Understanding the FAO's 'Wood Supply from Planted Forests' Projections

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Summary

The world's **Planted Forests** produce wood, fibre and fuelwood, and protect soil and water catchments, while their management generates diverse social and environmental outcomes. The Food and Agriculture Organization of the United Nations (FAO) recently prepared three scenario-based projections of potential wood supply from the world's Planted Forests between 2005 and 2030. The projections were published in the article *Wood from Planted Forests: A Global Outlook 2005-2030* at the end of 2008.

At a time of global climate change, the FAO's contribution to the public discourse on forest use and management is particularly important because it unified the previously separate concepts of **Forest Plantations** and **Semi-Natural Planted Forests (SNPF)** into the single concept of **Planted Forests**. This draws attention to the definitions by which the world's wood resources are identified and the potential wood supply from those resources.

Planted Forests are areas predominantly composed of trees established through planting or deliberate seeding, and are likely to be more intensively managed than some native forests. The FAO regards Forest Plantations as areas of introduced tree species, and in some cases native species, established through planting or seeding. SNPF are areas of native tree species established through planting, seeding or coppicing, but may include areas with naturally regenerated areas of introduced species. The FAO considers that the main shared features of these different 'estates' justify their unification as a single statistical unit that can be used for modelling projections of potential wood supply from the world's Planted Forests.

This report's primary objective is to examine the data on which the projections were based to understand the characteristics of the two components of the Planted Forest estate and how they interact with the assumptions used to prepare the projections. The FAO provided the data and detailed their assumptions for this investigation. The secondary objective is to explain the definitions and use of the terms Planted Forests, Forest Plantations and Semi-Natural Planted Forests to increase understanding of the place of

these terms and the FAO's projections in the continuing discourse on the use and management of the world's forests.

The FAO based its projections on a Planted Forest estate at 2005 of almost 261 million hectares in 61 countries. This area was about 95% of the world's then total Planted Forests and comprised 128.1 million hectares of Forest Plantations and 132.4 million hectares of SNPF. The FAO presented three scenarios of the projected potential wood supply from those Planted Forests:

- Scenario 1 *'Pessimistic'* – area expansion is half that of Scenario 2
- Scenario 2 *'Business as usual'* – a continuation of recent planting rates with no productivity increases
- Scenario 3 *'Higher productivity'* – a continuation of recent planting rates with annual productivity increases of up to 2% in some Planted Forests.

The FAO considers that the projections reflect a range of justifiable assumptions about the world's Planted Forests and their management, and concluded that Scenario 3 is the most likely. In presenting the projections, the FAO did not distinguish between Forest Plantations and SNPF, but presented a total projection for Planted Forests.

The projections indicate that Planted Forests (about 7% of global forests and 2% of global land use) may already provide around 70% of the world's recent production of industrial roundwood (logs for timber and pulpwood), but only 7% of reported global fuelwood production. Under Scenarios 2 and 3, the FAO projects that the potential supply of industrial roundwood would increase by 20% and 55% respectively between 2005 and 2030. While the potential supply of 'bioenergy/fuelwood' from Planted Forests is projected to increase by similar percentages, volumes would remain relatively small, so global fuelwood use would continue to rely overwhelmingly on native forests and woodlands.

The FAO's projections of potential wood supply from Planted Forests using a Planted Forest database build on the FAO's 60-year history of reporting on world forestry in the face of limited data and resources. The new term Planted Forests draws into such modelling Semi-Natural Planted Forests (especially the shorter rotation SNPF in Asia and the longer rotation SNPF in Europe), which the FAO views as sharing characteristics

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with Forest Plantations. The term Planted Forests can comprise areas of planted trees (Forest Plantations or SNPF) established on natural forests and grasslands, SNPF created from 'assisted regeneration' semi-natural forests, re-planted SNPF and Forest Plantations, Planted Forests established on already cleared land, and areas of naturally regenerated trees that also contain more than a minimum proportion of planted trees.

Thus, the FAO's projections of potential wood supply are based on an 'estate' comprising the two overlapping continuums of characteristics of, and assumptions about, Forest Plantations and SNPF. These continuums share important features, but also have notable differences, that are ultimately reflected in the potential wood output from the two estates:

- At 2005, the distribution of Forest Plantations around the world was more extensive than SNPF

- At 2005, SNPF had a larger area of age-classes older than 40 years than Forest Plantations, but a smaller area of age-classes of 10 years or less

- At 2005, about half of both SNPF and Forest Plantations had tree growth rates (Mean Annual Increment – MAI) of 5-10 m^3/ha/year. However, almost all the remaining area of SNPF had MAIs of 5 m^3/ha/year or less, while Forest Plantations with MAIs outside the 5-10 m^3/ha/yr range included larger areas with much higher growth rates

- At 2005, 43% of SNPF had a rotation time of 40 years or less, but 67% of Forest Plantations had a rotation time of 40 years or less. The area and percentage of SNPF with a rotation length greater than 60 years is about 2.5 times those for such Forest Plantations

- At 2005, Forest Plantations with a rotation of less than 30-40 years contained a disproportionately larger area of higher growth rates

- The locations of Forest Plantations and SNPF with different rotation lengths are distributed differently around the world

- The projections reflect the assumption that future investment in management for greater productivity will favour Forest Plantations over SNPF.

As a consequence, the modelling produced the following results:

- The total wood volume projected to be available from SNPF at 2030 is less than that at 2005 in Scenarios 1 and 2, but marginally greater in Scenario 3

- The wood volumes projected to be available from Forest Plantations under the three scenarios at 2030 are between 31% and 87% greater than at 2005

- At 2030, the total projected potential wood supply from Forest Plantations is between 2 and 2.6 times greater than that from SNPF

- The projected volumes for all products available from Forest Plantations between 2005 and 2030 are substantially greater than those projected for SNPF.

The projections themselves, as well as the characteristics of Forest Plantations and SNPF used in preparing the projections, challenge some previous perceptions and classifications of 'forests' and wood–producing plantations that separate such plantations from SNPF. Also, the unification of Forest Plantations and SNPF into Planted Forests for statistical and modelling purposes is useful in providing an important perspective on global wood resources; while the simplification of 'forest' categories and data collection by the Global Forest Resources Assessment (FRA) process that reports on the condition of the world's forests eases the reporting burden of countries that participate in that process.

However, the unification of Forest Plantations and SNPF into Planted Forests hides the substantial diversity in the physical and management characteristics within these categories that will also be lost in the data collection of the FRA. It is the diversity of physical, productive and establishment processes within Planted Forests that produces the substantial differences in the FAO's projections of potential wood supplies from Forest Plantations and SNPF. This diversity challenges the simplified categorisation by the FAO and associated data collection by the FRA. The diversity, similarities and differences within the resource characteristics will be obscured when data collection and publication are based on the unified category of Planted Forests. This could help direct attention away from the social and ecological dimensions of different wood resources included in the Planted Forests category. Also, some intensive management techniques applied to Planted Forests are also applied to some native forests; this raises questions about how such native forests are categorised and viewed from a socio-ecological perspective.

At this time of global climate change when Planted Forests are being promoted to remove carbon from the atmosphere, produce wood products and generate social and environmental benefits, it is important that such promotional arguments can be

empirically analysed. Having access to detailed and consistent data on the past, current and possible future condition of the world's forests, including Planted Forests, becomes very important for policy formulation. Individuals and groups concerned with the future of the world's forests should investigate if, and how, the unification of forest categories and simplification of data collection by the FAO and the FRA impact on their interests.

This report recommends that:

- The FRA should expand the amount of data collected on Planted Forests for its regular global forests reports so that the FAO's Plantation Forest Database can be updated systematically, and expanded as necessary. The information so collected should be made publicly available. Sufficient funds should be provided to the FAO and FRA for this purpose.

- The FAO and FRA should begin establishing a new global forest database for major 'forest' areas other than Planted Forests. This should be based on the FAO's Plantation Forest Database and its collection of specific technical and management data, such as rotation times, thinning practices and logging methods. The information collected should be 'relational' so that the characteristics of each area can be understood, and it should be made publicly available. Sufficient funds should be provided to the FAO and FRA for this purpose also.

- Governments of countries participating in the FRA process should ensure that they have sufficient funds to report thoroughly on the condition of their 'forests', including Planted Forests, to perform the above actions.

- Such a new global forest database should be made accessible to the general public for data submission and retrieval; it could be located on the World Wide Web.

- If the relevant governments and international governmental organisations do not establish such a global database, then interested non-government organisations should consider doing so, using available FAO and FRA data as a starting point.

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Special terms and abbreviations

FAO	The Food and Agriculture Organization of the United Nations
Firewood/fuelwood	Wood burned to provide heat for human use, such as cooking or steam generation
Global Forest Resources Assessment (FRA)	The global process coordinated by FAO that collects, analyses, manages and makes available information about forest resources, their management and uses for all countries
ha	Hectares
MAI	Mean Annual Increment
m^3	Cubic metres
Sawlogs	Logs used to manufacture sawn timber
Pulpwood	Wood in the form of logs or chips used to manufacture pulp for paper, paperboard or artificial fibres
Resources	Available assets that can be used to achieve an objective
Wood products	Sawn timber, plywood, veneers, particleboards and similar solid wood items used for construction

Preface

People see forests differently and some views have more power to determine their use than others. The political-policy process is the forum for these inescapable contests. Those wishing to engage in this process need relevant and reliable information: some may choose subsequently to silence it. Information helps shape our understanding, develop strategy and make more informed choices with greater knowledge about the trade-off implications of different options. Generating policy-relevant information was the aim of the Food and Agriculture Organization (FAO) in preparing its plantation wood supply projections and Ian Penna's subsequent investigation opens the way for a deeper understanding of those projections.

World-wide, the forestry and forest products industry is highly commodified. Most of the sawn timber, wood panels and paper that we buy is used to meet our basic housing and communication needs. They are not specialty appearance products, but rather highly standardised. Most buyers choose the lowest-priced product from amongst the various on offer. Cost reduction strategies are therefore front-and-centre for producers seeking to maintain profit margins. Competition from non-wood products reinforces the focus on cost competitiveness. It should be no surprise that plantation wood growing regimes–as cost reduction strategies–are so prevalent. For many people, however, the large volume of wood available from the existing plantation estate is a surprise, even in Australia where the overwhelming majority of plantations are single species tree crops planted in rows for the sole purpose of wood production.

Each forest interest group uses a particular 'forest' terminology, which obscures the different values within natural forests and wood-producing plantations. Many production foresters view a forest as an area of land dominated by trees of a certain size and canopy potential: they aim to manage the estate to maximise wood production and revenue. To an ecological scientist, a forest is an area of land with trees predominately native to the locality and where natural regenerative processes operate either fully or in part for the recovery of canopy structure following natural or artificial disturbance.

Historically, the wood production definition has dominated the public debate over forest use and management, and policy development. 'Forest' has come to mean plantations and natural forests and everything in between. Our forest products statistics rarely separate the various products by their ecologically different wood-growing system. The economically driven shift in the forestry industry's wood source is thereby rendered invisible to the consumer and public at large. A public understanding of forests through the eyes of a forestry definition suits the forestry industry as a whole and is perpetuated by their major players. It helps keep open for wood production more forests, particularly natural forests, where the land-use contests are greatest.

By contrast, adopting ecologically-based definitions opens the door to making more inclusive trade-off decisions. At one end are largely intact natural forests prized for their interlinked biodiversity, resilience and carbon stock attributes. At the other end are plantations, undisputed tree crops prized for their efficiencies concerning time, productivity and processing. Where natural forests are the basis of indigenous peoples' traditional activities or have high biodiversity conservation values, it makes sense to concentrate commodity wood production out of them and into (in the first instance) existing plantations. This policy frame is impossible to visualise while a wood production definition of forests dominates the public view, and data collection and reporting systems.

The FAO's important work to increase the sophistication of forest terminology has attracted attention to the more complex area in the middle of the natural forest–plantation continuum. In the contest over the forests in these grey areas, we should not overlook the ends of this continuum – the large areas of high ecological value natural forests at one end and the plantations with their large wood volumes at the other. Concentrating wood production in plantations whilst conserving these natural forests presents the best opportunities for immediate, pragmatic policy development that suits the core interests of both industry and the environment. But realising these opportunities at the ends of the continuum will be frustrated by the inevitable conflict over land-use allocation in the middle of the forest-plantation continuum. We must attend to this and, here, systems thinking ecological scientists have much to offer.

Ian Penna's report alerts us to the importance of the task. By painstakingly trawling through the FAO's unpublished data that accompanied its recent plantation wood supply projections, he has constructed a picture of the diverse features of the forests in the more contentious grey area. The findings are an important contribution to the ongoing task of refining forest definitions and developing classification criteria for on-ground decision-making. Ian Penna's report facilitates a greater engagement of ecological scientists and other interested parties in this task. The FAO's work and this report are welcome developments in our long history of unresolved forest conflict and lost opportunities.

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1. Introduction

This report examines the projections of potential wood supply from the world's Planted Forests produced by the Food and Agriculture Organization of the United Nations (FAO) as published in late 2008 (Carle & Holmgren 2008). The report has two objectives.

The primary objective is to explain the FAO's projections of potential wood supply from the world's Planted Forests in terms of its two resource components – Forest Plantations and Semi-Natural Planted Forests (SNPF) - using unpublished FAO modelling assumptions. Examination of this detail is important because the amalgamation of the Forest Plantation and SNPF categories for statistical purposes is recent and will likely influence the way that statistics on global forest and wood resources are presented and analysed.

The secondary objective is to explain some of the history of the definitional and statistical issues related to the terms Forest Plantations, Semi-Natural Planted Forests and Planted Forests as used by the FAO and others. This objective supports the primary objective by providing a context for, and helping readers understand, the use of these terms in data collection, modelling and discussions on the world's wood resources.

It is expected that the information provided by meeting these two objectives will help users of the FAO forest data identify any implications from the change in the presentation of statistics on planted wood resources for global forest policy issues in which they are interested.

The latest projections of potential wood supply from the world's Planted Forests produced by the Food and Agriculture Organization of the United Nations (FAO) (Carle & Holmgren 2008) were published at a very important time. They appeared 12 months before the 15th Conference of Parties in the Framework Convention on Climate Change held in December 2009 (Denmark 2009), and contributed to the continuing discussion and debate on the roles that forests and timber plantations might play in mitigating the impacts of increasing levels of atmospheric carbon dioxide and responding to climate change. This discourse has included: examination of the role of natural forests in carbon storage (Mackey et al. 2008a); analysis of the potential influence of carbon markets on

the future use of wood-producing plantations (Wood & Ajani 2008a, 2008b); descriptions of the importance of definitions of 'forests' and 'forest degradation' to the outcomes of climate change agreements (Zomer et al. 2006; Sasaki & Putz 2009); analyses of the potential impact of new tree plantations on water resources (Trabucco et al. 2008; Zomer et al. 2008), and the presentation of arguments for (IFFA 2009) and against (Anon. 2009) the use of tree plantations in climate change mitigation.

The FAO's 2008 study *Wood from Planted Forests: A Global Outlook 2005-2030* (Carle & Holmgren 2008) highlighted two important issues:

- the potential supply of wood-based products (sawlogs, pulpwood and fuelwood) from an expanded area of Planted Forests (areas dominated by trees planted by humans)

- the definitions used in delineating the boundaries of wood resources upon which such projections were based.

These issues emphasise the economic, social, environmental and political importance of projections of the potential wood supply from forests, including Planted Forests. Such projections influence public policy, patterns of investment in forestry resources, the rate of establishment of Planted Forests and the rate of exploitation of existing native and other forests. All projections make assumptions about the future, but those assumptions may or may not reflect how a society values the environments in which those resources are located, and the way it wants those landscapes to be managed.

The projections of wood resources available from Planted Forests that were created by humans have a special significance. Such areas of trees can produce more wood per unit area than naturally regenerating or native forests; they can be created with preferred wood fibre characteristics; and they can be located at sites that maximise their economic and political value. They play an increasing role in global wood supply as their area, extent and rates of exploitation grow. Areas of planted trees also have important social, cultural and environmental impacts, the magnitude of which depends on their size, location, species, management and use (Carle & Holmgren 2008). Thus, understanding the assumptions and methodology used to create a projection of potential wood supply from

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Planted Forests is important for community discussions and decisions on how to create, manage and use those resources.

The FAO's latest projections (Carle & Holmgren 2008) also illustrate the importance of definitions in the discourse on global forest management. Prior to 2005, the FAO used the term 'Planted Forests', but it only collected and reported statistics on Forest Plantations, which it primarily considered to be monocultures of introduced tree species established by planting or seeding. Thus, former reporting related to a subset of the forests encompassed by the 2008 projections for Planted Forests.

After 2005, the FAO began using the term Planted Forests as a statistical unit. Along with Forest Plantations, the FAO included in the boundaries of this term 'planted semi-natural forests not previously reported' (Carle & Holmgren 2008, p. 7), which primarily comprise native tree species that were established by coppicing of previously established stock, planting, or seeding. This definitional change basically doubled the area of the 'planted' estate that was recorded as having wood production as the primary activity. The FAO's 2008 projections of potential wood production from Planted Forests were modelled using this expanded definition. However, at the time of writing this report, the FAO had not published all the details and assumptions underlying their modelling exercise (Carle & Holmgren 2008).

Thus, this report provides an entry point for more detailed understanding of the recent work of the FAO in modelling potential global wood supply from Planted Forests. Chapter Two presents the historical examination of the main Planted Forest-related definitions, particularly issues related to their preparation and use. This provides a context for Chapter Three, which contains the analysis of the 2008 FAO projections of potential wood supply from Planted Forests, based on the Forest Plantation and SNPF components. Chapter Four integrates the main points from these two chapters for a discussion of issues surrounding the 2008 Planted Forests resource projections and definitions.[1]

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[1] The author considers that the term Forest Plantations is contradictory. It would be more accurate and consistent to name such areas by their outputs. For example, if the plantation has a commercial wood production objective, then 'wood plantation', could be used; this is in line with terms such as 'cotton

plantation' or 'palm oil plantation'. Nevertheless, this report uses the FAO's terms of Planted Forests, Forest Plantations and Semi-Natural Planted Forests for the sake of convenience and consistency. The terms 'analogue forest' (Duffy 2001) or 'biorich plantation' (Murphy 2009) have also been used to describe areas of human-established trees grown to mimic natural forests.

2. Planted Forests and definitional issues

2.1 The FRA Process

The FAO has been collecting data on the world's forests and wood resources since 1946. This work became formalised as the Global Forest Resources Assessment (FRA) in 1980. The FAO now coordinates this process, which uses data from participating countries to produce reports about forests. In particular, the FRA publishes reports every 5-10 years on the changing condition of the world's forests, and the next such report is due in 2010.

Notably, the social context in which the FRA reports are prepared has also changed over time. While the initial assessments were concerned primarily with wood resources, the increasing global interest in forest conservation and climate change has meant that the topics now covered by assessments include forest biodiversity, carbon stocks, as well as socio-economic, protective and productive functions of forests, including Planted Forests (Carle 2001; Holmgren 2006; Anon. 2008b).

The number of countries that contribute to the process has increased, but those that can supply information from a national forestry database is relatively small and those that have been able to consistently do so over time is very small (Holmgren 2006). The input of international forestry specialists has been important in developing the FRA process and in modifying the conceptual frameworks that direct the way that FRA reports are prepared and presented (FAO 2001, 2005; Anon. 2002). Preparing an FRA report on the world's forests now takes about two years, but the process has been plagued by problems of funding, data collection, as well as inconsistent definitions that have produced a lack of consistency and comparability of information on the world's tree-covered areas (Anon. 2008c).

2.2 Forests, Planted Forests, Forest Plantations and SNPF

The FRA and FAO include timber-producing plantations in their definition of 'forests' because that definition covers land 'spanning more than 0.5 hectare with trees higher than 5 metres and a canopy cover of more than ten percent, or trees able to reach these thresholds in situ' (FAO 2006, p. 169). The FAO adopted the term 'Forest Plantations' for plantations of such trees. However, the historical variation in definitions and data

collection for 'forests' and 'Forest Plantations' has been a continuing difficulty in comparing data sets and determining their usefulness for policy formation.

The FAO recognised the need for consistent definitions (FAO 2004, p. 5):

> Variations in definitions, however minor, increase the likelihood of divergent outcomes. Definitions are, therefore, the corner stone of any information and knowledge system… The global forest resource assessment reports have always provided a set of definitions as the basis for their information content. The development of such a set of definitions is necessary for producing compatible information across countries and time and to facilitate harmonization of information with that provided to/by other international agencies and processes.

Nevertheless, the definitions and terms used by the FAO and the FRA in relation to forests often changed in accordance with international processes and discourses, and after identification of problems with previous definitions and data (FAO 2001).

The FAO used the term 'man-made planted forests' in 1965 for what might be called timber-producing plantations. It relied on the British Commonwealth forest terminology to justify this (Anon. 1967):

> 'A forest crop raised artificially, either by sowing or planting.' This could be interpreted to include all forms of artificial regeneration but no natural regeneration. 'To regenerate' in English is normally defined as "to cause to be born again, to recreate," which implies the renewal of something pre-existing rather than its replacement by something different. In this sense a forest formed by artificial regeneration can be said to be remade by man rather than made by man.

The FAO's first estimate of the area of the world's timber plantations was also produced in 1965, but did not include the former Soviet Union or China (Carle et al. 2003).

The problems faced by the FRA and FAO in the application of definitions and data collection for plantations are emphasised by the fact that the four FRA reviews of global plantations conducted between 1980 and 2000 created four data sets using different criteria (Carle 2001). Even the wording of the 'forest' definition was modified during the process of preparing the FRA 2000 report (published as FAO 2001). However, the FRA 2000 report was the first to use consistent definitions for all forests and Forest Plantations for all countries, so its estimates could not be compared to those of earlier reports.

FRA 2000 classified 'forests' into broad components that attempted to reflect their structure and degree of human disturbance or modification (FAO 1998, 2001):

- natural forests (undisturbed by humans or disturbed by humans)
- semi-natural forests
- plantations.

Also, it refined the meanings of 'reforestation' and 'afforestation' as they were applicable to plantations. Thus, Forest Plantations became (FAO 2001, p. 365):

> Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either:
>
> - of introduced species (all planted stands), or
> - intensively managed stands of indigenous species, which meet all the following criteria: one or two species at plantation, even age class, regular spacing.

New plantations became (FAO 2001, p. 369):

- afforestation for artificial establishment of forest on lands which previously did not carry forest within living memory, or
- reforestation for artificial establishment of forest on lands which carried forest before.

In contrast to earlier FRA reports, the FRA 2000 report included rubber plantations in its estimates because they are sometimes used as a source of wood fibre. Also, it applied reduction factors to account for tree death, while the database included statistics from industrialised countries that had not been included previously. Areas of Forest Plantations were estimated separately from those for 'forests'.

The changes in definitions meant that the FRA 2000 estimates of 'forest' areas included areas and vegetation types that had not been included in previous FRA reports, thereby increasing the apparent estimate of global forest cover. The accuracy of forest area and area change estimates was concluded to be good, but potentially skewed by systematic errors. It was thought that one of these might have been the area of Forest Plantations in Europe, because of differing perceptions amongst European countries and the FAO of what constituted a Forest Plantation. As a result, the FAO recognised that an acceptance and use of common definitions for terms like 'natural forest', 'semi-natural forest' and

'forest plantations' was needed if countries were to accurately use the terms to represent forest quality (FAO 2001).

The FRA 2000 process also elicited poor responses from countries to requests for information on their areas of Forest Plantations (Carle et al. 2003). To help overcome this problem, the FAO established a new global plantation database (PDB) to support the 2000 FRA, which included statistics on plantation areas, planting rates, productivities, and taxa.

Around this time, the FAO started to review its forest-related definitions and terminology to make them more applicable to carbon studies (FAO 2000). In 2002, the FAO began an ongoing process to 'harmonise' definitions used for the FRA process in conjunction with the Intergovernmental Panel on Climate Change (IPCC), the Center for International Forestry Research (CIFOR), the International Union of Forest Research Organisations (IUFRO) and the United Nations Environment Programme (UNEP). Harmonisation was seen as a process to 'improve consistency, compatibility and comparability' between existing terms and their definitions (FAO 2005).

Of particular concern in the harmonisation process was the development of appropriate definitions of categories along the forest-plantation continuum (extending from natural forests to modified natural forests, semi-natural forests, planted forests and forest plantations, as in Figure 2.1) and accounting for their differences in relevant statistics. The 'harmonisation' process aimed to consider the 'naturalness' of these types of tree-cover, the degree of human manipulation of their content and structure, and consequently the social, economic and environmental roles that the vegetation fulfilled (Carle & Holmgren 2003a). To help overcome the definitional problems related to distinguishing 'plantations' from 'semi-natural' forests that were modified by human activity, it was recommended that 'that type and intensity of management, particularly enrichment planting and/or seeding be used to assist countries to determine whether their semi-natural forest qualify as a type of planted forest' (Carle et al. 2003, p. 8).

Figure 2.1 The continuum of forest characteristics (Carle & Holmgren 2008)

Continuum of Forest Characteristics						Non-forest
Primary	Modified natural	Semi-natural		Plantation		Trees outside forests
		Assisted natural regeneration	Planted	Productive	Protective	
Forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed	Forest of naturally regenerated native species where there are clearly visible indications of human activities	Silvicultural practices for intensive management (weeding, fertilising, thinning, selective logging)	Forest of native species, established through planting, seeding or coppice of planted trees	Forest of introduced species and in some cases native species established through planting or seeding mainly for production of wood or non-wood goods	Forest of native or introduced species, established through planting or seeding mainly for provision of services	Stands smaller than 0.5 ha; trees in agricultural land (agroforestry systems, home gardens, orchards); trees in urban environments, and scattered along roads and in landscapes

←——— **Planted Forests** ———→

Advisors to the FRA process proposed that the concepts of 'naturalness' and 'management' would be defined by the degree to which the natural ecological processes operated in the relevant tree-covered area and the intensity of human intervention required through modification of forest structure to achieve the stated objectives (Table 2.1). The categorisation of a forest's naturalness would thus be based on four primary criteria that may overlap to produce eight different forest classes (Figure 2.2). The four primary criteria were: maintenance of natural ecological processes; establishment by natural regeneration; establishment by human intervention – planting or seeding; and stand management by direct intervention. The FAO considered its next step was to work out how to integrate the three issues of 'management objectives', 'naturalness' and 'management intensity' and use them to reshape the older concepts used in the FRA process to report on categories of natural and planted forests for the FRA 2005 report (Carle & Holmgren 2003a).

The FRA 2005 process (published as FAO 2006) formally introduced the concept of the forest-plantation continuum. It used a definition of 'forests' that was basically the same as that used in FRA 2000. However, as well as including the categories of 'primary forests' and 'secondary forests', it introduced two other categories - 'modified natural

forests' and 'semi-natural forests' as in Table 2.1 (FAO 2004). It distinguished between 'primary/modified natural forests' and 'semi-natural forests' on the basis of regeneration methods – 'primary/modified natural forests' regenerate naturally, while 'semi-natural forests' are established by 'assisted natural regeneration, planting or seeding'. However, if Forest Plantations 'resembled natural forests of the same species mix, such as many planted forests in Europe, then they were classified as semi-natural forests' (FAO 2006, p. 23).

Table 2.1 Descriptions of Forest Characteristics of Naturalness and Intensity of Management (Carle & Holmgren 2003b)

Number	Proposed forest naturalness class	Explanation
1	Primary forest	Forests that regenerate naturally, where the natural set of ecological processes are undisturbed by humans
2	Modified natural forest (1)	Forests of native species that regenerate naturally where the natural set of ecological processes has been modified or disturbed but where intensive stand management is not practised
3	Modified natural forest (2)	Forests of native species, established either through assisted or natural regeneration, or a mix of these, under non-intensive management. Example: soil protection areas where enrichment planting has been made
4	Semi-natural forest (1)	Forests of native species, established either through assisted or natural regeneration, or a mix of these under intensive stand management (Includes forests in which assisted regeneration carried out with same species and similar species composition as in the natural forests in the area.) Example: many production forests in Europe, some teak plantations
5	Semi-natural forest (2)	Forests of native species that have regenerated naturally and are under intensive stand management. Example: pine forests in boreal areas
6	Production plantation forest	Forests of exotic species that have been planted or seeded by human intervention and that are under intensive stand management, fast growing, short rotation. Example: *Poplar, Acacia* or *Eucalyptus* plantations
7	Protection (and other environmental) plantation forest	Forests of exotic species that have been planted or seeded by human intervention and that are not under intensive management. Example: tree plantings for soil and water conservation purposes and ecological rehabilitation
8	Not applicable	

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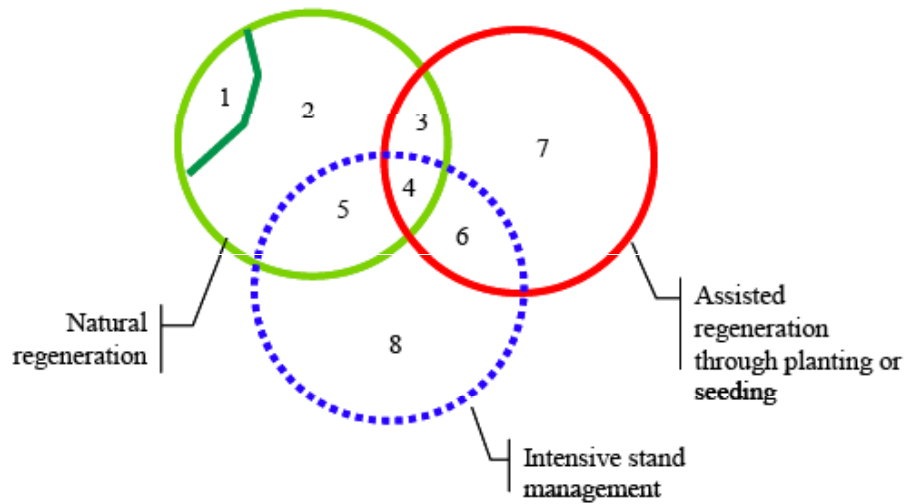
Figure 2.2 Representation of forest characteristics of 'naturalness' and 'intensity of management' (Carle & Holmgren 2003b)

The FRA 2005 process tried to collect data from participating countries that illustrated their forests' degrees of 'naturalness' and intensities of management or modification. Countries were asked to report on their primary forests, modified natural forests, semi-natural forests, protective forest plantations, and productive forest plantations. This initiative enabled the collection of detailed information on forest values rather than an integration of wood production information. Nevertheless, many country reporters did not have sufficient suitable data on their forests to allow such reporting at the global level, or they provided inconsistent data (Anon. 2006). Some countries reported an increase in the area of primary forests by using reserved forest areas as proxies for primary forests, or assuming that forest growth made human impacts less visible. Some European countries and Japan classified all natural forests over a certain age or size as primary forests if there had been no human intervention in the previous 25 years; this approach was consistent with the FRA's definition of primary forests (FAO 2006).

The FRA 2005 report concluded that the global area of 'assisted' semi-natural forests had declined between 1990 and 2005, while the area of 'planted' semi-natural forests had expanded. FRA 2005 included the term Forest Plantations, recognising it as a subset of Planted Forests (FAO 2006). It also collected statistics on Forest Plantations, but more

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importantly laid the groundwork, particularly through the complementary Planted Forests Thematic Study (Del Lungo and Carle 2005; Del Lungo & Ball 2006; Del Lungo et al. 2006), for adopting the concept of Planted Forests, and using it, rather than Forest Plantations, as the preferred statistical category in FRA 2010 (FAO 2007).

The preparation of the FRA 2010 report began in 2008 and the report will cover 235 countries and territories. It is promoted as 'the most comprehensive and reliable assessment yet' because of its use of advanced technologies, better global communications, and increased support from governments and forestry-related organisations (Anon. 2008a).

However, in contrast to the earlier proposal to collect detailed information on the degree of 'naturalness' and 'management' within the categories of the 'forest-plantation' continuum, FRA 2010 will simplify the statistics on forest characteristics by blending, and reducing the number of, the forest characteristic categories. It will use the same basic definition of 'forests' as FRA 2000 and FRA 2005 but, instead of the four main forest characteristic categories of FRA 2005, there will now be three such categories on which countries are to provide statistics (Appendices 2.1 and 2.2). The older category of 'primary forests' will remain, and is distinguished from the other two categories by the degree of human impact. 'Primary forests' should not have any 'clearly visible indications/signs of human activities. Furthermore, primary forests should show natural forest dynamics, such as natural tree species composition, occurrence of dead wood, natural age structure and natural regeneration processes' (FAO 2007, p. 25).

The two new categories were formed to clarify and ease reporting on forest characteristics. They are:

- 'other naturally regenerated forests', formed by combining 'modified natural forests' with the naturally regenerated component of 'semi-natural forests'
- Planted Forests, formed by merging the planted native species component of 'semi-natural forests' with the older category of Forest Plantations.

Within both of these new categories, FRA 2010 is seeking data for specific years from 1990 on the areas of tree species that are native or introduced to a site, as well as forest reestablishment through the natural expansion of forests, and by 'afforestation' and

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'reforestation', which produce Planted Forests (FAO 2007). It is not collecting data on technical matters that would update the Plantation Forest Database.

Thus, the definitions of, and collection of comparable statistics for, Forest Plantations and SNPF have been problematic for the FAO and FRA for many years. The organisations need more precise, consistent and robust data on Planted Forests and all other 'forest' forms to enable comparative reporting. However, rather than moving towards more consistent detail on forest characteristics − which would allow improved understanding of those 'forests' − the relevant statistical categories for data to be collected for the FRA 2010 report will be simplified. This is the definitional and statistical context within which the FAO prepared its recent projections of potential wood supply from the world's Planted Forests (Carle & Holmgren 2008).

3. The FAO 2008 Planted Forest wood resource projections

3.1 Projection results overview

The FAO published its latest 'Outlook' projections of wood resources from about 95% of the world's Planted Forests in late 2008 (Carle & Holmgren 2008). Planted Forests include:

- Forest Plantations, in which the trees are predominantly non-indigenous species planted or seeded uniformly at regular intervals
- the planted component of 'semi-natural forests', comprising primarily tree species indigenous to that site.

Both of these categories comprise treed areas that are managed primarily for wood production (about 75% of each area) and areas that have a protective role, but within which wood production can occur (about 25% of each area).

The projections cover the period 2005 to 2030, and are based on three detailed scenarios called: i) 'pessimistic'; ii) 'business as usual'; and iii) 'higher productivity'. The basic assumptions of these scenarios are (Carle & Holmgren 2008, p. 10):

- Scenario 1 *Pessimistic*: the annual area changes in the Planted Forest estate are half those of the 'business as usual' scenario, and there are no productivity increases
- Scenario 2 *Business as usual*: the annual area changes in accordance with recent trends to the year 2030, and there are no productivity increases. The total area increases, but the area of some Planted Forests decreases
- Scenario 3 *Higher productivity*: the annual area changes are those of Scenario 2, with productivity increases of up to 2% per year in some Planted Forests 'where genetic, silvicultural or technological improvements are expected'.

The FAO did not prepare a 'do nothing' scenario based on an unchanged area of Planted Forests with a continuation of current management practices, but Scenario 1 *Pessimistic* is the closest to such a scenario. The projections' authors considered it reasonable to conclude that, because of the success of past applications of technologies to increase the productivity of trees grown for wood production, Scenario 3 would be the most probable until 2030. The projections were also modelled to 2105, but the FAO recognised the great

uncertainty surrounding such extended projections (Carle & Holmgren 2008), so they are not discussed in this report.

Table 3.1 and Figure 3.1 show the area of Planted Forests used in the projections at 2005 with the growth in their areas assumed under the three scenarios to 2030 (Carle & Holmgren 2008; FAO 2009a). Table 3.2 presents the results of the projections for wood production from all Planted Forests in the three scenarios between 2005 and 2030. The results for 'industrial roundwood' production (an amalgamation of 'wood products' and 'pulp/fibre') and for 'bioenergy/fuelwood' production are shown in Figure 3.2, together with the reported global production of industrial roundwood and fuelwood from all sources (i.e. forests, plantations, etc) between 1980 and 2007 (FAO 2009b).[2]

Several features stand out from these data:

- The potential supply of 'industrial roundwood' from the world's Planted Forests at 2005 was equivalent to about 70% of reported global industrial roundwood production at that time, but whether or not they supplied this amount is unknown.

- The potential supply of 'bioenergy/fuelwood' from the world's Planted Forests in 2005 was equivalent to about 7% of reported global fuelwood production at that time, but whether or not they supplied this amount is unknown.

- If the total area of Planted Forests continues to increase at recent rates without any productivity improvements, as in Scenario 2, the FAO projects that potential 'industrial roundwood' yields would increase by 20% between 2005 and 2030. The FAO expects that adding productivity improvements to this ongoing planting rate, as in Scenario 3, would increase 'industrial roundwood' yields from Planted Forests by a further 35% over that period.

- The proportional increases in the projected supply of 'industrial roundwood' between

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[2] The process used to collect data for FAOSTAT wood products statistics was different to that used for data collection and modelling by the FAO. The model data is more closely related to the Global Forest Assessment 2005, as they used complementary data collection processes (Del Lungo 2009). The FRA 2005 (FAO 2006, p. 91) reported that global production of 'industrial roundwood' and 'fuelwood' was: 1995 – 1.78 and 1.26 billion m³; 2000 – 1.73 and 1.17 billion m³; 2005 – 1.79 and 1.21 billion m³. These figures are different from those reported by FAOSTAT (FAO 2009b): 1995 – 1.52 and 1.74 billion m³; 2000 – 1.61 and 1.8 billion m³; 2005 – 1.7 and 1.85 billion m³; in particular, fuelwood production is consistently and substantially lower. FRA 2005 (FAO 2006, p. 89) recognised that these estimates have 'uncertainties that should be considered' because of data problems. Also, the FAO model covers 95% of the world's Planted Forests (Carle & Holmgren 2008).

2005 and 2030 for each scenario are larger than those for 'bioenergy/fuelwood' over the same period (Scenario 1: 13% and 7% respectively; Scenario 2: 21% and 14%; Scenario 3: 55% and 40%).

Table 3.1 Expansion in the area of Planted Forests between 2005 and 2030 as assumed in the three FAO scenarios (FAO 2009a, 2009b)

| | Area (million hectares) by year | | | | | | Total increase |
	2005	2010	2015	2020	2025	2030	
Scenario 1	260.538	268.985	277.432	285.880	294.327	302.774	16.2%
Scenarios 2 & 3	260.538	277.371	294.204	311.037	327.869	344.702	32.3%

Note: The area of Planted Forests (SNPF and Forest Plantations) listed in this and other tables is the net area as reported by the FAO.
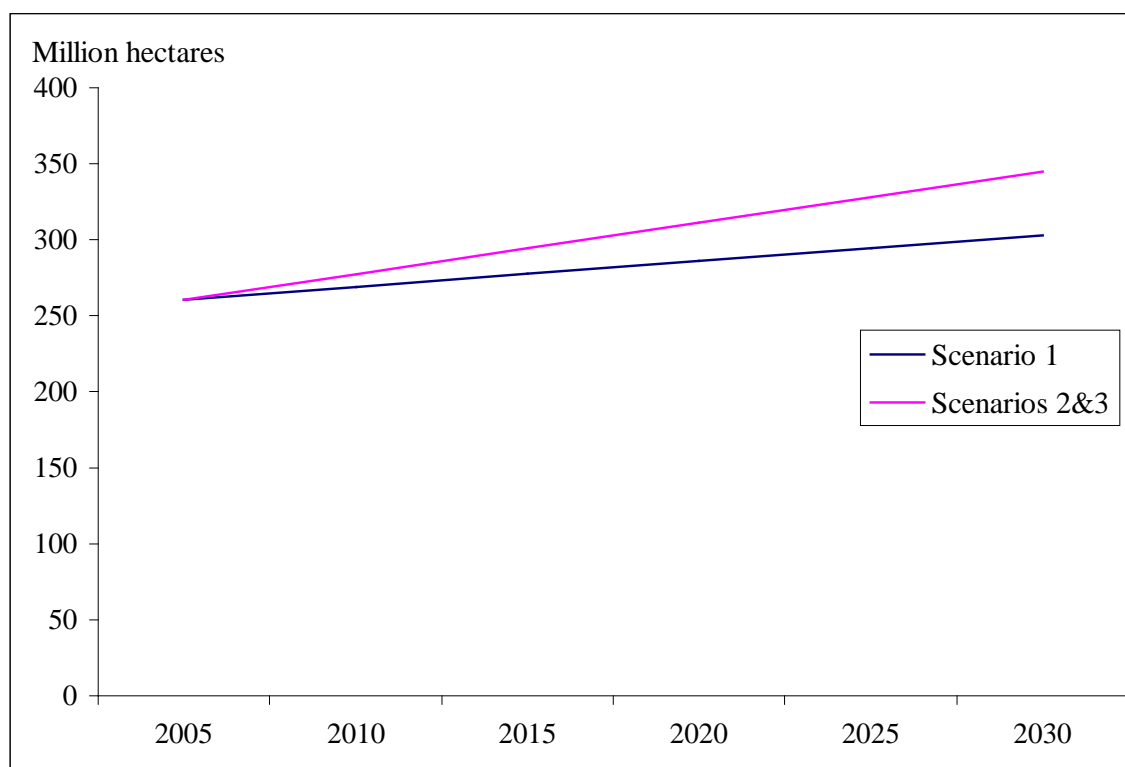
Figure 3.1 Expansion in the area of Planted Forests between 2005 and 2030 as assumed in the three FAO scenarios (FAO 2009a, 2009b)

Table 3.2 Wood supply from Planted Forests between 2005 and 2030 as projected by the three FAO scenarios (FAO 2009a, 2009b)

Scenario	Wood supply (million m^3) by year					
	2005	2010	2015	2020	2025	2030
Scenario 1						
Total	1399.89	1297.04	1446.16	1526.28	1544.94	1588.74
Fuel/ Bioenergy	136.31	124.42	131.50	149.52	148.54	146.48
Pulp/ Fibre	540.36	553.76	551.94	617.08	624.87	593.13
Wood products	658.52	559.45	695.39	688.41	700.38	766.90
Unspecified use	20.60	16.83	20.58	22.96	17.91	29.27
Harvest losses	44.10	42.59	46.75	48.30	53.24	52.96
Scenario 2						
Total	1399.89	1297.04	1455.26	1551.27	1610.03	1689.21
Fuel/ Bioenergy	136.31	124.42	132.39	153.76	154.89	155.12
Pulp/ Fibre	540.36	553.76	558.99	632.63	658.17	647.12
Wood products	658.52	559.45	696.29	693.21	722.48	799.92
Unspecified use	20.60	16.83	20.57	22.95	19.25	30.46
Harvest losses	44.10	42.59	47.03	48.72	55.24	56.58
Scenario 3						
Total	1399.89	1355.53	1580.16	1786.74	1944.79	2144.60
Fuel/ Bioenergy	136.31	129.02	141.58	175.35	183.95	191.24
Pulp/ Fibre	540.36	585.26	619.34	759.12	834.98	866.02
Wood products	658.52	581.62	750.62	778.74	849.68	998.08
Unspecified use	20.60	17.04	21.59	24.82	20.94	32.68
Harvest losses	44.10	42.59	47.03	48.72	55.24	56.58
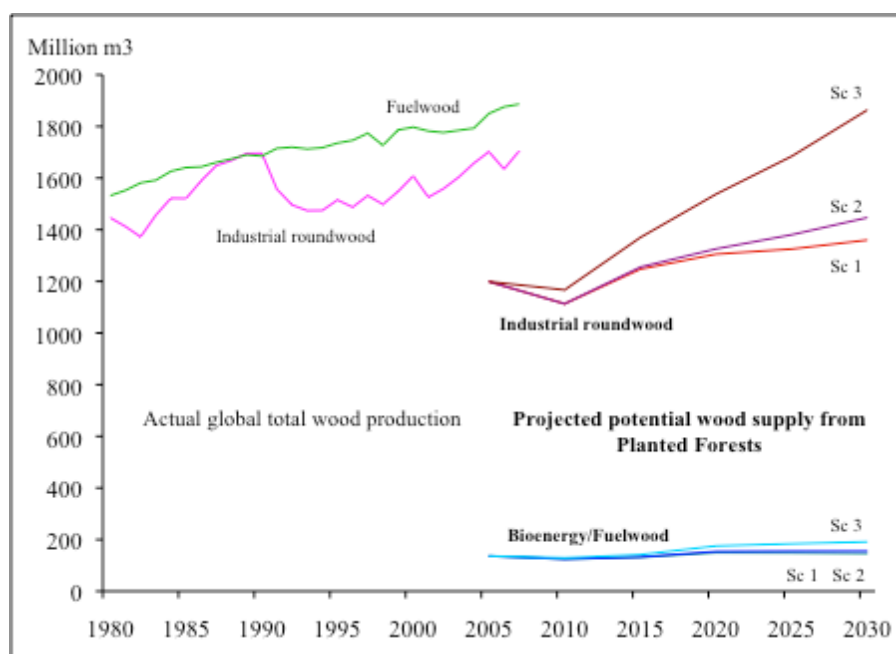
Figure 3.2 Global production of industrial roundwood (wood products and pulp/fibre) and fuelwood from 1980 to 2007, and the FAO projected supply of 'industrial roundwood' and 'bioenergy/fuelwood' from Planted Forests between 2005 and 2030 (FAO 2009a, 2009b)

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Thus in broad terms, Planted Forests may already generate most of the world's recent requirement for industrial roundwood, while the FAO projections illustrate the capacity for greater wood production from an expanded Planted Forests estate and the application of technologies to increase productivity, particularly of 'industrial roundwood'.

In contrast, Planted Forests appear to supply a very small component of the world's 'fuelwood'. While the potential output of 'fuelwood' from Planted Forests would grow in all three scenarios, the projected volume increases are very small compared to those projected for 'industrial roundwood'.

Table 3.3 Actual regional production of industrial roundwood and fuelwood from forests, including Planted Forests, in 2007 compared with potential supply from regional Planted Forests at 2030 as projected by the FAO's Scenario 3 (FAO 2009a, 2009b)

Region	Industrial roundwood (million m^3)	
	2007 – Actual production	2030 – Scenario 3 Planted Forests supply
Africa	68.97	84.50
Americas	769.22	611.87
Asia	240.00	620.45
Europe	576.28	473.36
Oceania	50.75	73.92
Total	1705.23	1864.09
	Fuelwood (million m^3)	
	2007 – Actual production	2030 - Scenario 3 Planted Forests supply
Africa	603.09	10.30
Americas	332.80	44.18
Asia	786.65	107.27
Europe	152.60	27.07
Oceania	11.04	2.43
Total	1886.18	191.25

Table 3.3 and Figure 3.3 present the projected yields from Scenario 3 of 'industrial roundwood' and 'bioenergy/fuelwood' from Planted Forests by the main global regions at 2030, compared with their actual regional supply from all wood sources in 2007. The projected volumes of Scenario 3 are higher than those of Scenarios 1 and 2 because Scenario 3 is the most productive (Appendix 3.1). The potential supply of 'industrial roundwood' from Planted Forests matches the historic regional supply of those products,
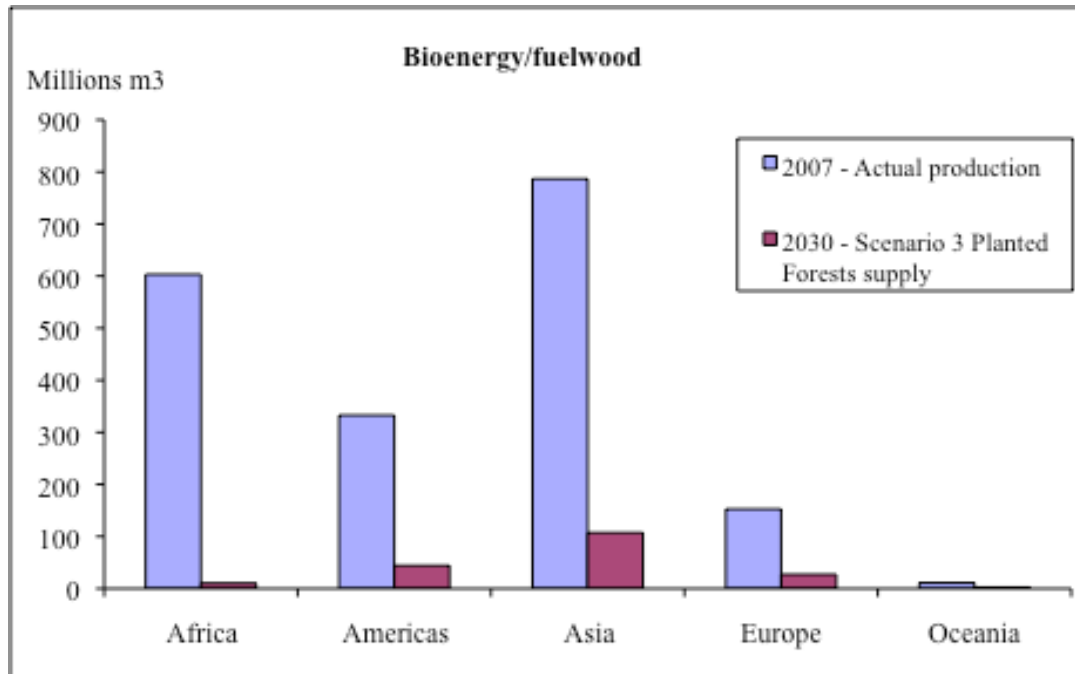
Figure 3.3 Actual regional production of industrial roundwood and fuelwood from forests, including Planted Forests, in 2007 compared with potential supply from regional Planted Forests at 2030 as projected by the FAO's Scenario 3 (FAO 2009a, 2009b)

except for Asia where the FAO projects substantial resource growth. However, there is no apparent relationship between the historic regional use of fuelwood and the FAO's projections of potential production of 'bioenergy/fuelwood' from Planted Forests. The projections do not allow for the production of wood for liquid biofuels (Carle & Holmgren 2008). Such products would require more new Planted Forests or the reallocation of wood from other markets.

3.2 Projection methods and assumptions

3.2.1 Defining Planted Forests for modelling

The FAO (Brown 2000; Carle et al. 2003; Carle & Holmgren 2003a, 2003b) noted the problems in delineating different forest ecosystems and histories, ambiguities in their definitions, and the extent to which they could be considered natural or human-made, when there is a continuum of forests (including Planted Forests) that is greatly influenced by the intensity of human intervention through exploitation and management.

Consequently, Brown (2000, p. 6) stated that 'a number of significant forestry countries, including, for example, Finland, Germany and Canada, report having no forest plantations. Conversely, neighbouring countries with seemingly similar forestry practices and philosophies report significant plantation areas.'

The FAO identified two general types of planted wood resources from information provided to the Global Forest Resources Assessment (FRA) process (FAO 2001, 2006) that collects data on the world's forests. The first was Forest Plantations, which comprise either areas of planted introduced tree species, or areas of planted native trees that are 'characterised by few species, straight, regularly spaced rows and/or even-aged stands'. The second was areas of planted native trees that 'resembled natural forests of the same species mix, such as many planted forests in Europe' (FAO 2006, p. 23). These were classified as 'semi-natural forests'. Many northern European countries reported areas replanted with one or two introduced species as 'semi-natural forests' rather than Forest Plantations. They felt that, because these Planted Forests contained a mix of native and exotic species, after 60 to 120 years they may resemble 'natural forests' – 'except for their lack of dead wood and hollow and old trees' (FAO 2001, p. 199).

The *Global Forest Resources Assessment 2000* (FAO 2001) included statistics on Forest Plantations in its 'statistical estimates for forest area'. Although the FAO did not want 'to imply that plantations are equivalent to natural forests' (FAO 2001, p. xxvii), this decision illustrates the process of integrating the concept of the 'forest characteristics continuum' into the FRA activities of forest-related data collection and presentation. Forest Plantations are at one end of this continuum, while at the other are 'primary forests' that lack visible modification by humans (Figure 2.1) (Carle & Holmgren 2008).

For the FAO (Del Lungo et al. 2006, p. iii), bringing together the two types of planted resources – Semi-Natural Planted Forests and Forest Plantations – under one concept of Planted Forests:

> unites two forest characteristics formerly considered separately: plantation forests
> and planted semi-natural forests. Together they make up the planted forest subset.
> The reason for this aggregation is that planted semi-natural forests have more in
> common with plantation forests than with the class of semi-natural forests

established by natural regeneration. They are managed more intensively than other types of semi-natural forests and, in particular, they:

- use similar types of planting stock, frequently derived from improved germplasm;
- use similar methods of establishment and tending;
- use thinning and pruning; and
- produce outputs that are uniform in size and technical specifications and are frequently intended for the harvesting of wood and fibre for industrial use.

During the last ten or so years, the FAO conducted two exercises in projecting potential output from the world's planted wood resources. The FAO's 'Outlook' projection conducted at the end of the 20th century (Brown 2000) based its calculations on the concept of Forest Plantations as defined by the Forest Resources Assessment 2000 program. For tropical and subtropical regions, these Forest Plantations were (Brown 2000, p. 5):

Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either:

- of introduced species (all planted stands), or
- intensively managed stands of indigenous species, which meet all the following criteria: one or two species at planting, even age class, regular spacing.

This definition was modified for Forest Plantations in temperate and boreal areas to exclude (p. 6):

stands which were established as forest plantations but which have been without intensive management for a significant period of time. These should be considered semi-natural.

Thus, although the concept of Planted Forests had been recognised for some time within the FRA process and elsewhere (Anon. 1992), future potential wood supplies from Planted Forests had not been modelled. The FAO drew on the forest-plantation continuum and the similarities between Forest Plantations and Semi-Natural Planted Forests to combine the two estates as Planted Forests for the 2008 projections. This decision more than doubled the size of the land base for the projections compared to the earlier projections. The modelling relied on a detailed database compiled by the FAO on the Planted Forest estate in these countries (Carle & Holmgren 2008).

3.2.2 *Modelling Planted Forest wood supply*

The main objective of the FAO in preparing projections of potential wood supply from the world's Planted Forests was 'to provide policy and decision-makers data and information on anticipated outlook options' for future wood yields from planted forests. Preparing an 'outlook' for the social and environmental dimensions of Planted Forests was beyond the scope of the study (Carle & Holmgren 2008, p. 8).

The FAO sought to prepare a comprehensive picture of potential future wood supply from the world's Planted Forests. The data sets and modelling assumptions used in the 2008 *Wood from Planted Forests* study (Carle & Holmgren 2008) were more detailed than those used in the earlier 'Outlook' projections (Brown 2000). Carle and Holmgren (2008) used data collected for the Planted Forest estates of 61 countries (described within the database as Forest Plantations or SNPF (FAO 2009a)), which cover about 95% of the world's area of Planted Forests. Thirty-six countries provided responses to an FAO questionnaire on their Planted Forests, while the FAO compiled information on, and estimated the characteristics of, the resources in the other 25 countries through desk studies (Del Lungo & Ball 2006; Carle & Holmgren 2008) (see Appendix 3.2). The datasets identified:

- the countries containing planted forests (Forest Plantations and SNPF)
- the gross and net areas of Forest Plantations and SNPF in those countries. The FAO estimated the net area of Forest Plantations in the 61 sampled countries at 2005 to be about 128 million hectares, and the area of Semi-Natural Planted Forests (SNPF) in those same countries to be about 132 million hectares
- tree species in the Forest Plantations and SNPF
- whether the Forest Plantations and SNPF were considered primarily as 'protective' or 'productive' - although both classes could provide wood
- management regimes, growth rates and rotation length applied to Planted Forest estates in each country
- the 'wood producing' efficiency of management regimes
- the area of each age-class of Forest Plantation and SNPF at 2005
- proportions of product outputs (bioenergy/fuelwood, pulp/fibre, wood products, unspecified uses) as well as assumed 'harvest losses'

- annual rates of change for each Planted Forest estate of between -4% and 8%, applied to their respective areas at 2005, over the 25-year modelling period
- productivity growth rates of 0%, 0.5%, 1%, 1.5%, or 2% compounded annually from 2005 that increased production from relevant management regimes over the 25-year modelling period by 0%, 13%, 28%, 45% or 64%, respectively.

Variables such as rates of area expansion and rates of productivity growth were applied differentially to the Planted Forests so that the modelling would reflect as closely as possible the 'real world' situation in different countries as perceived by the FAO using available information. The compounding productivity growth variable allows for increases in wood yield through the projection period via a combination of genetic manipulation, improved management and more efficient utilisation.

Some factors would not have impacted on the projections to 2030 because some Planted Forests did not reach their rotation time in the projection period. As with the earlier Outlook projections (Brown 2000), the investment to expand the area of Planted Forests and increase their productivity (as in Scenario 3) was assumed to occur, while the projections themselves were of the potential physical output of Planted Forests as determined by the scenario assumptions and efficiency ratios. Land was assumed to be available for the establishment of Planted Forests, but no judgements were made about the availability of different kinds of land (Carle & Holmgren 2008).

The FAO reflected the occurrence of Planted Forests in its model as it found them around the world. For example, the modelling used Finland's identification of its Planted Forests even when that country recognised ambiguities about its own classification. Also, the FAO identified Planted Forests in Canada generated by the conversion of native forests that would otherwise have been omitted from the database because of Canada's failure to respond to the information request. The USA did not include 'augmented forests' where supplementary planting occurred, despite them being included in the Forest Service's data on Planted Forests (Appendix 3.3).

The primary outputs from the FAO's modelling were then expressed as production from Planted Forests, without distinctions between Forest Plantations and SNPF (Carle & Holmgren 2008).

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3.2.3 SNPF and Forest Plantations assumptions and outputs

Given that this report aims to understand the implications of the amalgamation of the categories Forest Plantations and SNPF, the modelling data and assumptions for the 61 countries used by the FAO (2009a) were disaggregated into these two categories so that their similarities and differences could be discerned. Specific values for some features (e.g. MAI, rates of area increase) were organised into value ranges, so that data could be more easily handled and any trends more easily seen. Features were examined, either singularly or in combination with another feature, by sorting them using the computer program Excel and checking the calculated total areas of Forest Plantations and SNPF against totals in the original FAO spreadsheets (the FAO data were supplied in spreadsheets formatted in Excel). Those features were:

- areas of Forest Plantations and SNPF and their expansion
- projected product outputs of Forest Plantations and SNPF
- regional locations of Forest Plantations and SNPF
- rotation lengths of Forest Plantations and SNPF
- mean annual increments of Forest Plantations and SNPF
- productivity growth rates of Forest Plantations and SNPF.

The results of these examinations are summarised below, with supporting detail presented as tables and graphs in Appendices 3.4 to 3.12. More information on the source data and how the data were used in preparing these graphs and tables is contained in Appendix 3.13. Values for specific categories in some graphs and tables may vary because of rounding of numbers in calculations, etc.

Area characteristics
- At 2005, the total area of SNPF was greater than that of Forest Plantations (Appendix 3.4). However, about 88% of SNPF were concentrated in northern and Central Europe, and in South Asia and South East Asia, while about 65% of Forest Plantations were found in these regions; so the distribution of Forest Plantations is more extensive (Appendix 3.5).
- At 2005, SNPF had a larger area of age-classes older than 40 years than Forest Plantations, but a smaller area of age-classes of ten years old or less (Appendix 3.6).

Area increase

- The total proportional increases in area assumed by the projections for SNPF and Forest Plantations are the same in each scenario. The total area of SNPF remains greater than that of Forest Plantations for the whole projection period to 2030 (Appendix 3.4).

- The rates of area change assumed for each management regime in the scenarios means that the change in areas of Forest Plantations and SNPF varies between regions, with some increasing, some decreasing and some staying constant (Appendix 3.5).

Growth rates (MAI)

- At 2005, about 50% of both SNPF and Forest Plantations had growth rates (Mean Annual Increment - MAI) of between 5 and 10 m^3/ha/year. However, 46% of the area of SNPF had an MAI of 5 m^3/ha/year or less, while Forest Plantations outside the 5-10 m^3/ha/yr range includes larger areas with much higher growth rates (Appendix 3.7).

Rotation times

- The maximum recorded rotation time for both SNPF and Forest Plantations is 120 years. At 2005, 43% of SNPF had a planned rotation time of 40 years or less, but 67% of Forest Plantations had a planned rotation age of 40 years or less. The area and percentage of SNPF with a rotation length greater than 60 years are about 2.5 times those for such Forest Plantations (Appendix 3.8).

- The distribution of growth rates (MAI) also varies between Forest Plantations and SNPF with the length of the rotation. At 2005, shorter rotation Forest Plantations contain a disproportionately larger area of higher growth rates. Also, Forest Plantations with rotation times of up to 30 years contain all the areas of Planted Forests with growth rates over 20 m^3/ha/year – about 5% of all Planted Forests (Appendix 3.8).

- Most of the Forest Plantations with rotation times of 40 years or less are in South Asia and South East Asia. The majority of longer rotation Forest Plantations are in northern and Central Europe. About half of the SNPF are in South Asia and South East Asia, and of these, most have a rotation time of less than 40 years. Of the longer

rotation SNPF, most are in northern and Central Europe and had rotation times longer than 60 years (Appendix 3.9). Thus, the locations of Forest Plantations and SNPF with different rotation lengths are distributed differently.

Productivity increase

- In Scenario 3, 66% of SNPF have no productivity growth factor applied, whereas 42% of Forest Plantations had no productivity growth factor applied (Appendix 3.10). Most of the Forest Plantations with MAIs greater than 10 m³/ha/year are assumed to have compounding annual productivity increases of 1% or more (Appendix 3.11). Thus, the modelling reflects future investment to increase productivity that favours Forest Plantations over SNPF, through such techniques as genetic manipulation, improved establishment and management, and more efficient harvesting.

Wood production

- At 2005, Forest Plantations had an average gross 'yield' from across the global estate of about 6.5 m³/ha, while SNPF had a lower average gross 'yield' from their total area of about 4.27 m³/ha (Appendices 3.4 and 3.12).

- The total wood volumes projected to be available from SNPF at 2030 are less than those at 2005 in Scenarios 1 and 2, and only marginally greater in Scenario 3. In contrast, the total wood volumes projected to be available from Forest Plantations under the three scenarios at 2030 are between 31% and 87% higher than at 2005. Because of assumed differences in productivity, rotation times, etc, the projected potential wood supply from 'plantations' at 2030 is 2-2.6 times greater than that from SNPF (Appendix 3.12).

- Consequently, the projected volumes for all products available from Forest Plantations to 2030 are substantially greater than those projected for SNPF (Appendix 3.12).

Thus, the FAO's statistical integration of the two categories Forest Plantations and SNPF into Planted Forests more than doubled the area of the existing 'planted' estate for use in the three projection scenarios. In doing so, it created a new continuum of physical and productive characteristics for Planted Forests comprising the two overlapping continuums of Forest Plantations and SNPF. The interaction between the characteristics of these

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continuums and the modelling assumptions means that the relatively large difference between potential wood supplies from Forest Plantations and SNPF at 2005 are projected to increase substantially over the next 25 years.

The differences and similarities between the physical and productive characteristics within and between Forest Plantations and SNPF indicate that there is a diversity of factors that may need consideration when making wood resource decisions in relation to Planted Forests. This applies particularly at broader regional and global levels where generalisations may be made and specifics ignored for the sake of convenience.

4. Discussion

The FAO's projections of potential wood supply from the world's Planted Forests as published in *Wood from Planted Forests: A Global Outlook 2005 –2030* (Carle & Holmgren 2008) were the product of deliberate efforts to improve the quality of publicly-accessible information on the condition of the world's forests and wood resources that can be used in land-use planning and policy development. Given the discourse on the use of trees in responding to global climate change, this work was published at a very important time.

Because human-created, fast-growing and intensively managed areas of trees can produce much more wood than a less-intensively managed native forest, understanding the potential for wood supply from such an estate is important in planning wood production and forest conservation, especially within the context of a changing global climate. The potential of Planted Forests to provide social and economic benefits and to reduce exploitative pressure on native forests has been recognised for many years (Anon. 1992). Whether and how specific Planted Forests can, will or do provide such benefits requires analyses of how those resources are placed in the physical landscape and of the political economy of product supply chains (Penna 2002).

The FAO published projections of potential wood supply from the world's Forest Plantations at the end of the 20th century (Brown 2000). However, the latest projections (Carle & Holmgren 2008) stimulate reconsideration of perspectives on how 'forests' and Forest Plantations should be categorised. These projections amalgamated statistics on Forest Plantations and Semi-Natural Planted Forests (SNPF) that included shorter rotation SNPF in Asia and longer rotation SNPF in Europe under the term Planted Forests. In so doing, they helped to make the previous differentiation by the FAO and the Global Forest Resources Assessment (FRA) between Forest Plantations and SNPF redundant for the collection of statistics on the world's wood resources and 'forests'.

While the term Planted Forests could be inferred as reflecting a relatively narrow range of characteristics across the forests so categorised, this report's analysis of the characteristics of Forest Plantations and SNPF as used in, and produced by, the FAO's projections show that their physical and productive characteristics can be quite different.

There is a continuum of characteristics comprising the physical characteristics of the Planted Forest estate, their management regimes and product outputs. This continuum comprises the two overlapping continuums of Forest Plantations and SNPF. The extent to which the characteristics of this continuum may be hidden by the use of Planted Forests as a statistical unit will depend on how information on Planted Forests is collected, used and published by the FAO, the FRA and other forest-related organisations.

Also, the FAO's projections reflect the perception that future investment to increase productivity will be directed more to Forest Plantations over SNPF using such techniques as genetic manipulation, shorter rotations, improved establishment and management, and more efficient harvesting. Such treatments will be important in making the potential wood supply from Forest Plantations far exceed that from SNPF, even though the area of SNPF is expected to be larger.

The term Planted Forests may include very different processes for creating such estates, including:

- conversion of natural forests or grasslands to Planted Forests

- conversion of assisted-regeneration 'semi-natural forests' to SNPF

- planting of trees on cleared land ('afforestation' or 'reforestation')

- replanting of Planted Forests (Forest Plantations or SNPF)

- planting sufficient numbers of trees in areas of natural regeneration to change the categorisation of those areas.

The distinction between Planted Forests (Forest Plantations and SNPF) and other types of human-modified forests has been an important consideration for the FAO and the FRA program in the way that they collect and organise forestry statistics, in the way that countries supplying data interpret the forest-related terms that define the statistics, and probably in the way that others interpret the statistics. Finland, at least, found problems in distinguishing 'semi-natural forests' from 'modified forests'. It and other Scandinavian countries (Norway and Sweden) seemed to resolve this issue by categorising all of their 'forests' other than 'primary forests' as 'semi-natural' (Del Lungo & Ball 2006). Furthermore, Finland is converting 'assisted naturally regenerated semi-natural forests' to more intensively managed SNPF (Hytönen & Kotisaari 2007).

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Also, the FAO identified the planting of logged areas of 'native forests' in Canada as conversion to SNPF. This Canadian information was not supplied to the FAO for its Planted Forests database, so may indicate an unwillingness by some countries to identify forests using the FAO's preferred definitions (FAO 2009a). The FAO incorporated the Canadian modifications to forest structure into its database on Planted Forests used in the projections. However, the modelling missed those 'augmented' regenerated forests in the USA that the US Forest Service considers as Planted Forests because they were not reported in 2005. The US included these areas in its reporting for FRA 2010 as part of attempts to harmonise data for the FRA program, even though the US definition is based on planted trees being at least 40% of all trees on a site whereas the FRA uses a minimum of 50% (Appendices 2.2 and 3.3).

This report's analysis of the FAO's latest projections of potential wood supply from Planted Forests based on the component Forest Plantations and SNPF adds to the challenges of categorising forests and wood resources. For example, the FAO's unification of Forest Plantations and SNPF, and the use of this unified category in its latest wood supply projections, challenge Friends of the Earth Netherlands' strategy for global wood production described in the report *Action Plan: Sustainable Netherlands* (Buitenkamp et al. 1993). The strategy did not appear to recognise the planted component of 'semi-natural forests' as 'plantation-like' for policy development (Penna 1995).

In contrast, the diversity of physical, productive and establishment processes within the Planted Forests category, as shown by this report, also challenges the simplification of data collection being conducted by the FRA 2010 process. The Planted Forest category may be useful for preparing global projections of a particular kind of wood supply, but the simplification has the potential to restrict understanding of the establishment and management implications of that production at regional and local levels. This applies not just to the wood production values of Planted Forests, but also to their social and environmental values. Some physical characteristics of Planted Forests (Forest Plantations or SNPF) that have productive dimensions which are influenced by management intensity and objectives – for example, rotation length (size and age of trees) and species types (indigenous or introduced) – also have an ecological dimension, for example, contribution to wildlife habitat and protection of water resources.

This ecological dimension is not reflected in a categorisation of Planted Forests based on the method of establishment and the unification of production values. Also, it is not necessarily directly relevant to modelling the future levels of wood production from Planted Forests. However, it is relevant to the ways that various Planted Forests can be viewed as providers of socio-environmental goods and services, and the position that they may be given along any 'forest characteristics continuum' that seeks to incorporate consideration for such values. The way that people are able to express the importance that they give to these values will influence the way that Planted Forests are established, managed, and produce wood.

This complication, as it relates to Planted Forests, also raises questions about how forest establishment and management techniques should be used to categorise some 'native forests'. If naturally regenerated forests are thinned, have rotation times or other management applications similar to Planted Forests managed for wood production, are they greatly different in ecological terms from such Planted Forests? And, how should the differences and similarities be identified and measured? While modelling wood output from Planted Forests is important, more illuminating and important social and ecological information might come from modelling the potential wood supply from the world's 'forests' based on their rotation times.

The FAO recognises that 'the wide range of forest formations, ecological conditions and forest cover types, which exist on a global scale, make global definitions necessarily broad' (FAO 2000, p. 5). Nevertheless, the accumulation of detailed information on the current and possible future condition of the global forest estate is assuming a new priority. At this time of global climate change, a detailed and accurate understanding of the physical condition of the world's forests, including Planted Forests, is important for developing national and international policies that recognise the potential of all forest types for carbon storage, biodiversity conservation, provision of ecosystem services and the growth of commercial wood and non-wood products.

The availability of comprehensive data on the management history of the world's natural and planted forests down to the local level will be important when trying to compile a comprehensive picture of the implications of global forces (climate change, atmospheric

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pollution, forest product supply chains) for those forests. For example, the potential of forest areas as long-term carbon sinks or emitters will depend on their condition – whether they are old growth, or if not, the specifics of the regimes under which they are being managed, perhaps for commercial outputs, such as wood. Crucial factors in such regimes will be the time between any logging events and the specific characteristics of each logging event (Harmon et al. 1990; Luyssaert et al. 2008; Mackey et al. 2008a, 2008b; Putz et al. 2008; Pelley 2009). Similarly, the physical characteristics of Planted Forests are important to the expression of their non-wood values and understanding of their potential ecosystem services. The species diversity in some conifer plantations is influenced by the length of the logging cycle (Ito et al. 2003; Nagaike & Hayashi 2004), while stand history is an important consideration when regenerating semi-natural forests after clearcutting such plantations (Yamagawa et al. 2006). Also, the condition (i.e. tree species and management regime) of plantations and semi-natural forests can affect the quality of ecosystem services, such as pollination and pest control, provided to nearby agricultural pursuits (Sugimura 2010).

The FAO began to tackle definitional and data concerns in the Global Forest Resources Assessment process when it proposed using concepts of 'naturalness' and 'management' to help categorise forests into a relatively detailed continuum extending from 'primary forests' through to Forest Plantations (Carle & Holmgren 2003b). The failure to include this initiative in FRA 2010 and the consequent simplification of categories of forest characteristics on which statistics are being collected limits the potential to understand the characteristics of the world's forests and the (now statistically-redundant) categories of Forest Plantations and SNPF within Planted Forests.

Information on Planted Forests collected from participating countries in FRA 2010 will be restricted to areas of 'indigenous' or 'introduced' species and areas of 'afforestation' and 'reforestation' for specified years from 1990 (FAO 2007). The FRA process once again has changed the categories used in its data collection, and the categories of 'introduced' and 'indigenous' species in the Planted Forests category will possibly be used by some people as proxies for the previous categories of Forest Plantations and SNPF. The limited data collection for FRA 2010 seems a wasted opportunity.

The valuable data collection framework established for the Planted Forest Database, and used for preparing the FAO's latest projections of wood supply from the world's Planted Forests, provides a model for the FRA process to use for collection of more detailed technical and management information on the world's forests, including Planted Forests. Information could be expanded to include variables for main areas that indicate: methods of site preparation; compatibility of tree species to sites; genetic sources of trees; and the potential invasiveness of trees into other areas (Smith 2010). Such information could be used to overcome the FRA's simplification and to avoid the use of perceptions when judging criteria for different forest categories as in FRA 2005 (Appendix 3.1; FAO 2006) and FRA 2010 (Appendix 3.2; FAO 2007).

Individuals and groups concerned with the future of the world's forests should investigate if, and how, the unification of forest categories and simplification of data collection by the FAO and the FRA impact on their interests. In addition, there are several actions that could be initiated to help overcome the issues identified in this report relating to the collection and distribution of data on the world's 'forests' and wood resources:

- The FRA should expand the amount of data collected on Planted Forests for its regular global forests reports so that the FAO's Plantation Forest Database can be updated systematically, and expanded as necessary. The information so collected should be made publicly available. Sufficient funds should be provided to the FAO and FRA for this purpose.

- The FAO and FRA should begin establishing a new global forest database for major 'forest' areas other than Planted Forests. This should be based on the FAO's Plantation Forest Database and its collection of specific technical and management data, such as rotation times, thinning practices and logging methods. The information collected should be 'relational' so that the characteristics of each area can be understood; and it should be made publicly available. Sufficient funds should be provided to the FAO and FRA for this purpose also.

- Governments of countries participating in the FRA process should ensure that they have sufficient funds to report thoroughly on the condition of their 'forests', including Planted Forests, to perform the above actions.

- Such a new global forest database should be made accessible to the general public

for data submission and retrieval; it could be located on the World Wide Web.

- If the relevant governments and international governmental organisations do not establish such a global database, then interested non-government organisations should consider doing so, using the available FAO and FRA data as a starting point.

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Appendices

Appendix 2.1   Forest-related definitions used in FRA 2005

Forest Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 metres (m) in situ. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10% and a tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate.

Includes: areas with bamboo and palms provided that height and canopy cover criteria are met; forest roads, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest; windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 ha and width of more than 20 m; plantations primarily used for forestry or protective purposes, such as rubber-wood plantations and cork oak stands. Excludes: tree stands in agricultural production systems, for example in fruit plantations and agroforestry systems. The term also excludes trees in urban parks and gardens.

Other wooded land Land not classified as forest, spanning more than 0.5 hectares; with trees higher than 5 m and a canopy cover of 5–10%, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10%. It does not include land that is predominantly under agricultural or urban land use.

Primary forest/ other wooded land

Forest/other wooded land of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.

Includes: areas where collection of NWFPs occurs, provided the human impact is small. Some trees may have been removed.

Modified natural forest/other wooded land

Forest/other wooded land of naturally regenerated native species where there are clearly visible indications of human activities.

Includes, but is not limited to: selectively logged-over areas, naturally regenerating areas following agricultural land use, areas recovering from human induced fires, etc.; areas where it is not possible to distinguish whether the regeneration has been natural or assisted.

Semi-natural forest/other wooded land

Forest/other wooded land of native species, established through planting, seeding or assisted natural regeneration.

Includes: areas under intensive management where native species are used and deliberate efforts are made to increase/optimise the proportion of desirable species, thus leading to changes in the structure and composition of the forest. Naturally regenerated trees from other species than those planted/seeded may be present.

May include: areas with naturally regenerated trees of introduced species.

Includes: areas under intensive management where deliberate efforts, such as thinning or fertilizing, are made to improve or optimise desirable functions of the forest. These efforts may lead to changes in the structure and composition of the forest.

Productive plantation (in forest/other wooded land)

Forest/other wooded land of introduced species and in some cases native species, established through planting or seeding, mainly for production of wood or non-wood goods.

Includes: all stands of introduced species established for production of wood or non-wood goods.

May include: areas of native species characterised by few species, straight tree lines and/or even-aged stands.

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Protective plantation (in forest/other wooded land)

Forest/other wooded land of native or introduced species, established through planting or seeding mainly for provision of services.

Includes: all stands of introduced species established for provision of environmental services, such as soil and water protection, pest control and conservation of habitats of biological diversity; areas of native species characterised by few species, straight tree lines and even-aged stands.

Source: FAO (2006)

Appendix 2.2   FRA 2010 Forest characteristics categories and definitions

Category	Definition
Primary forest	**Naturally regenerated forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.** Explanatory note 1. Some key characteristics of primary forests are: - they show natural forest dynamics, such as natural tree species composition, occurrence of dead wood, natural age structure and natural regeneration processes; - the area is large enough to maintain its natural characteristics; - there has been no known significant human intervention or the last significant human intervention was long enough ago to have allowed the natural species composition and processes to have become re-established.
Other naturally regenerated forest	**Naturally regenerated forest where there are clearly visible indications of human activities.** Explanatory notes 1. Includes selectively logged-over areas, areas regenerating following agricultural land use, areas recovering from human-induced fires, etc. 2. Includes forests where it is not possible to distinguish whether planted or naturally regenerated. 3. Includes forests with a mix of naturally regenerated trees and planted/seeded trees, and where the naturally regenerated trees are expected to constitute more than 50% of the growing stock at stand maturity.
Other naturally regenerated forest of introduced species *(sub-category)*	**Other naturally regenerated forest where the trees are predominantly of introduces species.** Explanatory note 1. In this context, predominantly means that the trees of introduced species are expected to constitute more than 50% of the growing stock at maturity.
Planted forest	**Forest predominantly composed of trees established through planting and/or deliberate seeding.** Explanatory notes 1. In this context, predominantly means that the planted/seeded trees are expected to constitute more than 50% of the growing stock at maturity. 2. Includes coppice from trees that were originally planted or seeded. 3. Excludes self-sown trees of introduced species.
Planted forest of introduced species *(sub-category)*	**Planted forest, where the planted/seeded trees are predominantly of introduced species.** Explanatory note 1. In this context, predominantly means that the planted/seeded trees of introduced species are expected to constitute more than 50% of the growing stock at maturity.

Source: FAO (2007)

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Appendix 3.1   Potential production of 'bioenergy/fuelwood' and 'industrial roundwood' from Planted Forests by global region as projected by the three FAO scenarios

Bioenergy/fuelwood

	2005	2010	2015	2020	2025	2030
			Million m3			
Scenario 1						
N Africa	0.018	0.025	0.033	0.027	0.035	0.042
WC Africa	0.288	0.431	0.440	0.404	0.991	0.991
ES Africa	10.613	4.898	3.995	4.665	4.399	9.399
W Asia	0.080	0.314	0.080	0.313	0.080	0.314
S SE Asia	78.448	70.323	79.868	88.365	84.617	82.617
NC Europe	17.302	15.398	17.524	15.781	17.662	18.248
ES Europe	2.962	3.002	4.059	4.140	4.884	4.923
NC America	6.756	6.449	6.704	6.615	7.029	7.474
South America	18.632	22.384	17.554	28.001	26.591	20.987
Oceania	1.207	1.192	1.247	1.212	2.257	1.482
Scenario 2						
N Africa	0.018	0.025	0.033	0.037	0.044	0.052
WC Africa	0.288	0.431	0.440	0.511	1.098	1.098
ES Africa	10.613	4.898	3.995	4.541	4.224	8.929
W Asia	0.080	0.314	0.080	0.313	0.080	0.314
S SE Asia	78.448	70.323	80.325	92.121	88.855	87.885
NC Europe	17.302	15.398	17.524	15.781	17.662	18.248
ES Europe	2.962	3.002	4.059	4.140	6.133	6.173
NC America	6.756	6.449	6.704	6.615	7.029	8.221
South America	18.632	22.384	17.981	28.494	27.512	22.716
Oceania	1.207	1.192	1.247	1.212	2.257	1.482
Scenario 3						
N Africa	0.018	0.026	0.036	0.042	0.054	0.066
WC Africa	0.288	0.445	0.470	0.569	1.208	1.239
ES Africa	10.613	4.906	4.013	4.569	4.269	8.987
W Asia	0.080	0.346	0.097	0.421	0.118	0.513
S SE Asia	78.448	72.301	84.863	103.850	103.256	106.755
NC Europe	17.302	15.573	17.968	16.323	18.528	19.511
ES Europe	2.962	3.091	4.351	4.603	7.204	7.560
NC America	6.756	6.754	7.335	7.613	8.486	10.425
South America	18.632	24.265	20.925	35.729	37.469	33.756
Oceania	1.207	1.316	1.520	1.631	3.354	2.431

Industrial roundwood

	2005	2010	2015	2020	2025	2030
Scenario 1						
N Africa	0.090	0.110	0.154	0.147	0.165	0.190
WC Africa	0.806	1.206	1.232	1.131	2.774	2.774
ES Africa	63.214	30.079	38.531	36.347	39.074	67.796
W Asia	1.440	5.717	1.440	5.718	1.441	5.718
S SE Asia	404.175	349.206	449.003	443.710	419.468	436.902
NC Europe	288.977	268.519	304.274	269.174	303.421	313.394
ES Europe	52.468	54.099	72.997	74.668	87.843	88.658
NC America	121.613	116.077	120.672	119.065	126.531	134.531
South America	224.337	248.452	202.125	309.786	286.751	262.673
Oceania	41.763	39.742	56.902	45.748	57.784	47.397
Scenario 2						
N Africa	0.090	0.110	0.154	0.169	0.187	0.213
WC Africa	0.806	1.206	1.232	1.432	3.075	3.075
ES Africa	63.214	30.079	38.921	36.667	39.677	67.327
W Asia	1.440	5.717	1.440	5.718	1.441	5.718
S SE Asia	404.175	349.206	451.985	457.650	439.467	461.929
NC Europe	288.977	268.519	304.274	269.174	303.421	313.394
ES Europe	52.468	54.099	72.997	74.668	110.325	111.143
NC America	121.613	116.077	120.672	119.065	126.531	147.971
South America	224.337	248.452	206.705	315.548	297.144	287.283
Oceania	41.763	39.742	56.902	45.748	59.381	48.994
Scenario 3						
N Africa	0.090	0.115	0.170	0.196	0.228	0.272
WC Africa	0.806	1.247	1.315	1.593	3.383	3.470
ES Africa	63.214	31.131	42.843	41.238	47.247	80.755
W Asia	1.440	6.311	1.752	7.691	2.134	9.372
S SE Asia	404.175	367.044	493.613	533.532	543.951	611.077
NC Europe	288.977	271.909	312.637	278.873	318.984	336.887
ES Europe	52.468	55.752	78.337	83.206	129.810	136.475
NC America	121.613	121.575	132.025	137.043	152.757	187.655
South America	224.337	268.804	239.778	395.717	401.814	424.212
Oceania	41.763	42.997	67.498	58.766	84.355	73.916

Million m3

Source: FAO (2009a)

Appendix 3.2   Countries with Planted Forests (Forest Plantations and SNPF) included in the FAO modelling database

Country	SNPF	Plantations	Country	SNPF	Plantations
Algeria	x	x	Slovakia	x	x
Argentina		x	Slovenia	x	
Australia		x	South Africa		x
Belgium	x	x	Sudan	x	x
Brazil		x	Sweden		x
Canada	x		**Thailand**		x
Chile		x	Ukraine	x	x
China	x	x	United Kingdom	x	x
Czech Republic	x		**Uruguay**		x
Croatia		x	USA		x
Finland	x		**Venezuela**		x
France	x	x	Vietnam		x
India	x	x	**Other CN Europe**		
Indonesia	x	x	**Austria**	x	x
Iran	x	x	**Belarus**	x	x
Ireland	x	x	**Denmark**	x	x
Italy		x	**Estonia**	x	x
Japan		x	**Germany**	x	
Latvia	x	x	**Hungary**	x	x
Lithuania	x	x	**Romania**	x	x
Malaysia		x	**Switzerland**	x	x
Myanmar		x	**Other SE Europe**		
Netherlands	x		**Albania**		x
New Zealand		x	**Bosnia**	x	x
Norway	x	x	**Bulgaria**	x	x
Pakistan		x	**Georgia**		x
Philippines		x	**Greece**		x
Poland	x	x	**Moldova**		x
Russia		x	**Portugal**	x	x
			Spain	x	x
			Turkey	x	x
			Central Africa		
			Cameroun		x
			Congo DPR		x
			Nigeria		x

Source: FAO (2009a)

Note: Countries in bold did not respond to the FAO questionnaire, so information on their Planted Forest estate was compiled by the FAO.

Semi-Natural Planted Forests		
Country	Region	Million ha
Algeria	N Africa	0.966
Belgium	NC Europe	0.149
Canada	NC America	10.787
Chile	S America	0.024
China	S SE Asia	39.957
Czech Republic	NC Europe	2.502
Finland	NC Europe	5.244
France	NC Europe	0.139
India	S SE Asia	26.802
Iran	W Asia	0.005
Ireland	NC Europe	0.090
Latvia	NC Europe	0.644
Lithuania	NC Europe	0.384
Netherlands	NC Europe	0.274
Norway	NC Europe	1.420
Poland	NC Europe	8.725
Slovakia	NC Europe	0.827
Slovenia	ES Europe	0.037
Sudan	ES Africa	1.216
Sweden	NC Europe	9.297
Ukraine	NC Europe	4.409
United Kingdom	NC Europe	0.264
Other SE Europe	ES Europe	18.278
Total		132.415

Forest plantations		
Country	Region	Million ha
Algeria	N Africa	0.073
Argentina	S America	1.229
Australia	Oceania	1.766
Belgium	NC Europe	0.275
Brazil	S America	5.384
Chile	S America	2.661
China	S SE Asia	31.369
Croatia	ES Europe	0.061
France	NC Europe	1.948
India	S SE Asia	3.226
Indonesia	S SE Asia	3.399
Iran	W Asia	0.616
Ireland	NC Europe	0.579
Italy	NC Europe	0.146
Japan	S SE Asia	10.321
Latvia	NC Europe	0.001
Lithuania	NC Europe	0.141
Malaysia	S SE Asia	1.573
Myanmar	S SE Asia	0.849
New Zealand	Oceania	1.882
Norway	NC Europe	0.262
Pakistan	S SE Asia	0.318
Philippines	S SE Asia	0.620
Poland	NC Europe	0.032
Russia	NC Europe	16.963
Slovakia	NC Europe	0.019
South Africa	ES Africa	1.426
Sudan	ES Africa	5.404
Sweden	NC Europe	0.667
Thailand	S SE Asia	3.099
Ukraine	NC Europe	0.378
United Kingdom	NC Europe	1.924
Uruguay	S America	0.766
USA	NC America	17.061
Venezuela	S America	0.863
Vietnam	S SE Asia	2.695
Other CN Europe	NC Europe	2.020
Other SE Europe	ES Europe	5.734
Other C Africa	WC Africa	0.349
Total		128.099

Source: FAO (2009a)

Appendix 3.3   Responses to the FAO questionnaire on Planted Forests

When providing the FAO with data on its planted forests, Finland identified 21.081 million ha of all its forested land at 2005 as being 'Semi-Natural Forests', of which 25% (5.24 million ha) was classified as 'planted' and 75% as 'assisted natural regeneration'. This was used in the modelling by the FAO, despite the Finnish equivocation about the categorisation in its response to the Questionnaire on Planted Forests used for the modelling (Del Lungo & Ball 2006, pp. 436-437):

> Please note that, on the basis of general discussions at the training session of national Correspondents at FAO in Rome on 17-21 November 2003, all Finnish forests were decided to put to category 'Semi-Natural', except those fulfilling the criteria 'Primary'. In the workshops and meetings of the training session, a general opinion was the boundary between 'Modified Natural' and 'Semi-Natural' is somewhat arbitrary. With a thorough analysis and instructions, a part of Semi-Natural forests could have been classified as Modified Natural. Furthermore, the forests established through plantations or seeding, i.e. planted component of semi-natural, are very similar to forests in the category 'Assisted natural regeneration'...

> Planted component includes all forest stands which have been established through planting or seeding. One should note that often these forests, particularly when getting older, are very similar to Modified Natural or even Natural forests with high proportion of naturally originated tree individuals and un-even age and size structure of trees. Further more, the forests in the category 'planted' are very similar to forests in the category 'assisted' after a certain age. (sic)

Scenario 2 of the FAO's model assumed that the area by which Finland's Planted Forests would expand each year was 89 148 ha (1.7% of 5.244 million ha). This is probably close to the total area that was planted each year in Finland during the recent past. In 2007, Finland's Ministry for Agriculture and Forestry reported that in preceding years about 78% of regeneration fellings were aimed at artificial regeneration and 22% at natural regeneration. 'Cultivation' is favoured because it 'generally results in good-quality seedling stands more quickly and reliably than natural regeneration' (Hytönen & Kotisaari 2007, p. 27). About 120 000 ha of 'forest cultivation' had been conducted each year, of which about 75% (90 000 ha) had been planted annually and the rest sown; the target for cultivation in the following planning period is 150 000 ha. Thus, Finland seems

to be in the process of converting 'assisted naturally regenerated' forests to Planted Forests in both name and fact.

Canada did not respond to the FAO's Planted Forests questionnaire (Del Lungo & Ball 2006). To compensate, the FAO used the annual State of Canada's Forest reports to estimate that Canadian Planted Forests totalled 10.787 million ha. These Planted Forests are the replanted areas of logged native forests, so reflect the conversion of 'native forests'. The FAO model classified these areas as Semi-Natural Planted Forests and assumed that almost all of the area would expand at 1.5% per year in Scenario 1 (161 805 ha per year) or 3% in Scenarios 2 and 3 (323 610 ha per year). Also, an annual productivity growth rate of 1% was applied in Scenario 3 (FAO 2009a), which increases their assumed productivity by 28% over the 25 years to 2030. The conversion process continues, and in 2007, 733 760 ha of Canadian native forests were logged, of which 451 318 ha (61%) was reported as being planted (Natural Resources Canada 2009). Thus, the long-term expansion rate assumed for Canada's Planted Forests by the FAO's Scenarios 2 and 3 could be conservative.

The response of the United States of America to the FAO's 2005 questionnaire provided an estimate of the nation's Forest Plantation estate of 17.061 million ha and 6.323 million ha of 'semi-natural forests'. All of the 'semi-natural forests' were reported as 'assisted' and not 'planted' because the American reporters considered the difference was 'very difficult' to distinguish from inventory data (Del Lungo & Ball 2006, p. 50).

However, the US Forest Service not only includes Forest Plantations of native species in its own statistics of Planted Forests, but also those regenerated forest sites 'where planting was undertaken to augment existing stocking' (Sheffield 2009, p. 67).

The Forest Service estimated the area of Planted Forests in the USA around the years 2001 and 2002 at 22.22 million ha (55.55 million acres), of which 5.54 million ha (13.6 million acres) in the 'West' region was classed as 'augmented' planting.

> The species planted are usually native, making these stands difficult to detect during field sampling. Additionally, there are thousands of acres of more traditional Forest Plantations such as those found in the East that are not currently identified during field sampling (Smith et al. 2004, p. 49).

By 2007, the estimated area of Planted Forests in the USA had increased to 25.26 million hectares (63 167 million acres), and the estimate of the area in the 'Pacific Coast' region was about 4.68 million ha (11.7 million acres) (Smith et al. 2009).

Thus, while the US Forest Service reported the area of 'augmented' plantings as Planted Forests in its own statistics, it seems that the figures were not considered to be sufficiently reliable for provision to the FAO as data on Semi-Natural Planted Forests. They are now included in the estimate of the area of Planted Forests in the USA supplied to the FRA 2010 process (Smith 2009b) because countries are trying to harmonise their data with those of the FAO definition (Smith 2009a). In the USA, 'augmented forests' consist 'of at least 40% planted trees, of native or introduces species, but not intensively managed to assure dominance of these trees in the stand at maturity' (Smith 2009b, p. 1), while the FRA 2010 expects that Planted Forests 'constitute more than 50% of the growing stock at maturity' (FAO 2007, p. 21).

Appendix 3.4   Expansion in the area of Forest Plantations and SNPF by the three FAO scenarios

A: Expansion in the area of Forest Plantations and SNPF between 2005 and 2030 as projected by the three scenarios
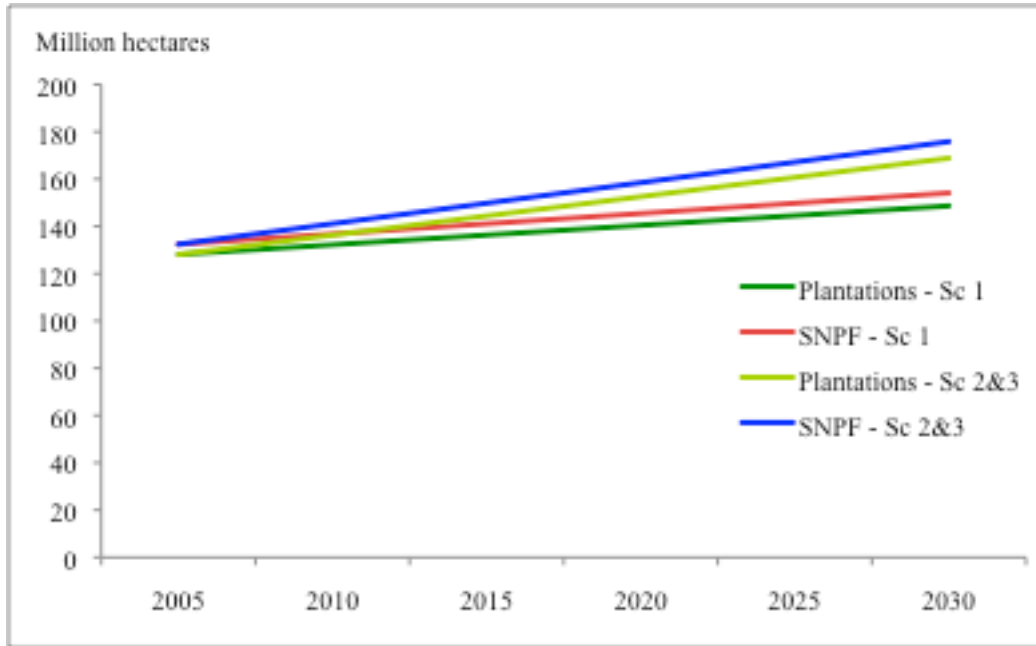
Million hectares						
	2005	2010	2015	2020	2025	2030
Plantations - Sc 1	128.10	132.21	136.32	140.43	144.54	148.65
SNPF - Sc 1	132.42	136.75	141.09	145.42	149.76	154.10
Total Planted Forests - Sc 1	260.51	268.96	277.41	285.86	294.30	302.75
Plantations - Sc 2&3	128.10	136.25	144.40	152.55	160.69	168.84
SNPF - Sc 2&3	132.42	141.10	149.78	158.47	167.15	175.84
Total Planted Forests - Sc2&3	260.51	277.35	294.18	311.01	327.85	344.68

Million hectares			
	2005	2030	Percent Increase
Plantations - Sc 1	128.10	148.65	16%
SNPF - Sc 1	132.42	154.10	16.40%
Plantations - Sc 2&3	128.10	168.84	31.80%
SNPF - Sc 2&3	132.42	175.84	32.80%

Source: FAO (2009a)

B: The rates of change in the area of Forest Plantations and SNPF as applied in the three scenarios
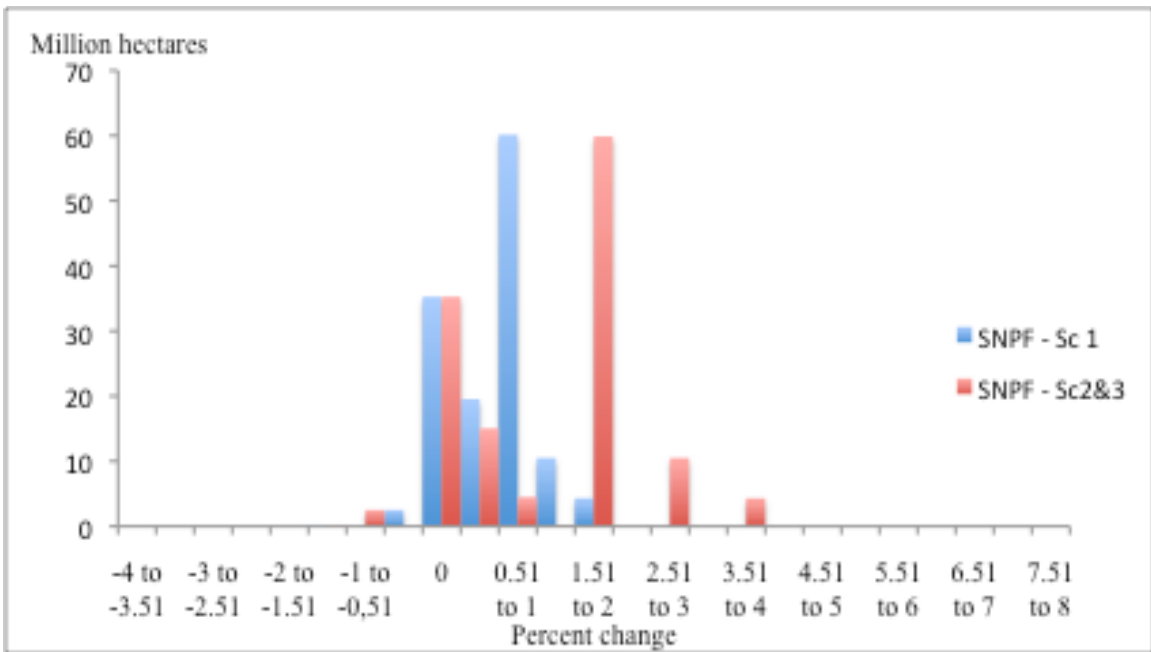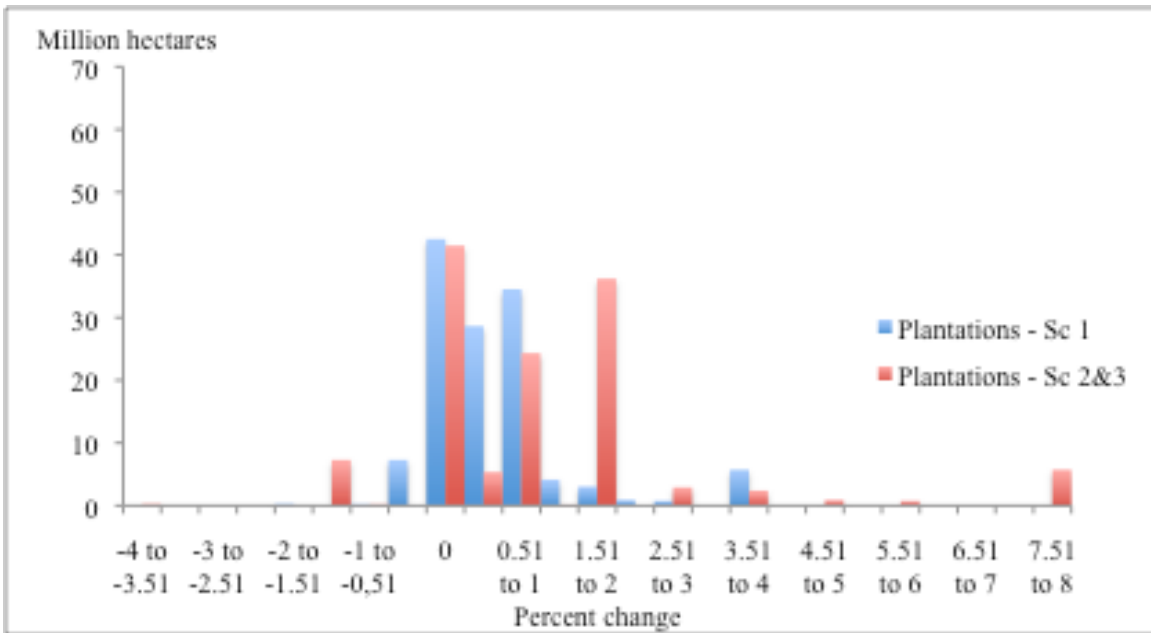
Million hectares

Percent change	Plantations - Sc 1	Plantations - Sc 2&3	SNPF - Sc 1	SNPF - Sc2&3
-4 to -3.51		0.32		
-3.5 to -3.01				
-3 to -2.51				
-2.5 to -2.01				
-2 to -1.51	0.32			
-1.5 to -1.01		7.28	0.15	0.15
-1 to -0,51	0.26	0.26		2.52
-0.5 to -.01	7.28		2.52	
0	42.51	41.46	35.25	35.25
0.01 to 0.5	28.63	5.36	19.54	15.05
0.51 to 1	34.51	24.32	60.15	4.49
1.01 to 1.5	4.15	0.19	10.51	0.27
1.51 to 2	3.05	36.19	4.32	59.88
2.01 to 2.5	0.90			
2.51 to 3	0.76	2.92		10.51
3.01 to 3.5				
3.51 to 4	5.73	2.39		4.32
4.01 to 4.5				
4.51 to 5		0.90		
5.01 to 5.5				
5.51 to 6		0.76		
6.01 to 6.5				
6.51 to 7				
7.01 to 7.5				
7.51 to 8		5.73		

Source: FAO (2009a)

Appendix 3.5 Area of Forest Plantations and SNPF at 2005 and 2030 sorted by region and scenario
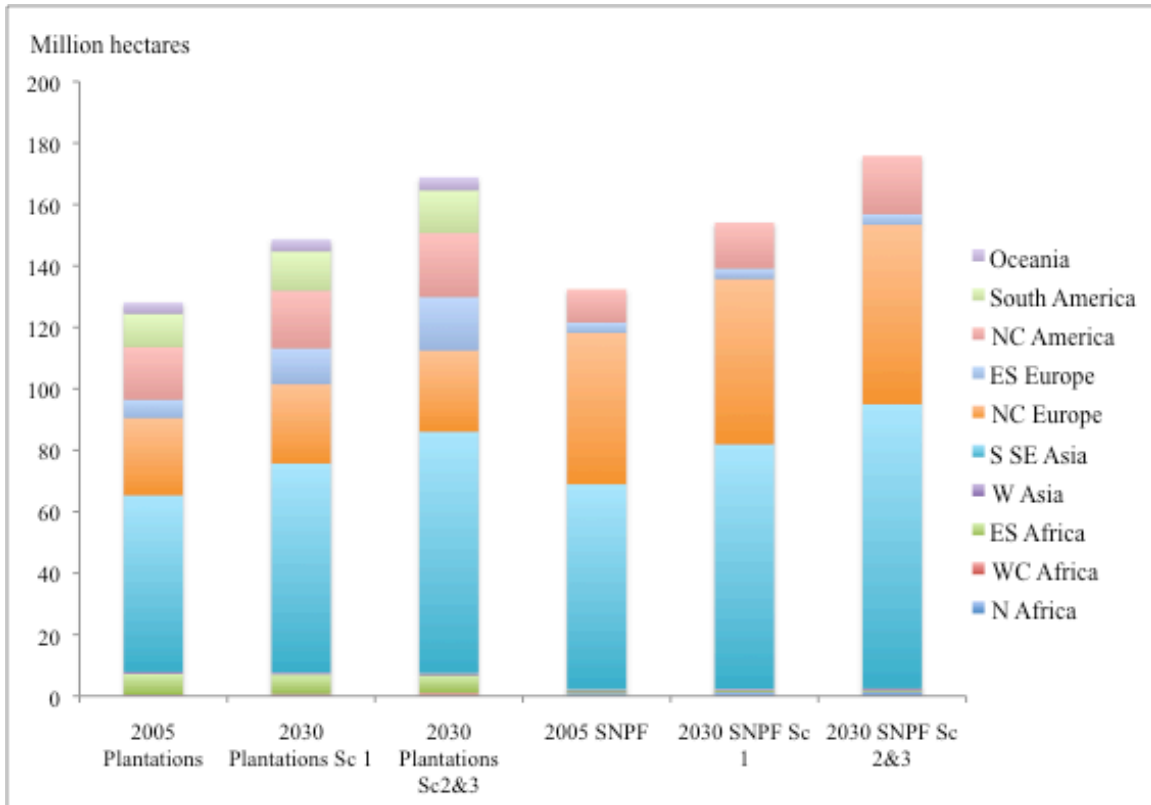
Region	2005 Plantations	2030 Plantations - Sc 1	2030 Plantations - Sc2&3	2005 SNPF	2030 SNPF - Sc 1	2030 SNPF - Sc 2&3
N Africa	0.07	0.10	0.13	0.97	1.22	1.48
WC Africa	0.35	0.61	0.87			
ES Africa	6.83	6.33	5.84	1.22	1.15	1.08
W Asia	0.62	0.62	0.62			
S SE Asia	57.47	68.04	78.61	66.76	79.59	92.42
NC Europe	25.21	25.81	26.46	49.27	53.83	58.43
ES Europe	5.94	11.68	17.42	3.41	3.41	3.41
NC America	17.06	18.81	20.79	10.79	14.90	19.01
South America	10.90	12.70	13.87			
Oceania	3.65	3.95	4.24			

Source: FAO (2009a)

Appendix 3.6   Age class distribution of Forest Plantations and SNPF at 2005
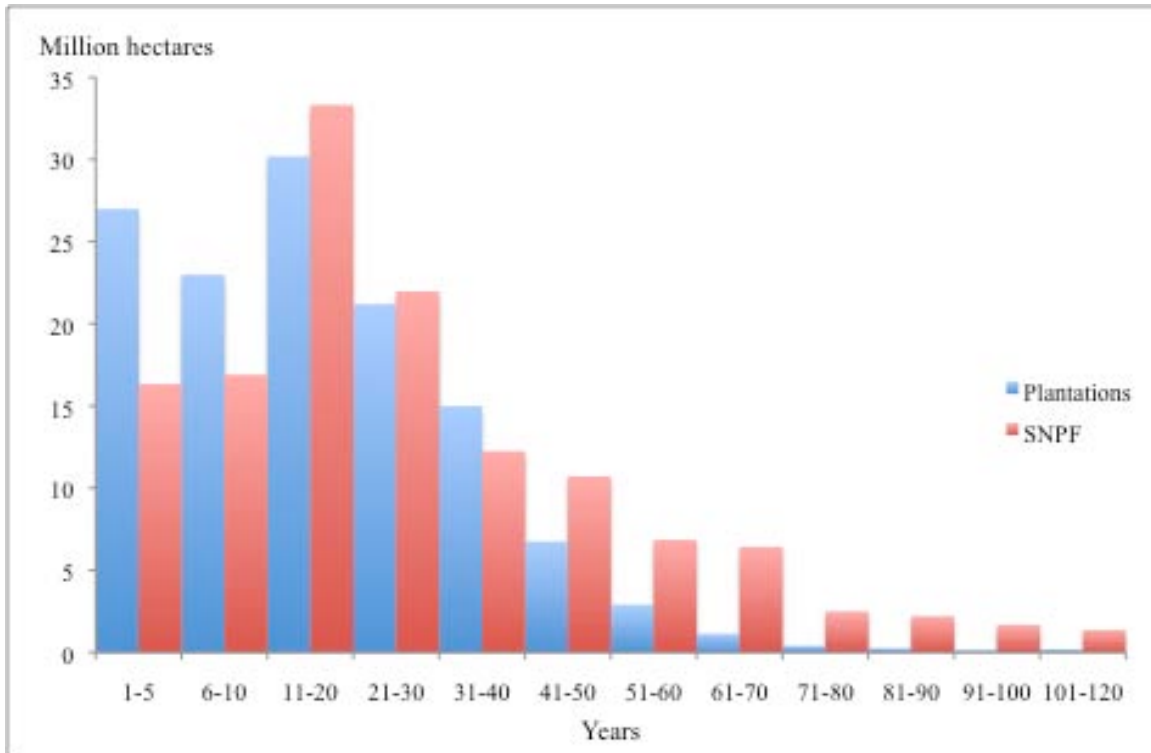
Million hectares

Age class (years)	1-5	6-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120
Plantations	26.99	22.98	30.18	21.19	14.98	6.75	2.90	1.13	0.40	0.26	0.14	0.18
SNPF	16.33	16.89	33.32	21.97	12.24	10.71	6.84	6.42	2.49	2.20	1.67	1.36

Source: FAO (2009a)

Appendix 3.7 Area of Forest Plantations and SNPF at 2005 sorted by growth rates (MAI)
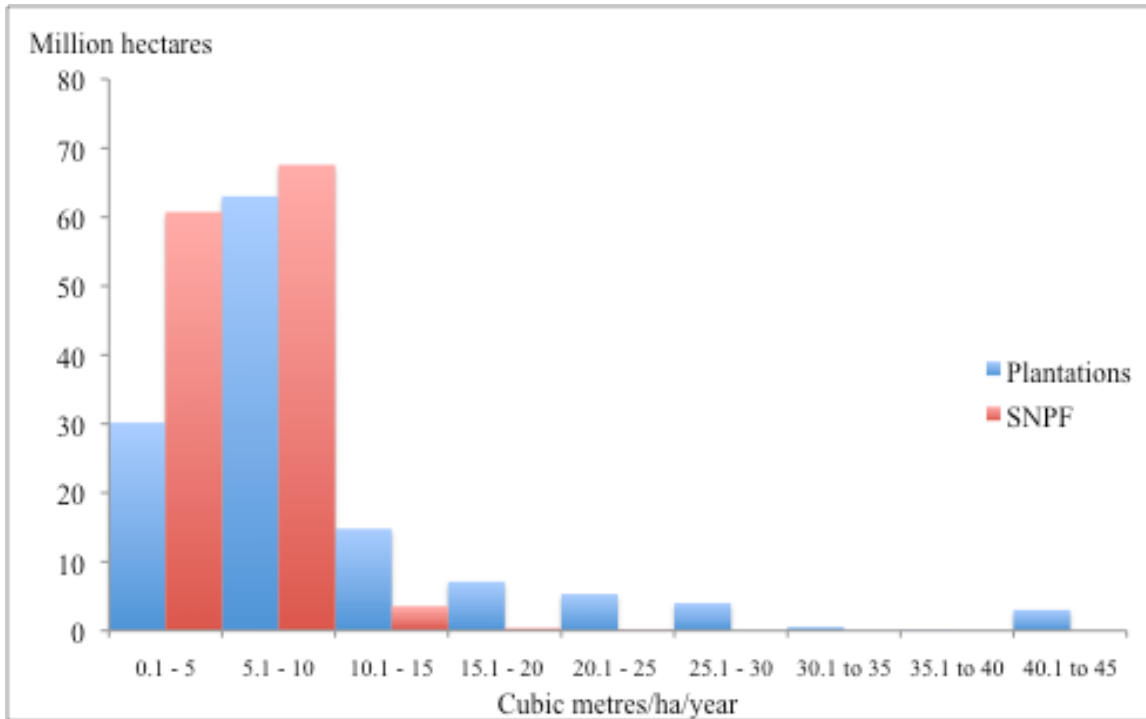
				Million hectares				
MAI (m3/ha/yr)	0.1 - 5	5.1 - 10	10.1 - 15	15.1 - 20	20.1 - 25	25.1 - 30	30.1 to 35	35.1 to 40	40.1 to 45
Plantations	30.17	63.02	14.80	7.12	5.33	4.02	0.54	0.08	3.03
SNPF	60.74	67.57	3.56	0.41	0.15				

Source: FAO (2009a)

Appendix 3.8 Area of Forest Plantations and SNPF at 2005 sorted by rotation length (years) and growth rates (MAI)

Forest Plantations
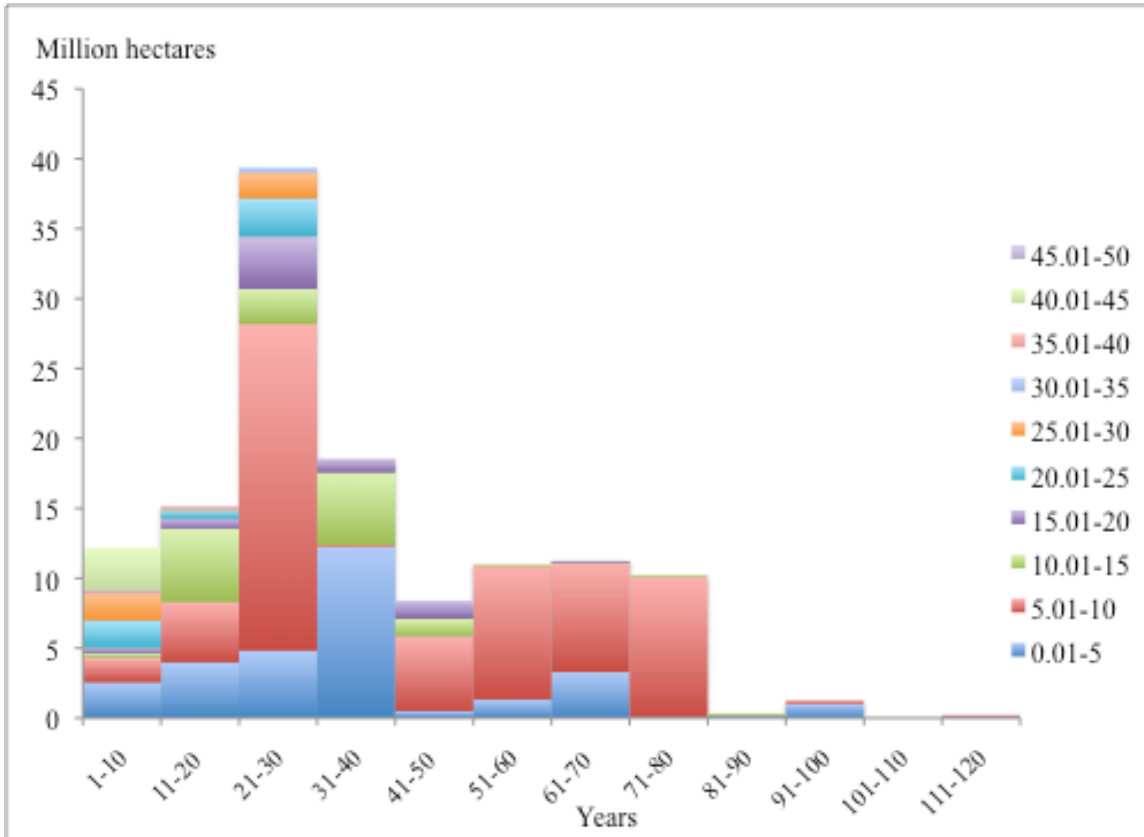
SNPF

| | | | | | Million hectares | | | | | | | |
| | | | | | Rotation time (years) | | | | | | | |
MAI (m3/ha/yr)	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120
0.01-5	0.003	0.237	17.809	13.425	1.382	0.562	9.382	3.761	10.62	0.112	1.518	1.933
5.01-10		7.504	14.810	0.575	4.016	11.43	17.861	1.290	0.450	1.045	6.277	2.313
10.01-15		1.765	0.025	0.436	0.0002		0.015			0.024	1.297	
15.01-20	0.268		0.142									
20.01-25	0.153											
25.01-30												
30.01-35												
35.01-40												
40.01-45												
45.01-50												

Source: FAO (2009a)

Appendix 3.9 Area of Forest Plantations and SNPF at 2005 sorted by rotation length (years) and region

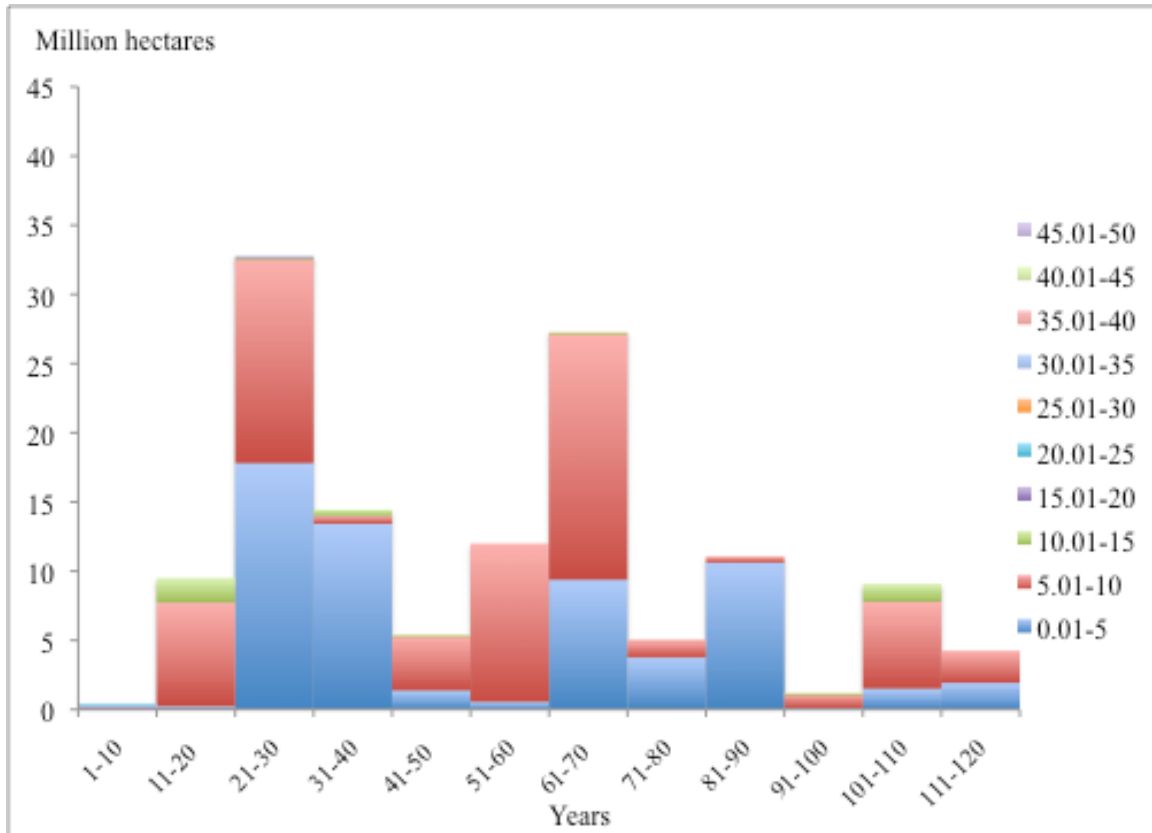*Forest Plantations*

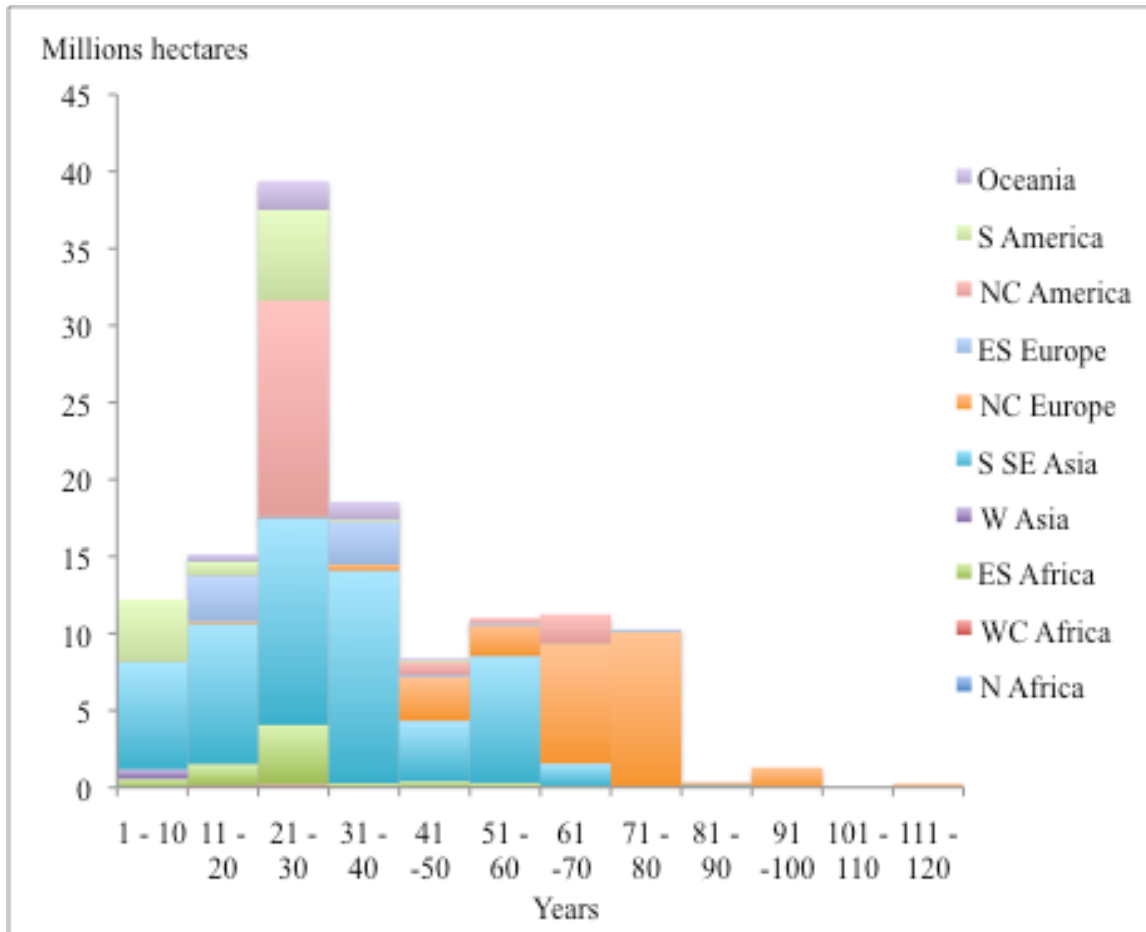|						Million hectares						
						Rotation time (years)						
Region	1 - 10	11 - 20	21 - 30	31 - 40	41 -50	51 - 60	61 -70	71 - 80	81 - 90	91 -100	101 - 110	111 - 120
N Africa		0.01					0.06					
WC Africa		0.14	0.21									
ES Africa	0.57	1.39	3.85	0.28	0.41	0.30	0.03					
W Asia	0.62											
S SE Asia	6.98	9.26	13.50	13.81	3.92	8.24	1.47		0.25		0.03	
NC Europe		0.01	0.05	0.40	2.99	2.07	7.81	10.25	0.11	1.29	0.001	0.24
ES Europe		2.97	0.02	2.88	0.01	0.05		0.01				
NC America			13.99		0.85	0.34	1.88					
S America	4.02	0.90	5.89	0.02	0.07							
Oceania		0.48	1.86	1.17	0.14							
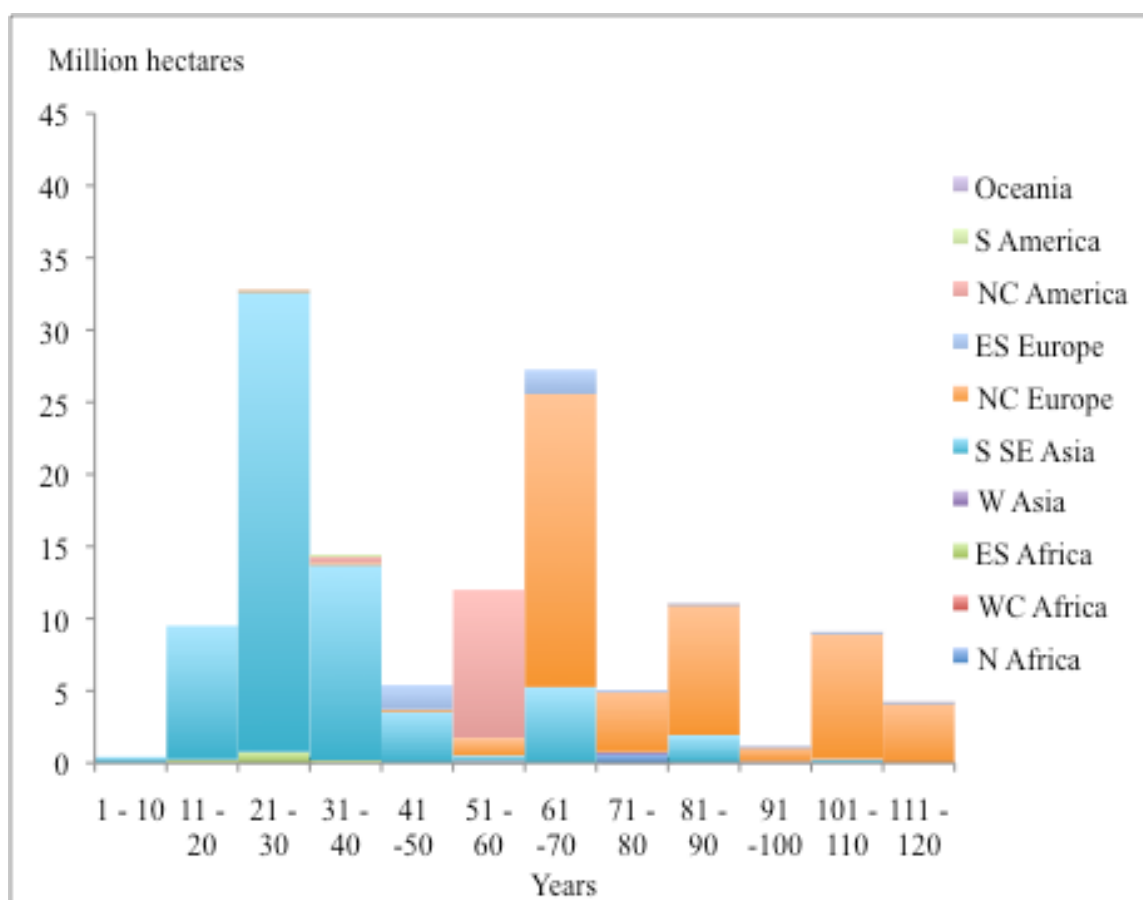
62

SNPF

	Million hectares											
	Rotation time (years)											
Region	1 - 10	11 - 20	21 - 30	31 - 40	41 -50	51 - 60	61 -70	71 - 80	81 - 90	91 -100	101 - 110	111 - 120
N Africa				0.004	0.001	0.11	0.000	0.76	0.02	0.07		
WC Africa												
ES Africa	0.003	0.24	0.76	0.19	0.003	0.02						
W Asia						0.001		0.000	0.001	0.002		0.001
S SE Asia	0.42	9.27	31.99	13.61	3.64	0.38	5.26		1.91		0.27	
NC Europe			0.03	0.07	0.07	1.23	20.32	4.29	9.13	1.10	8.80	4.24
ES Europe					1.69		1.69	0.002	0.0004	0.01	0.02	0.004
NC America				0.54		10.25						
S America				0.02								
Oceania												

Source: FAO (2009a)

Appendix 3.10 Areas of Forest Plantations and SNPF in the FAO's Scenario 3 to which productivity growth rates were applied
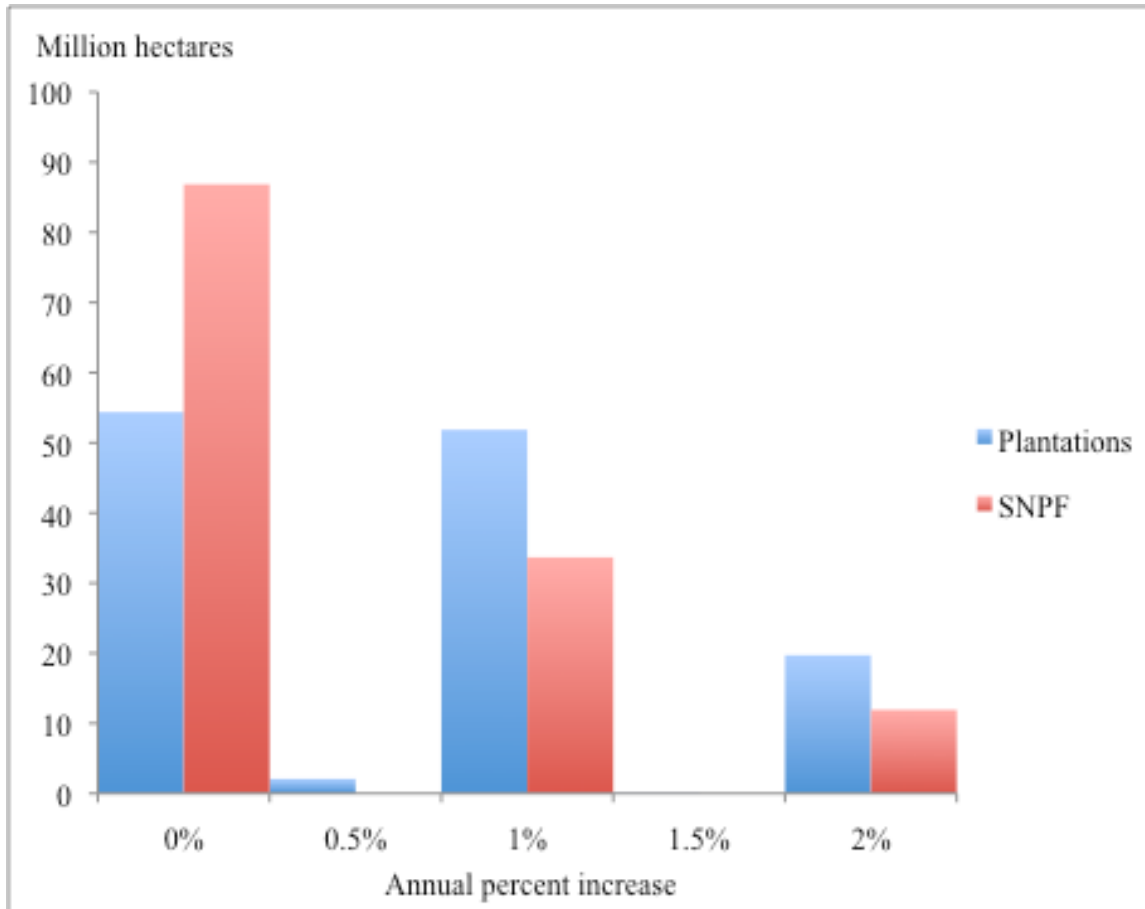
Million hectares

Annual % increase	0%	0.5%	1%	1.5%	2%
Plantations	54.37	2.08	51.85	0.08	19.71
SNPF	86.85		33.66		11.93

Source: FAO (2009a)

Appendix 3.11 Area of Forest Plantations and SNPF at 2005 sorted by MAI and productivity growth rates

Forest Plantations
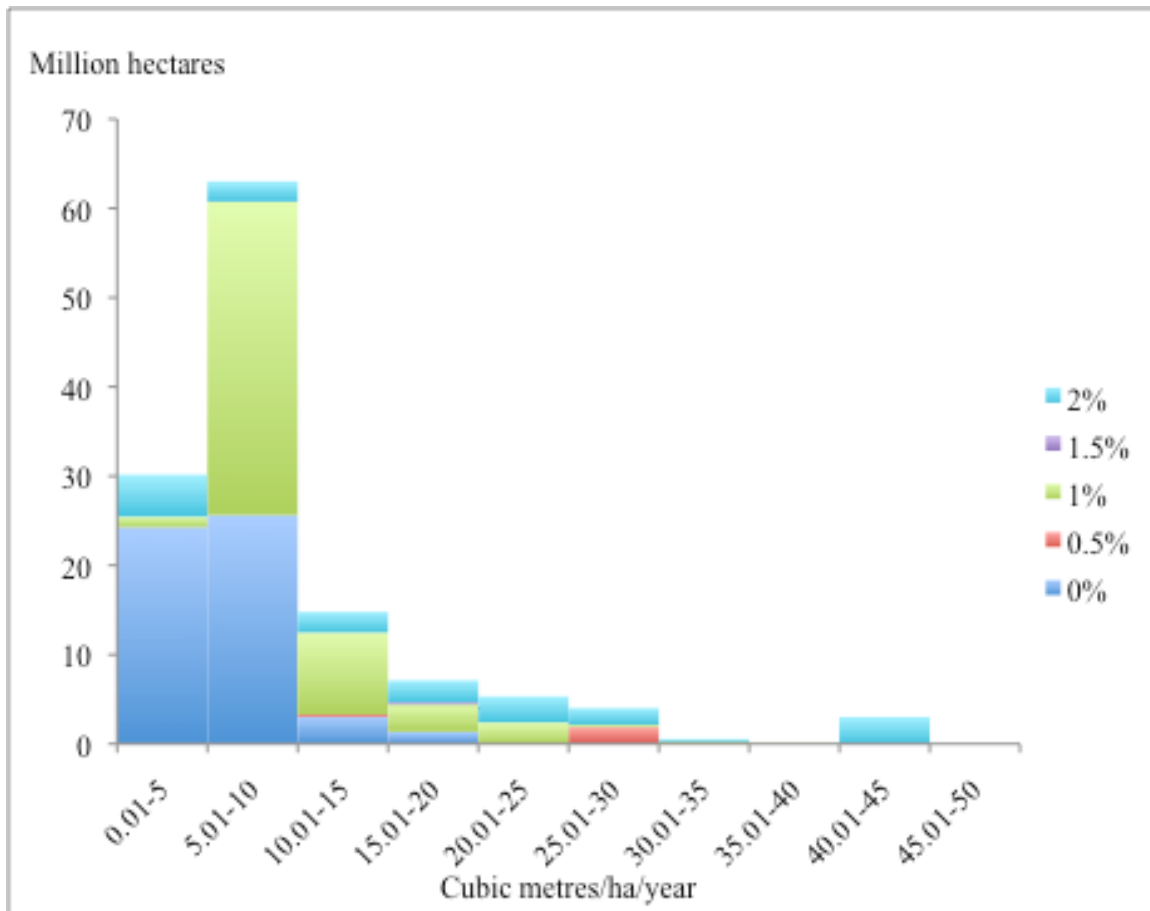
	Million hectares				
	Productivity increase				
MAI (m3/ha/yr)	0%	0.5%	1%	1.5%	2%
0.01-5	24.28		1.18		4.71
5.01-10	25.63		35.12		2.26
10.01-15	3.09	0.20	9.20		2.31
15.01-20	1.36		3.22	0.08	2.45
20.01-25	0.01		2.41		2.91
25.01-30	0.01	1.88	0.27		1.87
30.01-35			0.37		0.17
35.01-40			0.08		
40.01-45					3.03
45.01-50					

SNPF
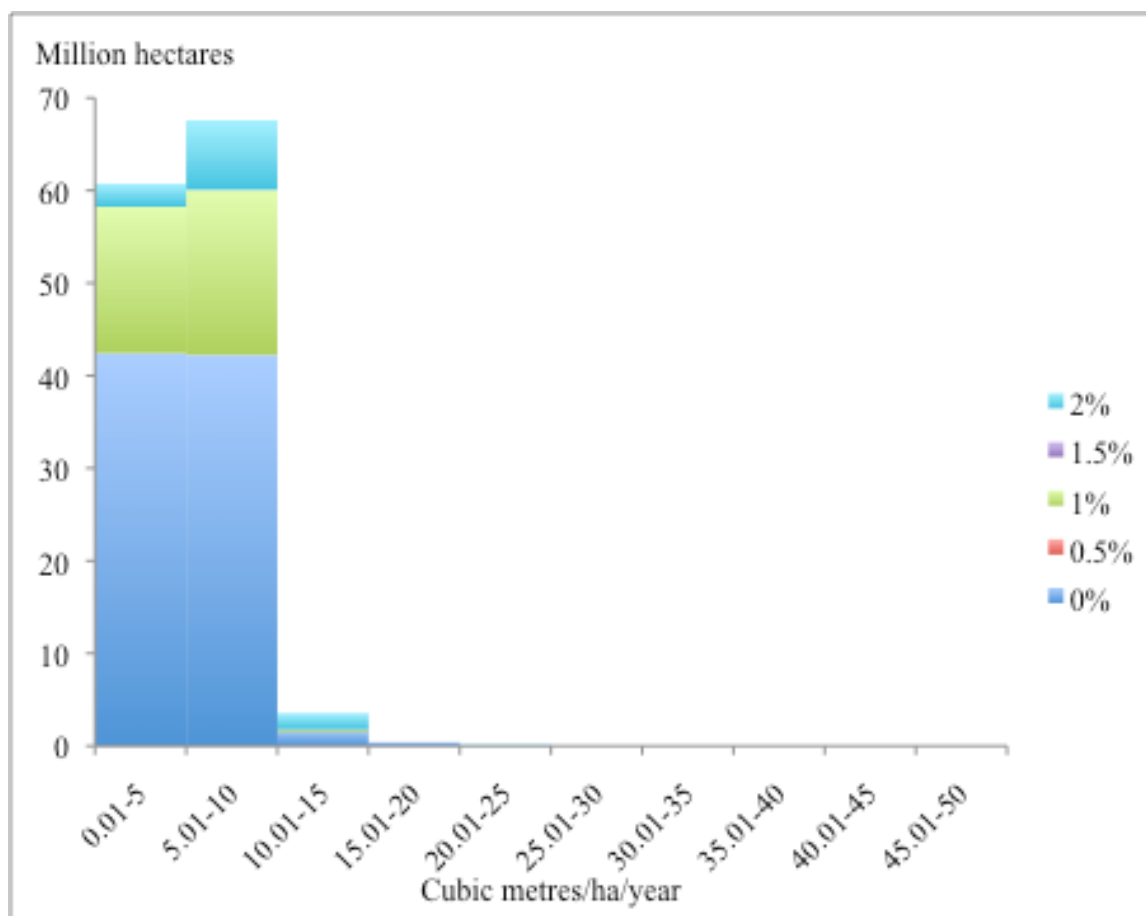
MAI (m3/ha/yr)	Productivity increase				
	0%	0.5%	1%	1.5%	2%
0.01-5	42.43		15.83		2.49
5.01-10	42.24		17.83		7.50
10.01-15	1.77		0.01		1.78
15.01-20	0.41				
20.01-25					0.15
25.01-30					
30.01-35					
35.01-40					
40.01-45					
45.01-50					

Million hectares

Source: FAO (2009a)

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Appendix 3.12 FAO projections of potential wood supply (total and individual products) from Forest Plantations and SNPF

A: Projections of total potential wood supply from Forest Plantations and SNPF by the three FAO scenarios
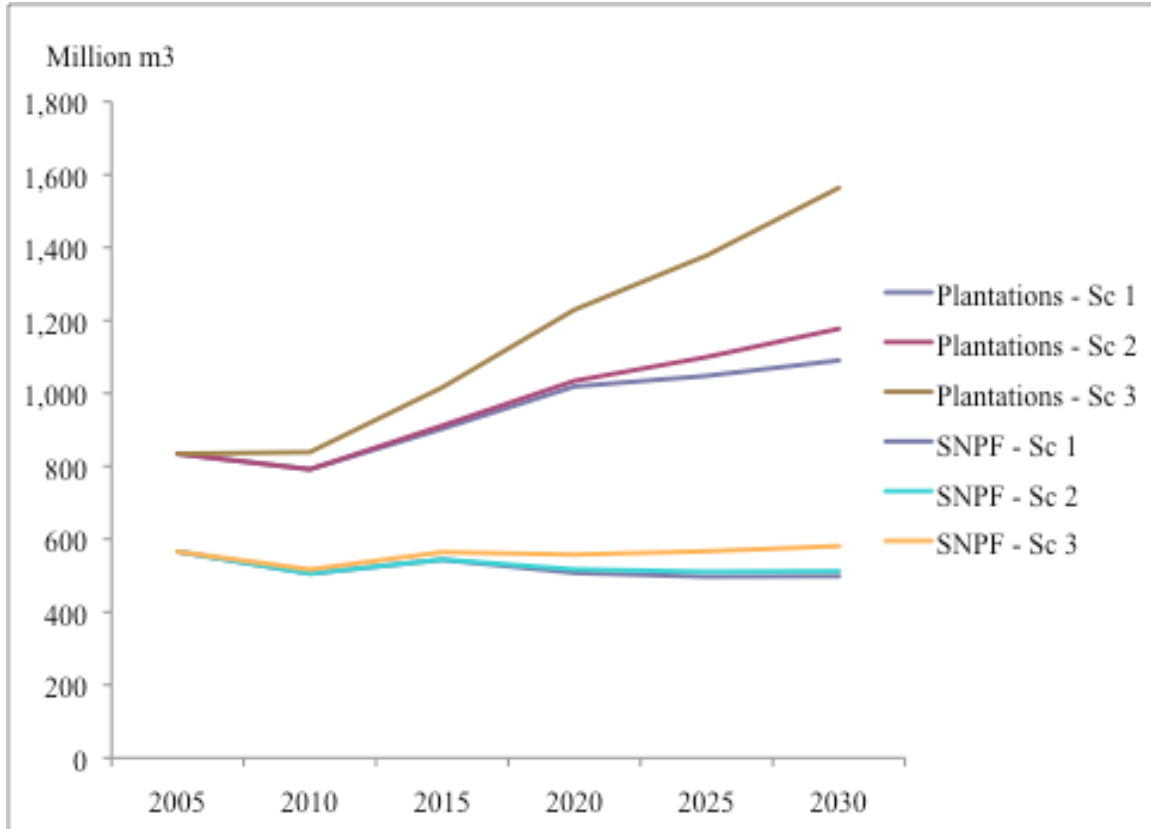
	Million m3					
	Total Volume					
Scenario	2005	2010	2015	2020	2025	2030
Plantations - Sc 1	834.13	791.44	902.55	1,018.83	1,047.90	1,090.23
Plantations - Sc 2	834.13	791.44	911.32	1,034.05	1,099.43	1,177.07
Plantations - Sc 3	834.13	838.53	1,015.96	1,229.10	1,378.07	1,563.69
SNPF - Sc 1	565.65	505.49	543.61	507.46	497.04	498.50
SNPF - Sc 2	565.65	505.49	543.94	517.22	510.61	512.14
SNPF - Sc 3	565.65	516.89	564.20	557.64	566.72	580.91

Source: FAO (2009a)

B: Projections of potential supply of individual products and harvest losses from SNPF and Forest Plantations by the three FAO scenarios

			Million m3			
	2005	2010	2015	2020	2025	2030
Scenario			Fuel/Bioenergy			
Plantations - Sc 1	68.00	63.42	70.44	83.06	84.22	84.94
Plantations - Sc 2	68.00	63.42	71.31	84.96	88.07	91.00
Plantations - Sc 3	68.00	66.84	78.61	100.03	109.58	118.75
SNPF - Sc 1	68.28	60.98	61.06	66.47	64.32	61.54
SNPF - Sc 2	68.28	60.98	61.08	68.80	66.82	64.12
SNPF - Sc 3	68.28	62.16	62.97	75.32	74.37	72.49
			Pulp/Fibre			
Plantations - Sc 1	354.51	384.11	383.09	459.04	472.96	446.15
Plantations - Sc 2	354.51	384.11	390.14	469.41	501.09	494.96
Plantations - Sc 3	354.51	412.17	444.69	580.45	660.14	693.77
SNPF - Sc 1	185.85	169.65	168.85	158.05	151.91	146.98
SNPF - Sc 2	185.85	169.65	168.85	163.22	157.09	152.16
SNPF - Sc 3	185.85	173.09	174.65	178.66	174.85	172.24
			Wood Products			
Plantations - Sc 1	366.89	303.36	400.03	422.43	437.05	494.48
Plantations - Sc 2	366.89	303.36	400.61	424.97	453.24	521.61
Plantations - Sc 3	366.89	318.76	442.38	492.08	549.69	679.48
SNPF - Sc 1	291.63	256.08	295.36	265.98	263.33	272.43
SNPF - Sc 2	291.63	256.08	295.36	265.98	263.33	272.43
SNPF - Sc 3	291.63	262.86	308.25	286.66	299.99	318.59
			Unspecified Use			
Plantations - Sc 1	14.07	10.41	15.43	17.75	12.81	24.33
Plantations - Sc 2	14.07	10.41	15.41	17.74	14.16	25.53
Plantations - Sc 3	14.07	10.62	16.43	19.57	15.80	27.72
SNPF - Sc 1	6.45	6.32	5.15	5.21	5.10	4.94
SNPF - Sc 2	6.45	6.32	5.15	5.21	5.10	4.94
SNPF - Sc 3	6.45	6.32	5.15	5.24	5.14	4.96
			Harvest Losses			
Plantations - Sc 1	30.65	30.14	33.57	36.55	40.86	40.34
Plantations - Sc 2	30.65	30.14	33.85	36.97	42.87	43.96
Plantations - Sc 3	30.65	30.14	33.85	36.97	42.87	43.96
SNPF - Sc 1	13.45	12.45	13.18	11.75	12.37	12.62
SNPF - Sc 2	13.45	12.45	13.18	11.75	12.37	12.62
SNPF - Sc 3	13.45	12.45	13.18	11.75	12.37	12.62

Source: FAO (2009a)

Appendix 3.13 Disaggregating FAO's Planted Forest data into Forest Plantations and Semi Natural Planted Forests

This appendix gives an overview of the kind of data supplied by the Food and Agriculture Organization of the United Nations for this report. It also gives background on data for Planted Forests in India and Ukraine included by the FAO in its modelling database as 'SNPF/Plantation'.

Staff of the Forestry Department of the Food and Agriculture Organization provided this report's author with access to the primary data on Planted Forests used to prepare the FAO's projections of potential wood supply from the world's Planted Forests as in Carle and Holmgren (2008). This is the information referred to in this report's reference FAO (2009a).

The material so accessed included:

- Excel spreadsheets for each relevant country that contain the basic input assumptions used in the modelling of planted forest production for that country, the actual modelling for each country's production included in each of the three scenarios for future wood production from the world's Planted Forests and the results of that modelling

- an Excel spreadsheet that contains all of the basic input assumptions for each country covered by the modelling of each of the three scenarios. This includes the area of Forest Plantations and SNPF assumed to exist in each country at 2005

- an Excel spreadsheet that contains all the results of the modelling for each country, including the projections for the expansion of the area of Planted Forests and the growth in wood production for each of the three scenarios.

The basic input data used in the modelling and contained in the Excel spreadsheets are:

- name of the country containing the Planted Forest

- name of the region containing each country

- name of tree species used in each Planted Forest and, in some cases, the silvicultural prescription applied to that area (final felling or thinning) that produced a volume of wood

- purpose of the Planted Forest – production or protection

- characteristics of the Planted Forest – Semi Natural Planted Forest or Forest Plantation
- rotation time for each Planted Forest in years
- growth rate (Mean Annual Increment) of each Planted Forest in cubic metres/ha/year
- efficiency of the Planted Forest area as a proportion of 1
- volume end use by percentage of each product from each Planted Forest (Fuel/Bioenergy, Pulp/Fibre, Wood Products, Unspecified, Harvest Losses)
- area of each Planted Forest in hectares
- percentage of each Planted Forest area by age class
- annual area change of each Planted Forest area as a percentage of the initial area for each of the three scenarios
- annual change in productivity of each Planted Forest Area for each of the three scenarios.

The results of the modelling of each of the three scenarios presented:
- name of the country containing the Planted Forest
- name of the region containing each country
- name of tree species used in each Planted Forest and, in some cases, the silvicultural prescription applied to that area (final felling or thinning)
- purpose of the Planted Forest – production or protection
- total gross volume of products from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year
- the volume of Fuel/Bioenergy from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year
- the volume of Pulpwood/Fibre from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year
- the volume of Wood Products from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year
- the volume of Unspecified Use wood from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year
- the volume of Harvest Losses from each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand m^3 per year

- the gross area of each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand hectares

- the net area of each Planted Forest for the years 2005 to 2030 at 5-yearly intervals in thousand hectares

- the 5-yearly totals for each of the above results (products and area) grouped by region

- the percentage of each product total and area total at 5-yearly intervals in each region.

The basic country data used in the modelling were taken from the country returns to the Questionnaire on Planted Forests collected for the Global Planted Forest Thematic Supplement to Forest Resources Assessment 2005 (Del Lungo & Ball 2006). Where countries did not provide specific figures for requested information, the FAO made assumptions about that data category based on other sources of information. Also, where ranges of values were provided or calculated, the FAO used the average value.

The main objective of this report's analysis was to understand the projections in relation to the two categories of Planted Forests: Semi Natural Planted Forests and Forest Plantations. This required separating the basic assumptions used in the modelling and the results of the modelling into two groups on the basis of whether the areas of planted trees were labelled as SNPF or Forest Plantations in the relevant Excel spreadsheets. The disaggregated data could then be manipulated to expose any similarities or differences between the two categories. However, the disaggregation of the data on Planted Forests into these categories was slightly complicated by the way that the inputs and results were presented by the FAO for India and Ukraine.

In the case of India, none of the species used in Planted Forests were distinguishable in the Excel spreadsheets as either SNPF or Forest Plantation, but were listed by the FAO as 'SNPF/Forest Plantation' because India reported in its return (contained in Del Lungo & Ball 2006) that each species had the same growth rate and age class distribution in each of the categories in which it was listed.

In the case of Ukraine, for all species of Planted Forests except 'Other', the category in the Excel sheet was listed as SNPF or Forest Plantation. However, 'Other' was categorised as 'SNPF/Forest Plantation', without detailing how much of the 'Other' species was SNPF and how much was Forest Plantation.

Consequently, this author referred back to the information supplied by India and Ukraine in Del Lungo & Ball (2006). The information from India reported that the country had 26.80 million ha of Semi-Natural Planted Forests and 3.23 million ha of Forest Plantations, as in Table 13.1a.

Table 13.1a India SNPF and Forest Plantations

India	Area (million ha)	Area
Semi Natural Forests	31.533	
Semi Natural Planted Forests	26.802	85% (of SNF)
Productive SNPF	16.08	60% (of SNPF)
Other species	6.75	42% (of Productive SNPF)
Protective SNPF	10.72	40% (of SNPF)
Other species	8.256	77% (of Protective SNPF)
SNPF Other species	15.01	56% (of SNPF)
Forest Plantations	3.226	
Productive Plantations	1.05	32.6% (of Plantations)
Other species	0.44	42% (of Productive Plantations)
Protective Plantations	2.17	77.4% (of Plantations)
Other species	1.67	77 % (of Protective Plantations)
Plantations Other species	2.12	65.6% (of Forest Plantations)
Planted Forests	30.028	
Other species	17.12	57.03% (of Planted Forests)

The proportion of the area covered by different tree species was the same in the productive sections of SNPF and Forest Plantations, but different to those in the protective sections of SNPF and Forest Plantations, which in turn were the same. Also, the growth rates, rotation times and age class distribution for each species were the same in both SNPF and Forest Plantations. The 'Other' species group was the largest species grouping in each of the four categories of Planted Forest. However, India did not provide the growth rates and age class distributions for 'Other' species, listing them as Not Available. Consequently, the FAO made assumptions about these factors for the modelling of its global projection scenarios.

For this report, the data on Area and Wood Outputs for all species of India's tree species included in the FAO's Excel spreadsheets were multiplied by 0.893 to give values for the area and output of SNPF, and multiplied by 0.107 to give values for the area and output of Forest Plantations. The calculated values were then used in the disaggregation of the India data into SNPF and Forest Plantations.

Ukraine reported that, at 2005, 'Other' species used in Planted Forests covered about 65 000 ha, as in Table 13.1b below. The area of 'Other' species in Forest Plantations (about 9680 ha) is minor when compared to the global area of Forest Plantations and Planted Forests. Consequently for this report, all of Ukraine's 'Other' species were categorised as SNPF in the disaggregation process. This has an insignificant effect on the calculations made for this report.

Table 13.1b Ukraine SNPF and Forest Plantations

Ukraine	Area (million ha)	Area
Semi Natural Forests	4.399	
Semi Natural Planted Forests	4.399	100% (of SNF)
Productive SNPF	2.99	68% (of SNPF)
Other species	0.015	0.5% (of Productive SNPF)
Protective SNPF	1.41	32% (of SNPF)
Other species	0.04	2.9% (of Protective SNPF)
SNPF Other species	0.056	1.3% (of SNPF)
Forest Plantations	0.388	
Productive Plantations	0.08	21% (of Plantations)
Other species	0.0002	0.2% (of Productive Plantations)
Protective Plantations	0.31	79% (of Plantations)
Other species	0.0095	3.1% (of Protective Plantations)
Plantations Other species	0.0097	2.5% (of Plantations)
Planted Forests	4.787	
Other species	0.066	1.37% (of Planted Forests)