 1988). Maximum annual growth rates can reach 40m^3ha^{-1}, ten to twenty times more than in Scandinavia, and in general, production levels are now 3 to 4 times greater than the 1960s. This means that a mill can reduce its forest

base to 37% of the original area, or expand pulp production by 160% from the same base (Suchek, 1991).

Main management issues
Plantations are cultivated intensively, including soil preparation, cultivation/weeding practices, chemical weed control, insecticides and fertilisation. Weeding is one of the most costly silvicultural treatments, together with the cost of insect control. Plantations are clear-felled and the harvesting operations still rely primarily on chain-saw/skidder operations.

Stakeholder pressures and debates
As the area of plantations expanded, there was mounting criticism about alleged adverse effects of eucalypts on soil, the water cycle, wildlife and local vegetation. As a result, some states passed laws prohibiting the planting of eucalypts on newly acquired land. This, in combination with rising land prices and opposition from environmentalists, and fuelled in part by adverse opinion regarding plantations in other tropical countries, has led to a shift in emphasis away from planting new areas to replanting harvested areas with improved, faster-growing planting material.

Government response - policy and legislation
In order to establish a forest plantation, a permit of the federal environmental agency IBAMA is required. If the land has already been affected by human interference the permit can be easily obtained. Conversion of tropical rainforest, however, is generally not permitted. Environmental laws specify that natural vegetation must be maintained on at least 20% of the area, including streamside riparian zones of at least 30 metres. Legislation and social pressure means that conditions for plantation employees are reasonably well regulated, particularly relative to the conditions for agricultural workers.

Industry response - policy and practice
Some companies have increased the proportion of indigenous vegetation above the regulated minimum. For example, Aracruz Celulose has 1 ha of indigenous forest for every 2.4 ha of eucalyptus - some of which have been enriched by planting native species to enhance riparian areas, reinforce biodiversity corridors, and act as barriers to pests and diseases. The pulp industry in Brazil is fairly integrated, with most wood fibre produced by plantations owned by pulp manufacturers. This has led to some debate over land rights, but has also provided employment in rural areas, with an estimated 4 jobs generated for each hectare of plantation (Ondro et al., 1995).

6. South Africa

History
Environmental awareness of the impacts of forest exploitation began as early as the mid-nineteenth century with concerns about the effects of fire. In the 1920s, controversy about the effects of afforestation on water supplies began, and continues today. As a result, there have been controls on afforestation for the last 23 years. More recently, a Code of Practice for Harvesting has been developed by the Forest Engineering Working Group of South Africa (Forest Engineering Working Group of South Africa, 1995), loosely based on a code developed in New Zealand, but adapted for the South African situation.

Forest cover and ownership

South African forests comprise plantations, natural forest and woodland. Almost 90% of 'forest and wooded land' in South Africa is wooded grasslands with less than 40% canopy cover. Total closed forest covers about 3 million hectares, of which 47% is plantations. Natural woodlands make up 42%, with natural forests just 11% of the total. Commercial forestry relies entirely on plantations, composed mainly of exotic species (usually eucalyptus, pine or wattle).

There is a marked degree of concentration of ownership in commercial forestry in South Africa, together with a high degree of vertical integration. Public control of plantations is operated through a partly-privatised wing of the former forest service - South African Forestry Corporation Ltd (SAFCOL). Large companies own most of the commercial forest and farmers own relatively little, although the last 10 years has seen a rapid growth in the number of black farmers participating in forestry. There are three main modes of development for small-scale plantations:

- Farmers with rights to communal lands in districts close to markets have planted eucalyptus (*E. grandis*) or wattle (*Acacia mearnsii*) in lots of 0.5 - 2 ha on their own initiative.
- Two large companies, Sappi and Mondi, have initiated contract outgrower schemes as part of corporate social investment programmes and commercial schemes.
- The South African Wattle Growers Union has opened its membership to small wattle growers whom it actively supports through extension services and loans.

As a result, there are now more than 7,000 farmers involved in forestry, but their contribution to wood industry remains low at about 2% (Department of Water Affairs and Forestry, 1995).

Types of pulp-producing forest

Plantations produce all the fibre required for pulp. In South Africa a lot has been learned from the vegetative multiplication and clonal forestry schemes in Brazil, specifically from the "success story" of Aracruz Florestal/Celulose; interspecific hybrids are becoming increasingly important to the South African industry. Presently, hybrids of the subtropical eucalypts are the most prominent, but exotic Pinus species are also receiving attention (Denison and Kietzka, 1993a). There is a strong emphasis on site/species matching (Denison and Kietzka, 1993b), and on setting up plantations with specific single products in mind (sawlogs, pulpwood and mining timber being the most important).

Main management issues

Parallel to current developments in Brazil, the management standard of plantations of genetically improved material is quite high. Poor sites receive intensive site-specific fertilisation strategies. In general, the hybrids can tolerate the limiting factors of soil, climate and terrain conditions, and appear to withstand stress more readily than the pure species. For this reason site/species matching is carefully planned according to a natural resource data base (Denison and Kietzka, 1993a). Harvesting is usually through clear-cuts with chainsaw felling and skidding.

Stakeholder pressures and debates

The main social issue facing the forest industry in South Africa over the next few years is the broadening of forest operations to benefit the disenfranchised black population as part of the country-wide restructuring

occurring in post-apartheid South Africa:

> *"The era of an industry, conservative, self-sufficient and perhaps somewhat complacent has come to an end. However, it is to become part of the new South Africa, to recognise that there are other aspects of our national life, hitherto largely neglected, on which forestry impinges and on which forestry must in future have a positive effect."* (Asmal, 1995).

One of the main environmental issues is water consumption, which is of growing concern in light of scientific assessments that the climate is becoming more arid long-term, and the reductions in yields that have been experienced over consecutive droughts (20% has been common). (Plantations are considered to compete with agriculture and industrial development and must generally apply for water permits.) A further issue is the narrow genetic base of plantations, particularly because further disease epidemics as well as climatic extremes are considered to become more frequent occurrences.

Government response - policy and legislation
In July 1995, a consultative document was produced (Department of Water Affairs and Forestry, 1995) which outlines a radical set of proposals on which to base forestry practice, including social equity, and the greater involvement of women. Recommendations are given for the establishment of commissions to assess the legitimacy of land claims. The document also covers ecological sustainability and economic stability, recognising the role of forest business in the country, but also emphasising the current low number of beneficiaries. Following consultation, the document will be used as a basis for development of a new national forest policy for South Africa. It is expected that this will give impetus to a major review of the social aspects of forestry and of corporate roles, which would have global spin-offs.

Industry response - policy and practice
In 1995, a set of guidelines for environmental conservation management was produced by the South African Forestry Industry, including an Environmental Statement covering integrated environmental management; soil, water and air; natural areas; cultural assets; efficient resource utilisation; work and living environments; and communication and education (FIEC, 1995).

However, the integration of the black population in the economic system is probably going to be one of the major issues in the near future. Some companies acknowledge this: for instance Mondi, one of the two biggest pulp and paper companies in South Africa, has initiated a project in KwaZulu (Natal) where farmers grow eucalyptus on a commercial basis on under-utilised land. Mondi provides the management, the technical expertise, a guaranteed market and superior clonal plants. There are already 800 farmers involved with 1600 ha. In future another 12,000 ha can enter the programme, which will provide Mondi in due course with 300,000 tonnes of fibre per annum. This means that Mondis mill in Richards Bay will be supplied two-thirds by Zulu-farmers (Denison and Kietzka, 1993a).

7. New Zealand

History

The current state of New Zealand's forest estate is the result of two waves of colonisation - the first by Polynesians about 1500 years ago and the second by Europeans starting in the early 1800s. At the time of first human contact, forests covered an estimated 20 million ha, 75% of the country's land area. This had been reduced to about 13 million ha by the time of European settlement and was further reduced, largely by clearance for agriculture, to the present 6.3 million ha (Purey-Cust and Hammond, 1995). Large-scale planting of exotic conifers during the 20th century has resulted in the creation of a commercial plantation estate of about 1.4 million ha and now most of the remaining indigenous forest is in reserve with virtually all of the wood produced coming from these plantations.

Commercial pulpwood forest types and ownership
Radiata pine, which comprises 90% of the plantation area, is by far the dominant plantation species with douglas fir making up 5%, other exotic conifers 3% and exotic hardwoods 2% (Lane 1995).

The ownership structure of the forest estate has changed dramatically since the initiation of Government policy in the mid-1980s to withdraw from commercial enterprises. This led to the dis-establishment of the Forest Service in 1987 and the subsequent privatisation of the Crown Forestry assets. Now large corporations (including the state-owned forestry companies) control more than 1 million ha, about 74% of the plantation area. The pulp and paper industry is dominated by five companies; 2 large firms, together responsible for 70% of the production, and 3 smaller ones.

Main management issues
Radiata pine plantations generally produce pulpwood only as a by-product, if produced at all. Efforts to improve productivity include selection and improvement of genetically superior planting material through a co-operative breeding programme, and an intensive management strategy, including pruning and thinning regimes to maximise value and volume output. It is projected that management intensity will increase as the estate expands (Ministry of Forestry 1993). As this essentially means pruning and thinning for production of clear sawnwood, emphasis will be on products other than pulpwood. Harvesting in plantations tends to be less mechanised than in Scandinavian forests and is mainly done by chainsaw. In general the management is increasingly incorporating environmental considerations.

Stakeholder pressures and debates
Environmental concerns about plantation establishment, largely focusing on issues of monoculture, first emerged in the early 1970s. Initially these were fuelled by concerns about conversion of indigenous forest to plantation in the Central North Island and the West Coast of the South Island, in the latter case, involving proposals to use southern beech for pulp. The concerns led to broader interest in how plantations were managed and the need to address issues other than timber production.

In 1991, this resulted in the representatives of the forest industry and the main environmental and forest recreation groups signing "The New Zealand Forest Accord". In the Accord the industrial groups undertook to exclude areas of naturally-occurring indigenous vegetation from conversion to plantation, while the conservation groups acknowledged the importance of plantation forestry. Currently, the New Zealand commercial plantation sector and New Zealand environmental and recreational organisations are attempting to define what is meant by sustainable commercial plantation forest management and have produced a draft set of principles (Anon, 1995).

Government response - policy and legislation
Increased public environmental concern and the resulting pressure on government has resulted in the Resource Management Act, which was introduced in 1991 and amended in 1993. The Act integrates existing environmental law by focusing on the control of adverse effects rather than prescribing activities. Activities are to be defined at regional or district levels as permitted, controlled, discretionary, prohibited or non-complying, depending on their effect on the environment. Implementation of the Act will therefore vary between areas but is expected to influence where and how plantation forestry is carried out.

Industry response - policy and practice
The forest industry is now generally taking a pro-active stance in achieving consensus on environmental matters. Apart from its support of and participation in the development of the Forest Accord and its present involvement in the definition of commercial plantation criteria, it is also participating in the development of regional policy standards and regional and district plans as required under the Resource Management Act. In particular it seeks to demonstrate that plantation forestry can be implemented sustainably thus ensuring that in most situations it should be a permitted activity with minimum controls and restrictions. The Forest Code of Practice, which includes principles covering soil and water values; scenic values; cultural values; recreational values; scientific and ecological values; forest health; site productivity; off-site impacts; safety and commercial has the stated aim: "To plan, manage and carry out forestry operations in a sustainable manner".

8. Indonesia

History
The Indonesian pulp and paper industry dates back to the 1920s, when the first mill was built. From 1930 to 1975 the sector developed along with the general industrial development. From the mid-seventies the sector has been expanding in terms of production volume and relative growth rates (FAO, 1990). To meet future demand for fiber, an aggressive programme establishing industrial plantations was undertaken beginning in the 1980s. In 1987 self-sufficiency in paper was achieved and Indonesia became a net exporter of the product (WRI, 1995).

Forest cover and ownership
Indonesia has a total of 142 million hectares of closed forest; 75% of the land area. Production forest covers 65 million ha; approximately 33% the total forest estate. In 1980 the area of established industrial plantations was about 1.5 million ha with a hardwood-softwood ratio of 70:30 (Sharma, 1992). By 1993 the area of industrial plantation in Indonesia had increased to 2.2 million ha of which 70% is owned by the Federal Government (WRI, 1995).

Types of pulp-producing forest
Indonesia went through approximately 20% growth in the development of the pulp and paper industry between 1980 and 1988 (Sharma, 1992), and has ambitious plans for establishment of industrial plantations. Over half the wood fibre for pulp in Indonesia comes from mixed tropical hardwood. There is now a great emphasis on plantations. Short-rotation plantations (Hutan Tanaman Industri - HTI) are in effect concessions, often on "conversion forest" to develop plantations for 35 years plus one rotation. Acacia mangium is the most commonly-planted tree (80%),

followed by Eucalyptus, Albizia, Gmelina and Pinus. Six million HTI plantations are planned, most of the production being used for pulp. One million ha have already been established, and 1997 will mark the maturity of the earliest plantations. Even though pulp production capacity in Indonesia is expanding, it is expected that the plantations will soon be able to provide other Pacific rim pulp mills in addition to those in Indonesia.

In 1988 a volume of 1 million cubic meters was used by the pulp and paper industry. By 1993 the area of industrial plantation in Indonesia had reached 2.2 million ha and the annual pulp manufacturing capacity is projected to expand. It is expected, however, that the plantations will produce a surplus of fiber despite the expansion in pulp manufacturing (WRI, 1995).

Stakeholder pressures and debates
Indonesia faces escalating attacks for the destruction of its natural forests. These attacks threaten to be translated into restrictions or bans on imports of forest products. According to Indonesian officials this concern is sometimes genuine, although often ill-informed, while some appear close to an attempt to use the environmental issue as a cloak for protectionist purposes (FAO, 1990). One of the debates concerns the legitimacy of the official "conversion forests" available for plantation development or agriculture. Salvage logging from these conversion forests is clearly capitalising the forest and pulp industries during the period while plantations are growing, providing as it does 40% of all industrial roundwood production (1993 figures). The government has a highly regulatory approach to the forest industry. Although the government has established large areas of forest under protection and conservation categories, enforcement of regulations is said to be weak.

9. China

History
The first eucalyptus trees were brought to China in the 1890s and after 1949, when the Peoples Republic was formed, plantations were established. In the 1950s and early 1960s a significant increase in stock coming from local seed sources took place. In 1972, in co-operation with the FAO, species (especially hybrids) suitable for tropical sites were introduced. At the moment there are still approximately 200 species varieties being cultivated, but often without knowledge of the provenance which has resulted in low productivity (Turnbull, 1981).

Forest cover and ownership
China is a country rich in native species but poor in forest resources. In 1949 the forest cover was estimated as 8.6% of the total land area, despite efforts since 1910 to increase the forest area. In 1981 the forest cover had reached 12.7% [122 million hectares] and a policy decision was made to increase the forest cover to 20% of the total land area by the year 2000, which means afforestation of some 2 million ha per year (Turnbull, 1981).

Types of pulp-producing forest
China's wood fibre supply for pulp production comes predominantly from plantations: exotic hardwoods (eucalypts), indigenous hardwood (*Populus*), and indigenous conifers (*Abies* and *Pinus*). However, there is also a

substantial contribution from managed regeneration and old growth conifer forest. The principal species planted since 1950 are *Eucalyptus citriodora, E. exserta,* and *E. globulus* and in the southern provinces there are large areas of commercial plantations of *Pinus massoniana, P.elliottii, P.caribaea,* and *P. taede*. The established industrial plantation area in China is about 12.7 million hectares and the paper and paperboard production in 1988 was over 14 million tonnes.

Stakeholder pressures and debates
In China environmental issues are a relatively new phenomenon; much of the population is poor and environmental concerns have a low priority. In addition, the government has not encouraged organised dissent. The pressure on the government in connection with environmental issues has been on the international stage.

10. Russia

History
At present, the vast and globally significant Russian forest sector is in crisis and many of the prevailing problems are rooted in the inefficiencies of the former command-and-control economy. Since 1989, pulp production has dropped from 3.2 million tonnes to 1.3 million tonnes by 1994. An emphasis on production targets (and not profitability) under the communist regime, combined with the lack of an economic pricing structure, meant that timber was treated as a virtually free product of infinite quantity, resulting in extremely inefficient wood use. Timber loss in harvesting occurred at an average rate of 40%. In addition, the paper industry was not seen as a strategic one and, therefore, no investments were made in the mills. As a result, Russian mills use three times the timber to produce the same finished product as their non-Russian competitors (Abusow, 1995). However, in 1988, of the 380 million m3 of wood harvested in the USSR, the pulp and paper industry consumed only about 12 - 15% (LTS, 1995).

Forest cover and ownership
The land area of Russia is 1183 million ha of which 670 million ha is potentially commercially viable forest land. A quarter of the worlds forests are located within Russia, including 50% of the worlds coniferous forests. There are over 550 million ha of coniferous forest, more than 100 ha of soft deciduous (birch, aspen, etc.), and some 20 million ha of hardwoods (mainly oak and beech). The government owns the freehold to all the forest resources in the Russian Federation (LTS, 1995). In recent years, it has (on paper at least) placed large areas of forest under protection and ecosystem conservation categories.

Types of pulp-producing forest
The extent of pulp-producing forest is enormous. However, these are mainly natural forests. In this century, a total of over 71 million ha of planting has taken place and the vast majority of this has been with native coniferous species in European Russia. No second or third rotations exist, due to the current lack of suitable management practices and the long harvesting cycles (frequently over 100 years for coniferous species).

Main management issues
There is a long tradition of forest management in Russia recorded over several centuries. However, due to poor harvesting practices, very large

clear-cuts, heavy erosion-causing machinery, and high logging intensities, the vegetation structure often changes towards one with a higher component of pioneer species and plantation-like structure. The current failure in the management of Russian forestry is not due to a lack of administrative structures, legislation or intention, but a continual and widespread disregard for the laws and regulations for short term benefit, lack of financial resources within the Forest Service to function effectively, and lack of infrastructure (only about 30% of potential commercial forest can be accessed). The general view that the forests in Russia are being over-exploited in certain areas - such as European Russia, where the annual harvest is in excess of the allowable cut - is certainly true on a localised basis. Considerable illegal logging takes place, i.e. the felling levels are in excess of those specified in the felling license or felling is taking place without any legal approval. Despite localised overcutting, Russian forests have been harvested at about only 20% of annual allowable cut for some years (Shutov, 1995). There is an almost overwhelming set of probable reasons for this: too many, inefficient authorities involved; lack of clear decision-making authority and coordination; poor silviculture and mismanagement; lack of skilled labour; fires and diseases; air pollution in European Russia; inefficient wood-using industries; marketing problems; lack of funding; unclear tenure; and poor transportation (Nilsson *et al*, 1992).

Stakeholder pressures and debates
With the current crisis in the Russian economy and employment, environmental concerns are not especially high priorities with the population at large. However, there is international concern about clearcutting of the boreal forests.

Government response - policy and legislation
Officially, a clear trend is emerging towards preserving productive forest areas for environmental, aesthetic, recreational and scientific reasons, and forest product companies are being forced to turn to new sources of fibre (Abusow, 1995). However, regulations are not enforced due to lack of funds in the Federal Forest Service of Russia, and there is considerable ambiguity on institutional mandates. This formerly had responsibility for both industrial production and forest protection but recently, industrial enterprises have been removed from the Forest Services direct control. Since there is no conflict of interest any more within the Service, the industry has been expected to become more responsible and efficient in their forest management practices, especially since they have been privatised.

Industry response - policy and practice
State-owned enterprises were converted into profit-seeking companies, owned and controlled by their former directors. Despite the privatisation, reductions in waste and inefficiency have not occurred. The privatised companies are managed in a economically opportunistic way. Given the uncertainty of their own future status, the ownership structures of their enterprises, and the possibility of a future with enforced legislation and tax collection, the managers have little incentive to take the long-term view. There is little to suggest that heavy overcutting will not continue or increase in accessible areas. Where there are threats of foreign companies "free-riding" on this incentive for over-exploitation (as opposed to SFM) - for example, some Asian companies in eastern Siberia - the prognosis for forests as not good. The big issues, therefore, concern the current set of incentives to exploit the natural forest, rather than technical issues of forest/plantation management.

Appendix 2.17

Appendix 3

The questionnaire sent out to companies

CONFIDENTIAL

PAPER FARMING: AN ASSESSMENT OF CURRENT PRACTICE

Pulpwood Plantation Company Questionnaire

Company:	

I. PLANTATION SIZE AND LOCATION

In which country are your plantations located ?	
In which regions are your plantations located ?	
What is the total plantation area managed by your company ?	ha
What is the current annual rate of planting new areas ?	ha
What is the current annual rate of harvest ?	ha
What is the current annual rate of regeneration of harvested areas ?	ha
What is the planned maximum area of plantation ?	ha

What proportion of the planted area is in first or subsequent rotations ?

First rotation	%	Second rotation	%	Subsequent rotations	%

II. MANAGEMENT INTENSITY

A. Mechanisation

What proportion of your operations are mechanised ?	> 85%	15-85%	< 15%
Site preparation			
Planting			
Maintenance (weeding, thinning, pruning etc.)			
Harvesting (felling, bucking, trimming)			

Do you vary the use of mechanisation in relation to:	Yes	No
Different terrain ?		
Different vegetation type?		
Different soil type?		
Different exposures to public view?		

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B. Soil

Are there areas of your plantation area where soils are inherently fragile ?

Yes		No		Don't know	

If yes, what percentage of the total area ?	%

Do you carry out any operations that potentially affect soil structure or fertility adversely?

	Yes	No	Details
Soil scarification			
Terracing			
Windrowing, piling and burning slash			
Machine planting			
Mechanised inter-row cultivation			
Ground based harvesting			
Cable harvesting			
Whole-tree harvesting including branches and bark			
Other operations (please specify):			

Does soil erosion occur as a result of any of the above operations ?

Yes		No		Don't know	

If yes: Have you adapted any of your operations to minimise erosion ?

Yes		No	

If yes: Give details ?

Do you lose substantial quantities of nutrients, either from the soil or in harvested trees, over each rotation ?

Yes		No		Don't know	

C. Fertilisers

Do you use fertilisers ?

Yes		No	

If fertilisers are used, what are the types and application rates ?

Fertiliser type	Crop age at time of application	Quantity applied /ha

Are there any fertiliser-related leaching losses to groundwater or streams ?

Yes		No		Don't know	

Do you have any specific management guidelines aimed at matching fertiliser application to plant uptake, and minimising losses ?

Yes		No		Don't know	

D. Pests and diseases

What levels of pests and diseases do you have currently ?

Low		Medium		High	

Do any pests or diseases cause particular problems ?

Tree species	Pest or disease

Do you use chemical pesticides or herbicides to control pests and diseases ?

Yes		No	

If yes: Which pesticides and herbicides do you use, and in what quantities ?

Pesticide or herbicide name	Application rate/ha/yr

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What levels of pests and diseases do you expect to have in the future ?

Low		Medium		High	

Do you expect your use of chemical pesticides and herbicides to increase, decrease or remain unchanged ?

Increase		Decrease		No change	

E. Water management

Do you have a water management policy ?

Yes		No	

Do you monitor groundwater levels and streamflow from the plantation area, and if so, have there been any changes ?

	Monitored				Changes					
Groundwater levels	Yes		No		Increase		Decrease		Don't know	
Streamflow	Yes		No		Increase		Decrease		Don't know	

Do you monitor the quality of water leaving the plantation, particularly suspended sediment loads, levels of dissolved nutrients and pollutants such as pesticide and herbicide residues ?

	Monitored				Changes					
Suspended sediment load	Yes		No		Increase		Decrease		Don't know	
Dissolved nutrient load	Yes		No		Increase		Decrease		Don't know	
Contaminant load	Yes		No		Increase		Decrease		Don't know	

III. GENETIC DIVERSITY IN AND AROUND THE PLANTATION

A. Planted trees

What tree species are used in your plantation and what proportion of the total area is planted with each ?

Species	% of area planted with this species

How important was each of the following criteria in selecting which species to plant ? (1 = not considered, 2: unimportant, 3: moderately important, 4: very important, 5: critical)

	1	2	3	4	5
Timber quality					
Pulp quality					
Market price for products					
Suitability for the site					
Potential for multiple use					
Growth rate					
Pest and disease resistance					
Security of seed source					
Ease of management					
Availability of silvicultural information					
Ecological benefit to area					
Importance for indigenous wildlife					
Other, please specify					

What proportion of your plantations are planted in single or in mixed species blocks ?

Single species	%	Mixed species	%

What is the average and maximum area of a block planted with a single species ?

Average	ha	Maximum	ha

What proportion of seedlings planted are clones ?

> 85 %		50 - 85		15 - 50 %		< 15 %	

If clones are used, what is the maximum size of a single clone block ?	ha

What is the maximum total area planted with a single clone in your plantation ?	ha

Do you have a regular program of clone replacement ?

Yes		No	

If yes: How frequently are clones replaced ?	Every	years

Do you have a program of planting indigenous trees ?

Yes		No	

If yes: What is the approximate number of indigenous seedlings planted per 1000 exotic seedlings	

If yes: Which indigenous species do you plant ?

B. Biodiversity of the plantation and its surroundings

Is your plantation in a single contiguous block, multiple large blocks, or many fragments ?

Single contiguous block		Large separate blocks		Fragments	

If your plantation has been established in multiple blocks or fragments, what is the maximum and minimum size of the blocks or fragments ?

Maximum	ha	Minimum	ha

How was land used immediately before establishment of your plantations ?

Primary forest	%
Secondary forest	%
Natural grassland	%
Degraded land	%
Agricultural land	%
Other (please specify)	

Does your plantation area include patches of natural forest ?

Yes		No	

If yes: What is the proportion of natural forest within the plantation matrix ?	%

Are buffers of natural forest left along watercourses ?

Yes		No	

Are corridors of natural forest maintained to link forest fragments ?

Yes		No	

Have there been any studies of indigenous plants in the plantation or in other plantations in the region ?

Yes		No		Don't know	

Have there been any studies of animal and bird or aquatic life in the plantation or in other plantations in the region ?

Yes		No		Don't know	

If any studies exist, do they report any change in the number of indigenous species ?

Increase		No change		Decline	

Do you take any active measures to increase the biodiversity of plants or animals within the plantation ?

Yes		No	

If yes, what measures are taken ?

Do you have any measures to control the spread of the exotic species or diseases from the plantation into surrounding indigenous ecosystems ?

Yes		No	

If yes, what measures are taken ?

IV. DIVERSITY OF USE OF PLANTATION AREAS

A. Multiple products of plantations

Which of the following products or services does your plantation provide, and on a commercial or subsistence basis ?

	Commercial	Subsistence
Wood for timber		
Wood for pulp		
Fuelwood		
Wood for charcoal		
Non-wood products such as fibres, berries, fruits etc. (Please specify):		

Agricultural produce		
Meat from hunting		
Fish from fishing		
Recreational activities (walking, rafting, camping etc)		
Other (please specify):		

B. Employment

How many people are employed by the plantation directly, and how many are employed through contractors ?

Directly	workers/year
Contractor	workers/year

What percentage of the work in the plantation is permanent, temporary or seasonal ?

Permanent	workdays/year
Temporary	workdays/year
Seasonal	workdays/year

What proportion are recruited locally, regionally, nationally or internationally ?

Locally	%	Regionally	%	Nationally	%	Internationally	%

What are the proportions of your labour force in administrative, management or research work versus labour and machine operators in the plantation ?

Administration, management or research	%	Plantation	%

What proportion of the staff employed in the plantation are skilled, semi-skilled and unskilled ?

Skilled		Semi-skilled		Unskilled	

C. Social considerations

Are there any indigenous people living in or around the plantation area ?

Yes		No	

If yes, what is the approximate population ?
What type of settlements do indigenous people have ?

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	Yes	No
Do any indigenous or local groups claim land rights within the area covered by the plantation ?		
Do you have any agreements with local groups other than those employed by the plantation about access to plantation areas or use of resources ?		
Does your company have a plantation outgrower scheme or provide an extension service ?		

Is access to the forest other then for workers free, conditional or prohibited ?

Free		Conditional		Prohibited	

Do you carry out activities which make a contribution to the welfare of your staff or the local community ?

	For your staff	For the local community
Education		
Health		
Roading/transport		
Other (please specify)		

D. Public relations

How important do you consider public relations to be ?

Very important		Somewhat important		Unimportant	

Do you use advertising or produce publicity material concerning your environmental or social performance ?

Yes		No	

If Yes: at which audiences is it aimed ?

Local		National		Customers		International	

What is the approximate budget for public relations activities ?	$/year

Do you have processes for consulting with local people and NGOs, or encouraging them to participate in making decisions which will affect them ?

Yes		No	

If yes: which of the following methods do you use (please give details) ?	
Meetings	
Committee	
Liaison officer	
Other:	

Has your company and its plantation operations ever been the subject of criticism from any of the following groups ?

	Yes	No
Local groups		
Regional groups		
National interest groups		
International interest groups		
Government		
Customers		

If your company has been criticised, did the criticism refer to any of the following areas, and to what extent was it justified in your view ?

	Yes	No	Details of criticism made, and whether or not it was justified:
Land tenure and rights			
Access to plantation areas			
Involvement of local people			
Species planted			
Management practices			
Biodiversity			
Other (please specify)			

Have any of these complaints resulted in changes in your practices ?

Yes		No	

If yes, what changes were made and what have been the costs involved (US $) ?	
Change made	Costs involved $/ha

V. ECONOMICS AND REGULATIONS

A. Costs and returns

What is the average cost of establishment per hectare from site preparation to free to grow state ?	US $

What are the average growth rates of the major species in your plantations in m^3/ha/yr ?

Species	Average growth in m^3/ha/yr

What is your annual harvest of wood and what proportions are for pulp and timber ?

	m^3 per year	ha per year
Pulpwood		
Other uses		

What is your average conversion factor for m^3 wood to tonnes of pulp ?

Species	m^3/tonne pulp

What is an average market cost per m^3 of pulp wood delivered in your area ?	US $

Are there any tax benefits or other incentives to encourage plantations ?

Is your company involved in any way with planning or implementing projects for carbon sequestration through forestry ? Please give details.

B. Statutory regulations

What are the environmental rules governing plantations in your country and region ?

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What other regulations relevant to plantations exist ?

Do you have corporate environmental or social guidelines or codes of practice ?

Yes ☐ No ☐

If yes: what type of guidelines do you have and what is their scope ?

Does your company have a working definition of 'Sustainable Forest Management' ?

Yes ☐ No ☐

If yes: please give details ?

Which areas of 'Sustainable Forest Management' do you think require further research or clarification ? Would it be helpful for your company if more research was carried out in these areas ?