



A PLATFORM FOR STAKEHOLDERS IN AFRICAN FORESTRY

FOREST PLANTATIONS AND WOODLOTS IN RWANDA



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ACRONYMS

ADB	African Development Bank
BEST	Biomass Energy Strategy
BNR	National Bank of Rwanda
CATALIST	Catalyze Agricultural Intensification for Social and Environmental Stability
CCAF	Climate Change Adaptation Fund
CDM	Clean Development Mechanism
CGIS-NUR	Centre for Geographical Information Systems of the National University of Rwanda
CHDI	Clinton Hunter Development Initiative
DFF	District Forest Fund
DFO	District Forest Officer
DRB	Rural Development project of Byumba
DRC	Democratic Republic of Congo
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFN	National Forest Fund
FIDA	International Fund for Agricultural Development (IFAD)
GBK	Reforestation project of Gisenyi, Butare and Kigali
GDP	Gross Domestic Product
GEF	Green Fund
GTZ	German Technical Cooperation Agency
ICRAF	World Agroforestry Centre
IRST	Institute for Research in Science and Technology
ISAE	Higher Learning Institute of Agriculture and Animal Husbandry
ISAR	Rwanda Agricultural Research Institute
IUCN	World Conservation Union
LDCF	Least Developed Countries Fund
MINAGRI	Ministry of Agriculture and Animal Resources
MINECOFIN	Ministry of Finance and Economic Planning
MINIFOM	Ministry of Forestry and Mines
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MINITERE	Ministry of Lands, Environment, Forestry, Water and Mines
NAFA	National Forestry Authority
NFF	National Forest Fund
NISR	National Institute of Statistics of Rwanda
NUR	National University of Rwanda
ORTPN	Rwanda Office of Tourism and National Parks
PAFD	District Forest Management Plan (Plan d'Amangement Forestier de District)
PAFOR	Forest Management Support Project
PAREF	Rwanda Reforestation Support Programme
PPF	Pilot Forest Project (Projet Pilote Forestier)
RDB	Rwanda Development Board
REDD	Reducing Emissions from Deforestation and forest Degradation
ROR	Republic of Rwanda
SDA	Swiss Development Agency
TROF	Tree Resources Outside Forest
SEW	Sustainable Energy Production through Woodlots and Agroforestry in the Albertine Rift
UGZ 1	Management Unit Zone 1 (Unité de Gestion Zone 1.)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework on Climate Change Convention
USAID	United States Agency for International Development
VCM	Voluntary Carbon Market
WB	World Bank
WHO	World Health Organisation

PREFACE

Forest plantations and woodlots play a vital role in the livelihoods of the people of Rwanda. In fact, most of the remaining natural forests are currently protected either as national parks or as protection forest reserves. With the exception of few imported products, such as quality timber and industrial wood products, most forest products, such as fuelwood, local timber, building poles and others used in Rwanda come from forest plantations, woodlots and agroforestry. Despite the dramatic reduction of forest cover which occurred as a consequence of the anarchy and state collapse following the genocide of Tutsi in 1994, and the aftermath demand for new settlements and wood for reconstructing the country, the forest cover has been rising and it is targeted to reach 30% of the country by 2020. This report is a comprehensive study to characterise and document information on the current status, challenges, opportunities and options for future management of forest plantations and woodlots in Rwanda.

Key issues covered include the evaluation and analysis of the current public and private forest plantations situation; surveys of wood products market and wood processing industries; the current licensing and revenue collection systems, management arrangements and pricing mechanisms for roundwood and industrial forest products; current income and employment and potential for future income generation and employment creation; incentives that could favour rapid forest plantation establishment by public and private sectors, and outgrowers/woodlots schemes by individual farmers; options for establishment, expansion and improved management of public and private forest plantations; and, processing of industrial round wood from forest plantations and its current and potential capacity.

Several sources of information and data were consulted including several publications and reports on the mentioned key issues addressed, national market surveys of wood products, supply and demand scenarios and interviews with key informants including forest professionals and various central and local government authorities. Units or organisations visited include various Ministries, Government agencies (e.g. REMA, NAFA and NLC), National Bank of Rwanda (BNR), Bank of Kigali (BK), forest projects (e.g. PAFOR and PAREF), tea plantation companies, wood processing plants (e.g. ADARWA and SORWAL), wood products business people (wood dealers), workshops and various NGOs involved in forest or agroforestry, environmental protection and conservation projects. The author is deeply grateful to all the people who expressed cooperation and friendly exchange during field surveys and secondary data collection. While some people are mentioned in the report, not all those who helped in this work could be mentioned, and the author is sincerely thankful to all the people who in one way or another assisted in realising the work.

The author is also sincerely grateful to the African Forest Forum (AFF) for initiating and providing the financial support which enabled the carrying out of this study. It is frankly hoped that the information contained in this report will be useful for effective planning of future interventions geared towards better and sustainable management of forest plantations and woodlots in Rwanda.

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Executive Summary

Rwanda is a small, landlocked country in Central Eastern Africa covering a surface area of 26 338 km². It is located between latitudes 1°04' and 2°51' South and longitudes 28°45' and 31°15' East. Rwanda is known as the "land of a thousand hills" as its terrain is characterised by steep slopes and green hills with an altitude ranging from 900 to 4 507 m above sea level. The population was estimated at 10.1 million people in 2009 (NISR, 2010) and therefore the average population density is 384 people per km² which is one of the highest population densities in the world. Dramatic reduction of forest cover in Rwanda occurred as a consequence of the anarchy following the genocide of Tutsi, state collapse and breakdown of law and order in 1994, and the aftermath demand for wood for reconstructing the country. However, an intensive reforestation programme resumed afterwards and a net increase in forest cover and/or agroforestry is evident. Currently, most remaining natural forests are protected either as national parks or as protection forest reserves. Official statistics estimate the forest cover of Rwanda to be about 21% of the country's area, consisting of 8% natural and 13% manmade forest (ROR, 2010). The target is to attain 30% forest cover by 2020.

This study assessed the current situation of public and private forest plantations/woodlots in the country with respect to the distribution and location of these plantations, species planted and sources of seedlings and seeds, age distribution of forest plantations, their management and quality of stands and other features. It was noted that the country has made a lot of efforts to establish plantation forests since the 1970s. Tree planting was generally driven by an urgent need to achieve two major objectives, viz. conservation of fragile landscapes and meeting the ever increasing demand of forest products by the growing population. As a matter of fact, Rwanda's landscape is now well dotted with trees and woodlots scattered on farmland. Nevertheless, there are no large size private or commercial forest plantations in Rwanda. Most of the large forest plantations are located in the western Province along the Congo-Nile rivers divide. They were established under projects funded by various donors or international financial institutions, e.g. the World Bank, African Development Bank, European Union, Switzerland, Netherlands and Belgium. These plantations are poorly managed because they missed follow up silvicultural management activities mainly due to disruption generated by the war situation from 1990 to 1994.

Most of the seeds used in the country are acquired from the Tree Seed Centre (CGF) established in 1978. However, there has been remarkable genetic degradation of germplasm especially for the dominant species, *Eucalyptus*, due to inbreeding and therefore efforts should be directed towards sourcing pure seeds in order to improve forest plantation yield. Other species found in forest plantations and woodlots in Rwanda include *Pinus patula*, *P. oocarpa*, *P. radiata*, *P. elliotii*, *P. kesiya*; *Cupressus lusitanica*; *Acacia melanoxylon*, *A. mearnsii*, *Callitris robusta*, *Grevillea robusta*, *Casuarina equisetifolia*, *Cedrela serrata*, *Alnus acuminata*, *Maesopsis eminii*, *Senna spectabilis*, *S. siamea*, *Leucaena leucocephala*, *Croton megalocarpus* and *Calliandra calothyrsus*. Indigenous species in plantations include *Entandrophragma excelsum*, *Podocarpus falcatus*, *Markhamia lutea* (or *platicalyx*), *Symphonia globulifera*, *Polyscias fulva* and *Prunus africana*.

The study observed that the statistics on the extent and ownership of forest plantations is deficient because no comprehensive forest inventory has been carried out so far. Consequently, in many studies on the forest sector in Rwanda, including this one, varying statistics can be found on area, ownership, management systems and resulting production, consumption and projection estimates. This is one of the most critical bottlenecks that the Forestry Department should address urgently in order to have an adequate basis for planning and development of the sector.

The existing incentive schemes that could favour rapid forest plantation establishment by public and private sectors, and outgrower schemes by individual farmers in the country were assessed. Particular attention was given to availability of land for forest expansion and of quality germplasm, financing mechanisms for plantation forestry, private sector involvement, policy and environmental issues, including land, forest and tree tenure issues, biodiversity considerations, and legislation and governance issues. The study provided options for establishment, expansion and improved management of public and private forest plantations, including ways to overcome existing and potential constraints. The potential for additional revenue from carbon trade projects was noted and already some projects have started in a few Districts. It was observed that the policy of free seedlings distribution and facilitation of woodlot establishment have greatly contributed to raising the rate of afforestation in the country. Forest plantation expansion in Rwanda is mainly

constrained by extreme poverty and shortage of land due to high population density. Forests are competing with food crop production and agroforestry is currently seen as the only feasible option.

On the basis of results from market and literature surveys, the study was able to determine supply scenarios and demand projections of plantation wood volumes for 2015, 2020, 2025, and 2030. An in-depth analysis of the current revenue collection systems, revenues collected annually, licensing/concession procedures, forest and tree tenure, management arrangements and pricing mechanisms for roundwood and industrial forest products was also carried out. Since the ban on harvesting in public forest plantations in 2000, with the exception of illegal tree cutting and some limited imports, most forest products used in the country originate from private forest plantations and woodlots. The study pointed out that the lack of adequate and systematic recording system of forestry business transactions is a great handicap to the development of forestry in the country. Indeed, it was noted that taxes, penalties and other revenues from forests and related activities are recorded under the general basket of incomes from either the agricultural sector or environment sector. Therefore the current forest fiscal system together with the recording systems of income sources need to be revised if more revenues are to be collected from the forestry business and forestry attributed its true economic value in the development of the country.

The current income and employment data were provided and estimates of the potential for income generation and employment creation were further established for 2015, 2020, 2025, and 2030. The study also analysed the processing of industrial round wood from the plantations in the country, ownership, its current and potential capacity, wood raw material supply (sources, types, and adequacy), product lines and quality of produce, potential for future investment in the sub-sector, constraints facing the sub-sector, future of the processing industry, growth and constraints. It was observed that there are no large scale forest industries in the country and still the supply of quality timber is inadequate. Most of the premium timber and other finished wood or wood simulated products are imported from neighbouring countries (mainly from DRC and Uganda) or Dubai and China. However, there are multiple opportunities for investment that would contribute to developing the forest sector in the country. Some such investments may include introduction of modern sawmills, wood based panel plants and timber treatment plants, ecotourism, etc. The country has also opportunities to tap from the mushrooming carbon trade initiatives in order to strengthen its forestry sector.

As ways forward, the study recommends:

- Continued reforestation effort to attain the target of 30% forest cover by 2020;
- A comprehensive forest inventory and assessment of trees outside forest;
- Establishment of a forest cadastre linked to a Geographic Information System (GIS) that would ensure that all classified forests are well managed and monitored;
- Introduce more incentive schemes including financial credit systems and special clearance of forest products and equipment;
- Improvement of the recording system of forestry business through capacity building of forest actors including both public and private institutions on the relevance of a good recording system;
- Quick conclusion of the revision and updating of the forest legislation with immediate effective implementation;
- Revision of the forest fiscal system and ensure equitable and transparent taxation system at all levels;
- Introduction of limited industrial activities such as wood based panel plants, timber treatment plants, revival of the match production plant, modern sawmills and ecotourism;
- Development of human resources capacity in terms of quality and quantity and the creation of a fully-fledged forestry vocational training centre; and,
- Launching and up-scaling of forest carbon trade projects in the country.

1. INTRODUCTION

1.1 Background information

Rwanda is a small, landlocked country in Central Eastern Africa. It is located between latitudes 1°04' and 2°51' South and longitudes 28°45' and 31°15' East. The territory of Rwanda covers a surface area of 26 338 km². It borders four countries, viz. the Democratic Republic of Congo (DRC), Burundi, Uganda and Tanzania (Figure 1). The population was estimated at 10.1 million people in 2009 (NISR, 2010) and, therefore, the average population density is 384 people per km², which is one of the highest in the world. The physiological density (people per area of arable land) is even higher, well in excess of 500 people per km² (UNDP and UNEP, 2006).

Rwanda is known as the “*land of a thousand hills*” as its terrain is characterized by steep slopes and green hills with an altitude ranging from 900 to 4 507 m above sea level. The highest point on Mt Karisimbi is 4 507 m a.s.l. Rwanda has volcanic mountains in the northern fringe and undulating hills in most of the central plateau. However, the eastern part of the country is relatively flat with altitudes slightly below 1 500 m. This topographic pattern gives Rwanda a mild and cool climate that is predominantly influenced by altitude. Average annual temperatures are about 18.5°C and average rainfall is about 1 250 mm annually.

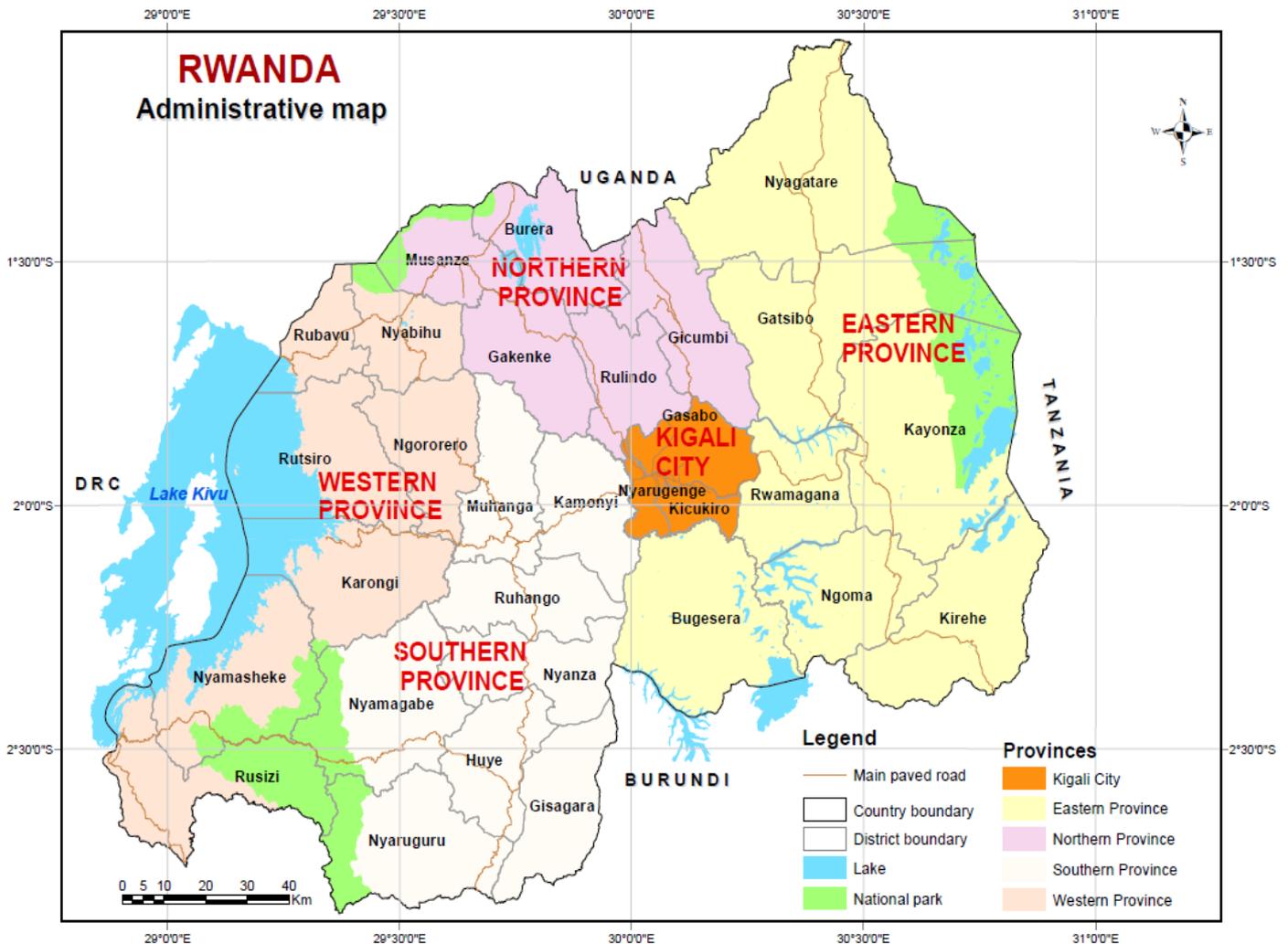


Figure 1: Administrative map of Rwanda (Source: CGIS-NUR).

One of the major problems facing the environment of Rwanda is the ever growing population pressure on natural resources (USAID, 2008). This is evidenced in various forms of land degradation, soil erosion, deforestation, loss of biodiversity and pollution (MINITERE, 2004). Natural forest areas declined by 65% during the period from 1960 to 2007 (ROR, 2010). Currently most of the remaining natural forests are protected either as national parks or as protection forest reserves. A dramatic reduction of forest cover in Rwanda occurred as a consequence of the anarchy following the genocide of Tutsi, state collapse and breakdown of law and order in 1994, and the aftermath demand for wood for reconstructing the country (ROR, 2010). In 2007, a satellite-based mapping of forest areas equal or greater than 0.5 ha with crown coverage of more than 10% and tree height greater than 7m, reported a forest cover of c. 240 700 ha which is approximately 10% of the country's area. Small woodlots, scattered agroforestry and other managed trees below 0.5 ha were not included in the inventory. These forest resources are currently estimated to cover c. 222 500 ha equivalent of conventional forests. Therefore, the official forest cover of Rwanda is estimated at 21% of the country's area, consisting of 8% natural and 13% manmade forest (ROR, 2010).

The economy of Rwanda is predominantly agricultural. In fact, agriculture is the main source of income for 87% of the population (MINAGRI, 2006) and it is estimated to contribute about 40% to Gross Domestic Product (GDP) and 30% to export earnings (USAID, 2008). The GDP per head was estimated at Rwf 296 000 (c. US\$ 520) at the nominal exchange rate in 2009 (NISR, 2010). The majority of farmers are subsistence farmers, although some earn a portion of their income from cash or commercial crops such as bananas (the most popular cash crop), coffee, tea and pyrethrum and cattle husbandry. Fish is also a source of income in the lake region in the eastern parts of the country. Health statistics deteriorated badly in the 1990s as a result of war and the genocide that culminated in 1994. However, there have been significant improvements in health service delivery, particularly after the introduction of a mandatory subsidised mutual health insurance system for all citizens (WHO, 2008).

1.2 Objectives of the study

The specific objectives of the study are as follows:

- (i) Undertake a study of the current public and private forest plantations situation, specifically with respect to the distribution and location of these plantations, species planted and sources of seedlings and seeds, age distribution of tree species, their management and quality of stands, and other features;
- (ii) Undertake market surveys to determine supply scenarios and demand projections of plantation wood volumes (by tree species, private and public sources), including prices of local and imported timber and wood products and sources of such products, for 2015, 2020, 2025, and 2030;
- (iii) Evaluate the current revenue collection systems, revenues collected annually during the last 5-10 years, licensing/concession procedures, forest and tree tenure, management arrangements and pricing mechanisms for roundwood and industrial forest products;
- (iv) Provide income and employment data during the last 5-10 years and estimate the potential for income generation and employment creation for 2015, 2020, 2025, and 2030;
- (v) Evaluate and propose incentives that could favour rapid forest plantation establishment by public and private sectors, and outgrower schemes by individual farmers. In this case, consideration should also be given to:
 - ❖ Availability of appropriate land;
 - ❖ Availability of quality germplasm;
 - ❖ Financing for plantation forestry;
 - ❖ Private sector readiness in plantation forestry;
 - ❖ Policy and environmental issues, including land and forest and tree tenure issues, biodiversity considerations, and legislation and governance issues; and,
 - ❖ Potential for additional revenues from carbon trade.

- (vi) Provide options for establishment, expansion and improved management of public and private forest plantations, including ways to overcome existing and potential constraints;
- (vii) Evaluate the processing of industrial round wood from the plantations in the individual countries, ownership, its current and potential capacity, wood raw material supply (sources, types, and adequacy), product lines and quality of produce, potential for future investment in the sub-sector, constraints facing the sub-sector, future of the processing industry, growth and constraints, among other key considerations; and,
- (viii) Make a presentation, based on this work, in a workshop that will be organised by the African Forest Forum (AFF).

1.3 Scope and coverage

This is an in-depth study to characterise and document information on current status, challenges, opportunities and options for future management of forest plantations in Rwanda. Key aspects covered include the evaluation and analysis of:

- (i) the current public and private forest plantations situation;
- (ii) surveys of wood products market and wood processing industries;
- (iii) current licensing and revenue collection systems, management arrangements and pricing mechanisms for roundwood and industrial forest products;
- (iv) current income and employment and potential for future income generation and employment creation;
- (v) incentives that could favour rapid forest plantation establishment by public and private sectors, and outgrowers schemes by individual farmers;
- (vi) options for establishment, expansion and improved management of public and private forest plantations; and,
- (vii) processing of industrial round wood from forest plantations and its current and potential capacity.

1.4 Approach of the study

The approach of the study consisted of data collection from various sources including several publications and reports on all aspects outlined in the specific objectives, national market surveys of wood products, supply and demand scenarios and interviews with key informants including forest professionals and various central and local government authorities. The targeted entities for gathering forestry statistics included Ministries, Government agencies, National Bank, forest projects, wood processing plants, wood products businesses, workshops and various non governmental organisations (NGOs) involved in environmental protection and conservation.

1.5 Structure of the report

An introductory Chapter 1 gives the background about forest plantations in the country. Thereafter, the report is divided as follows:

- Chapter 2 gives the current situation of forest plantations in the country;
- Chapter 3 describes the status of out-grower schemes and other woodlots;
- Chapter 4 explores forest and tree tenure systems in the country;
- Chapter 5 analyses the financial and human resources for plantations and out-growers or woodlots;
- Chapter 6 looks into incentives for plantation establishment in the country;
- Chapter 7 analyses the supply and demand of forest products;
- Chapter 8 deals with forest revenues systems;
- Chapter 9 deals with produce processing issues;
- Chapter 10 assesses socio-economic and environmental contributions of forests in the country; and,
- Chapter 11 provides conclusions and recommendations as a way forward.

2. FOREST PLANTATIONS SITUATION

2.1 Historical background

The people of Rwanda had the tradition of planting some indigenous tree species, e.g. *Ficus thoningii*, *Euphorbia tirucalli*, *Erythrina abyssinica*, *Vernonia amygdalena*, *Dracaena afromontana*, etc., around household compounds (urugo). However, major reforestation efforts with woody perennials for timber, energy generation or other services, date from 1920 to 1948 (Twagiramungu, 2006). During this colonial period, the target was to afforest one ha of woodland for every 100 persons. By independence in 1962, about 20 000 ha of communal land had been afforested mainly with *Eucalyptus* species. The launching of the Kibuye Pilot Forestry Project (PPF) in 1967, with funding from Switzerland, marked the beginning of true forestry practices in the country. By 1976, PPF had established more than 5 000 ha of forest plantations (FAO, 2002).

The alarming degradation of forest cover and encroachment of natural forests observed during the 1970s due to population pressure, led to the creation by decree of the Rwanda Office of Tourism and National Parks (ORTPN) in 1974 (FAO, 2002). This office was charged to ensure the protection of all national parks and to manage tourist activities in parks. The development of tourism today and effective protection of the remaining natural vegetation in the country can be mainly attributed to the efforts made by ORTPN since its establishment in 1974. In fact, currently almost all the remaining natural forests are under protected area management.

Intensive reforestation efforts were carried out between 1975 and 1990. Actually, 1975 marked a turning point in the practice of forestry in Rwanda, with major reforestation campaign and launching of large scale development projects, each with a major forestry and agroforestry component. The compulsory community works ("*Umuganda*") launched in 1975, and the annual National Tree Planting Day institutionalised in 1976 helped to mobilise the population for tree planting activities. As a result, the forest plantation area rose from 25 500 ha in 1975 to 247 500 ha in 1989 (FAO, 2002). Major donors to forest projects during the period 1975-1990 included the World Bank, the European Union and Switzerland through the Swiss Development Agency (SDA) and INTERCOOPERATION. The main objectives of most forest plantations established during this period were protection of vulnerable soils against erosion, reduction of pressure over the remaining natural forests and protected areas (buffer zone) and fuelwood supply to an ever growing population.

The law no. 47/1988 organising the forest regime in Rwanda was enacted in 1988 but due to the war that broke out in 1990 and culminated in 1994 this law was never adequately implemented. From 1989 to 1993, there were a number of projects to establish public and private forest plantations with free distribution of tree seedlings from forest nurseries. Forestry activities were suspended from 1993 to 1995, and a number of forests (both natural and plantations) were completely destroyed by displaced people fleeing the war and later on for new settlements for the returning refugees. Between 1995 and 1999, forestry activities resumed on a modest scale with the resumption of the national tree planting day and of some NGOs and small projects involved in reforestation and tree seedling production. However, from 1999 onwards, seedlings were distributed freely to peasant farmers, which helped to increase the area under private forest plantations. The launching in 2003 of the Forest Management Support Project (PAFOR) funded by the African Development Bank (ADB), the first National Forest Policy of 2004, the creation of the National Forestry Agency (NAFA) in 2008, the launching of the new forest support project (PAREF) funded by the Netherlands and Belgium; and the adoption of the National Forest Policy in 2010 have greatly boosted the forestry sector in Rwanda in recent years. *Table 1* shows major events that have marked forestry practice in Rwanda since the 1970s (LTS, 2010).

Table 1: Timeline of major influences on forestry development since 1976. Sources: ROR (2004); LTS (2010).

Year	Event	Status in May 2011
1976	Institutionalisation of the National Tree Planting Day	Now Annual Tree Planting Week
1981	Creation of General Directorate of Forestry in the Ministry of Agriculture	No more
1984	Action Plan for the conservation and management of the Zaire–Nile Ridge natural forests	-
1986	Elaboration of a Ten-year Forest Plan (1986-1997)	To be revised (tendered)
1988	Promulgation of the first forestry law	Being revised
1989	Creation of the National Forest Fund (FFN)	Operational
1993	Creation of the Commission for the Congo-Nile Ridge Natural Forests	Inexistent
1994	Genocide, interruption of forest project activities and repatriation of donors	-
1996	Afforestation activities with the National Tree Planting Day resumed	-
1999	Revision of the technical guide for Forest Management at district level	-
2000	Institutionalisation of the National Tree Planting Week	Annually fixed
2000	Ministerial order (MINAGRI) to stop tree harvesting in all public forests	Still in force
2002	Creation of the Forest Protection Service by a Prime Minister order	Under NAFA
2002	Appointment of the Minister of State for Forestry	No more
2002	Rwanda Forest Management Support Project (PAFOR) was launched (ADB funding)	Ended in 2009
2003	A ministerial order (MINAGRI) on the procedures governing the public forest management contracts was issued	Never implemented
2003	Transfer of Directorate of Forestry to MINITERE	Now NAFA
2004	Adoption of the first National Forestry Policy	Updated in 2010
2004	Ministerial order (MINITERE) to ban brick making using fuelwood	Still in force
2006	Ministerial order (MINITERE) to decentralise the process of issuing of permits for harvesting, transport and commercialisation of forest products	Partially still in force
2008	Rwanda Reforestation support programme (PAREF) launched (Netherlands and Belgium funding)	On going
2008	Creation of the National Forestry Authority (NAFA)	-
2009	Creation of the Ministry of Forestry and Mines (MINIFOM)	Now merged in MINIRENA
2010	New National Forestry Policy	-

2.2 Location, areas and species composition

2.2.1 Location and climatic conditions

There is a high concentration of forest plantations in the western parts of Rwanda along the ridge dividing waters of the Congo and Nile rivers. The region is extremely mountainous with altitude ranging from 1 700 to 3 000 m and average annual rainfall up to 1 500 mm. With the exception of the National Park of Akagera, all other protected areas are located in the west of Rwanda (*Table 2*). Most forest plantations in western Rwanda were established to address the dual objectives of protecting vulnerable soils against erosion and reducing pressure over protected areas (buffer zone). *Table 3* provides the location, establishment period and site conditions of major forest plantations in Rwanda. *Figure 2* indicates agro-ecological regions delineated using altitude, rainfall and soil types variations.

Table 2: Protected areas in Rwanda. Sources: GAT (2008), RDB (2011).

Name	IUCN category	Management responsibility	Date established	Area (km ²)
Akagera National Park	I	African Parks Network	1934	1 085
Nyungwe National Park	I	RDB	2004	970
Volcano National Park	I	RDB	1929	160
Gishwati Forest Reserve	IV	NAFA	1933	10
Mukura Forest Reserve	IV	NAFA	1933	16

Note: IUCN category I = National Park; category IV = Habitat/Species Management Area.

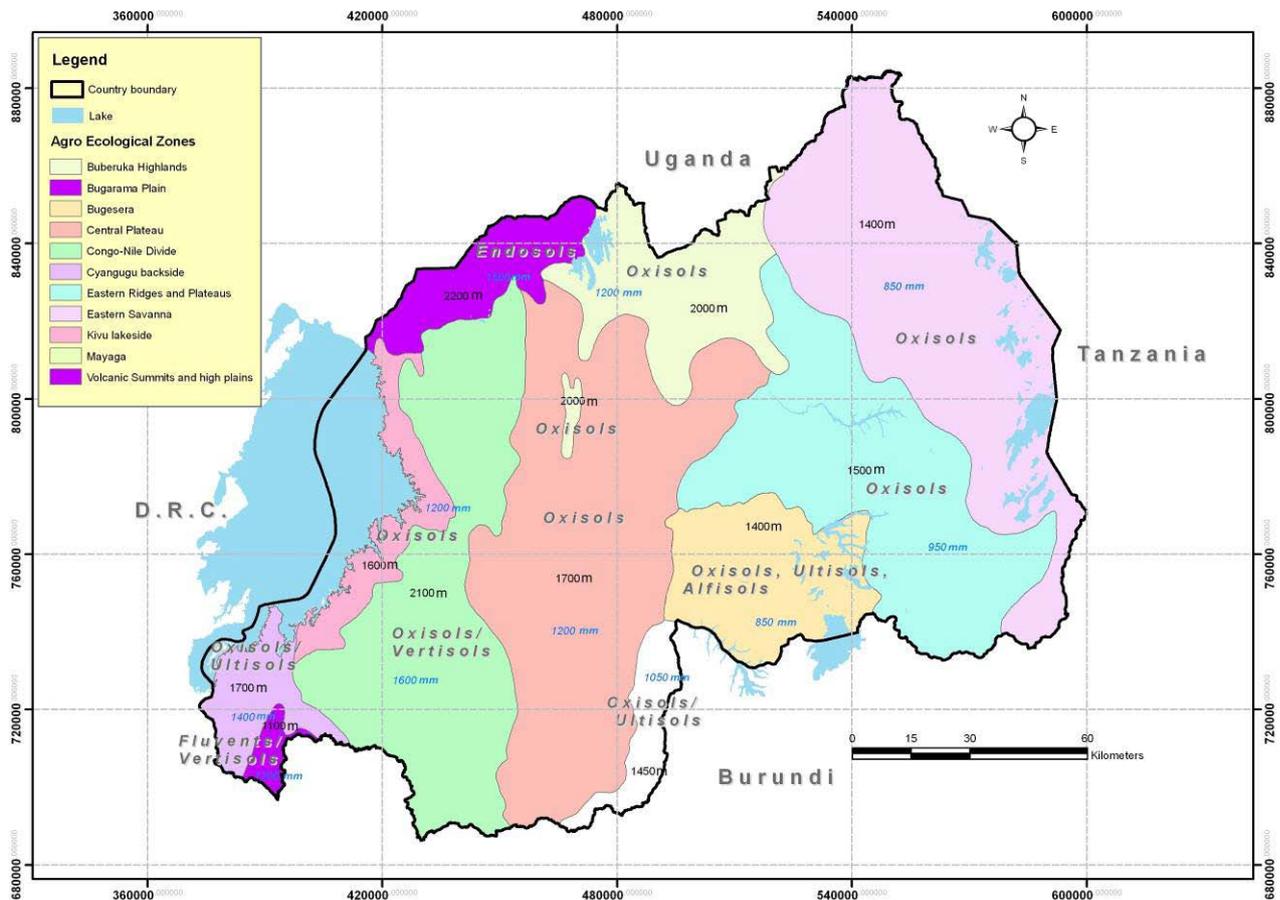


Figure 2: Map of Rwanda showing agro-ecological regions, soil types, average altitude and average rainfall (Mutanganda *et al.* 2010).

Table 3: Location, establishment period and site conditions of major forest plantations. Sources: Barbier (1992), NAFA staff (pers. communication); MINAGRI, MINITERE& MINIRENA reports (various years), Project reports (UGZ1, 2, 3, 4, 5 annual reports); PAFOR and PAREF annual reports (2011).

Forest plantation / management unit	Year established	Altitude range (m)	Mean annual rainfall (mm)	Soils	Accessibility
Public plantations					
Nyungwe buffer zone: UGZ1 (Swiss) UGZ2 (EU) UGZ3 (WB) UGZ4 (EU)	1986-1992 1983-1992 1987-1992 1987-1992	1 700-3 000	1 400-1 500	Soils derived from schistose, sandstone and quartzite formations	Mostly difficult
Mukura buffer zone UGZ5 (Swiss)	1983-1993	1 900-3 000			
Gishwati buffer zone UGZ6 (WB)	1981-1993	1 900-3 000			
PPF and ASFPK projects (Swiss)	1973-1992	2 000-3 000			
GBK project (WB): Gasabo-Kicukiro-Rulindo-Rwamagana Districts	1980-1992	1 500-2 000	1 000-1 200	Soils derived from granite and gneissic formations	Varied (some difficult, others easy)
Gatsibo District	1980-1992	1 200-1 800	1 000		
Muhanga District	1980-1992	1 500-2 000	1 200- 1 300	Soils derived from granite and gneissic formations	
Huye District (Mt Huye)	1980-1992	1 500-2 500			
DRB project (IFAD)	1983 -	2 000-2 500			
Gakenke-Burera Districts (CARE International)	1999 - 2002	2 200-2 500			Difficult
PAFOR Project (ADB)	2003 - 2009	1 000-3 000	800-1 500	-	Varied (some difficult, others easy)
PAREF project (Belgium & Netherlands)	2008 – 2010	1 200-1 500	900-1 300	Soils derived from granite and gneissic formations.	Easy
ISAR Arboretum	1934 - 2010	1 638-1 728	1 232		
Private plantations					
Gisovu Tea Factory	1982 -.....	2 300-2 500	1 500	Soils derived from schistose, sandstone and quartzite formations	??
Nyabihu Tea Factory	-				Easy access
Pfunda Tea Factory	-	2 000-2 200	1 200	Soils derived from schistose, sandstone, volcanic formations	Difficult
SORWATHE Tea Factory	-	2 200-2 500	1 400	Soils derived from granite and gneissic formations	Difficult to easy access

Note: In brackets (e.g. WB, Swiss, ADB) are funders

2.2.2 Location, areas, ownership and species composition

Statistical information on forest cover in Rwanda is varied and contradicting figures are reported by several authors, mainly because no thorough forest inventory has ever been carried out in the country (SSEE & ROR, 2011; ROR, 2010; FAO, 2002, 2005, 2010; GTZ, 2008; etc.). The first national forest inventory was carried out in 2007 by Agricultural Research Institute of Rwanda (ISAR) and Centre for Geographic Information Systems of the National University of Rwanda (CGIS-NUR) and involved only forest areas larger than 0.5 ha due to relatively low resolution of the satellite images used [Landsat (30 m), Aster (15 m) and SPOT (10-20 m)] and financial constraints (MINIRENA/CGIS-NUR, 2007). This inventory was therefore incomplete because it left out smaller woodlots (< 0.5 ha). In a recent study, FAO (2010) reported that small woodlots and tree resources outside forest (TROF) cover around 6.6% of the country's land area. The forest mapping also considered only forested areas with more than 10% crown cover and tree height greater than

7 m (MINIRENA/CGIS-NUR, 2007). *Table 4* shows the forest cover areas as mapped by CGIS-NUR in 2007 and *Figure 3* illustrates the forest cover map (≥ 0.5 ha; 10% crown cover with trees greater than 7 m height) of Rwanda in 2007.

Table 4: Forest cover areas in 2007 (≥ 0.5 ha; 10% crown cover, > 7 m height). Source: MINIRENA/CGIS-NUR (2007).

Forest Classes	Area (ha) (rounded to nearest 100 ha)
Natural forests	125 900
Bamboo forest	4 400
Degraded natural forest	38 000
Humid natural forest	79 800
Savannah	3 700
Plantations	114 900
Eucalypts plantations	63 600
Young plantations and coppice	39 200
Pine plantation	12 100
Total	240 800

There are no large size private or commercial forest plantations in Rwanda. As shown in *Table 3*, most of the large forest plantations belong to the state because they were established by projects funded by various donors or international financial institutions. However, there are several small private plantations scattered throughout the country which are owned by farmers and institutions such as private companies (mainly tea factories), religious and education institutions. According to Biomass Energy Strategy (BEST) survey, 89% of traded wood in Rwanda comes from forest plantations of less than 2 ha (GTZ, 2008).

Taking into account the areas classified as protected areas but which did not satisfy the definition of a forest in the 2007 forest inventory, the tree resources outside forests and woodlots below 0.5 ha (estimated by FAO in 2010 to cover 6.6% of the country's total area), and the recent forest plantations established by the PAFOR and PAREF projects, which were not inventoried earlier (most recent satellite images used was dated early 2005), the overall forested areas in Rwanda by 2010 are as shown in *Table 5*.

There is no reliable statistics on forest ownership, species and age distribution. But, based on personal communication with staff of the National Forest Authority (NAFA), other Foresters and scattered patchy records on forest plantations made since the 1970s in the country, *Table 6* has been compiled for 2010. *Table 7* presents the age distributions for a few forest plantations for which age records were found during data search.

The dominant species in forest plantations are Eucalypts including *E. globulus*, *E. maidenii*, *E. grandis*, *E. saligna*, *E. camaldulensis*, *E. tereticornis*, *E. maculata*, *E. dunnii*, *E. microcorys* and several hybrids. In fact, Eucalypts have become naturalised in the country and there are so many hybrids that it is difficult to identify with 100% certainty the exact types of Eucalyptus species found in Rwanda. Moreover, many farmers obtain seedlings from eucalypts wildlings.

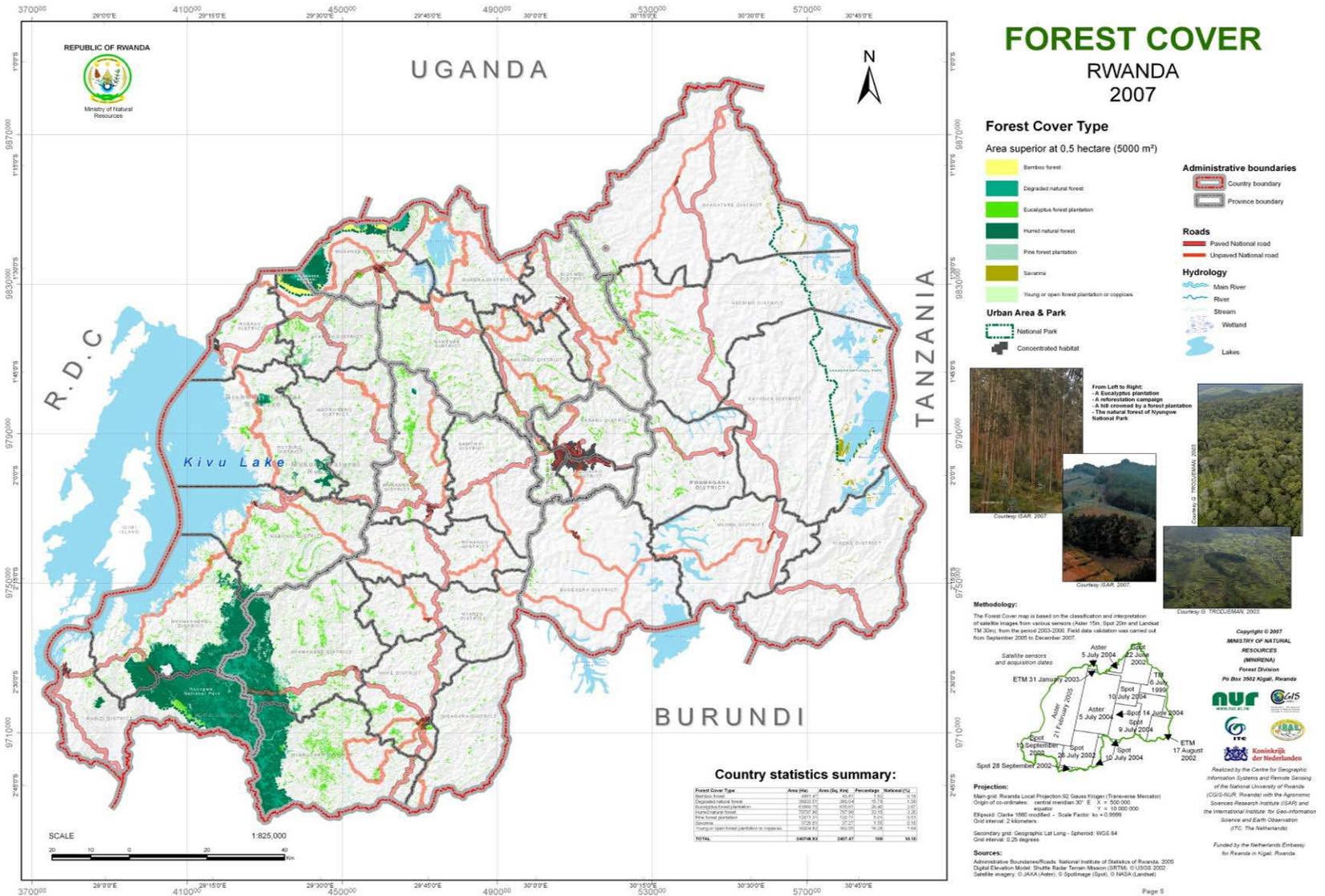


Figure 3: Forest cover map (≥ 0.5 ha; 10% crown cover and trees >7 m height) of Rwanda (2007) (MINIRENA/CGIS-NUR, 2007).

Table 5: Overall forest areas in 2010. Sources: MINIRENA/CGIS-NUR (2007), FAO (2010), RDB (2010), PAFOR and PAREF reports (2011).

Forest classes	Area (ha) (rounded to nearest 100 ha)
Protected areas	224 000
Akagera National Park	108 500
Nyungwe National Park	97 000
Volcano National Park	16 000
Gishwati Forest Reserve	1 000
Mukura Forest Reserve	1 600
Plantations	301 500
Eucalypts plantations	63 600
Young plantations and coppice (mainly <i>Eucalyptus spp.</i> and <i>Acacia spp.</i>) *	62 700
Softwood plantation (<i>Pinus spp.</i> , <i>Cupressus spp.</i> And <i>Callitris spp.</i>)	12 100
Woodlots and tree resources outside forests (<i>Eucalyptus spp.</i> , <i>Grevillea spp.</i> , <i>Pinus spp.</i> , <i>Cupressus spp.</i> ; <i>Callitris spp.</i> , <i>Acacia spp.</i> , <i>Alnus spp.</i> , <i>Casuarina spp.</i>)	162 800
Total	525 500

Note: MINIRENA/CGIS-NUR (2007) plus young plantations by PAFOR (16 764 ha) and PAREF (6 747 ha).

The dominant softwood timber species is *Pinus patula*. However, there are a few plantations with other *Pinus* species such as *Pinus oocarpa*, *P. radiata*, *P. elliottii* and *P. kesiya*. The other softwood timber species (but also for household fencing) that was abundant before the attack by *Cinara cupressii* aphids in 1988 is *Cupressus lusitanica*.

Other exotic species frequently found either in pure or mixed plantations and agroforestry include: *Acacia melanoxylon* (most abundant in plantation), *Callitris robusta*, *Grevillea robusta* (mainly in agroforestry), *Casuarina equisetifolia*, *Cedrela serrata*, *Alnus acuminata*, *Maesopsis eminii*, *Acacia mearnsii* and recently in agroforestry systems *Senna spectabilis*, *Senna siamea*, *Leucaena leucocephala*, *Croton megalocarpus* and *Calliandra calothyrsus*.

Some of the indigenous species in plantations include *Entandrophragma excelsum*, *Podocarpus falcatus*, *Markhamia lutea* (or *platyalix*), *Symphonia globulifera*, *Polyscias fulva* and *Prunus africana*.

Table 6: Forest plantation areas (ha) by ownership, species and management objectives in 2010.

Forest plantation/management unit	Total area	Timber area	Fuel-wood area
Nyungwe buffer zone: UGZ 1 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>Eucalyptus spp.</i> , <i>indigenous spp.</i>)	5 066	4 914	152
UGZ 2 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>Eucalyptus spp.</i> , <i>indigenous spp.</i>)	3 896	3 779	117
UGZ 3 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>Eucalyptus sp.</i> , <i>indigenous spp.</i>)	2 271	2 203	68
UGZ 4 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>Eucalyptus spp.</i> , <i>indigenous spp.</i>)	822	797	25
Mukura buffer zone UGZ 5 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>indigenous spp.</i>)	645	626	19
Gishwati buffer zone (GBK project) UGZ 6 <i>Pinus spp.</i> , <i>Cupressus spp.</i> Others (<i>A. melanoxylon</i> , <i>Eucalyptus spp.</i> and <i>indigenous spp.</i>)	3 342	3 242	100

PPF and ASFPK projects <i>Pinus spp.</i> , <i>Cupressus spp.</i> , <i>Callitris spp.</i> <i>Eucalyptus spp.</i>	10 500	9 450	1 050
GBK project Gasabo-Kicukiro-Rulindo-Rwamagana <i>Eucalyptus spp.</i> , <i>Pinus spp.</i> , <i>Callitris spp.</i> Gatsibo <i>Eucalyptus spp.</i> and <i>Pinus spp.</i> Muhanga (ex-Rutobwe) <i>Eucalyptus spp.</i> Huye (Mt Huye) <i>Eucalyptus spp.</i> , <i>Callitris spp.</i>	3 500 2 600 550 3 000	2 800 1 300 550 300	700 1 300 550 2 700
DRB project Gicumbi ex-Kiyombe, Bwisige, Mukarange <i>Eucalyptus spp.</i> , <i>Pinus spp.</i> , <i>Callitris spp.</i>	5 000	1 000	4 000
ISAR Ruhande Arboretum 206 local and exotic species with 69 <i>Eucalyptus spp.</i>	200		
CARE International Gakenke-Burera <i>Eucalyptus spp.</i>	700		700
PAFOR Project Kamonyi, Muhanga and Ruhango <i>Pinus spp.</i> , <i>Callitris spp.</i> , <i>Eucalyptus spp.</i> , <i>A. mearnsii</i> Bugesera <i>Eucalyptus spp.</i> ; <i>Grevillea spp.</i> Nyagatare, Kayonza <i>Eucalyptus spp.</i> , <i>Grevillea spp.</i> , <i>Callitris spp.</i> , <i>Jacaranda mimosifolia</i> Gishwati (Nyabihu, Ngororero, Rutsiro, Rubavu) <i>Pinus spp.</i> , <i>Eucalyptus spp.</i> , <i>A. melanoxyton</i> , <i>indigenous spp.</i> Nyamasheke, Rusizi <i>Pinus spp.</i> , <i>Eucalyptus spp.</i> , <i>A. melanoxyton</i> Nyamagabe and Nyaruguru <i>Pinus spp.</i> , <i>Eucalyptus spp.</i> , <i>A. melanoxyton</i>	1 890 3 900 4 095 2 779 1 600 2 500	189 1 560 1 638 834 320 250	1 701 2 340 2 457 1 945 1 280 2 250
PAREF project <i>Eucalyptus spp.</i> Others	6 747	675	6 072
Sub-total	65 603	35 877	29 526
Gisovu Tea Factory (<i>Eucalyptus spp.</i>) Nyabihu Tea Factory (<i>Eucalyptus spp.</i>) Pfunda Tea Factory (<i>Eucalyptus spp.</i>) SORWATHE Tea Factory (<i>Eucalyptus spp.</i>)	340 354 364 1 000		340 354 364 1 000
Sub-total	2 058		2 058
Out-grower / Other woodlots <i>Eucalyptus spp.</i> , <i>Grevillea spp.</i> , <i>Pinus spp.</i> , <i>Cupressus spp.</i> , <i>Callitris spp.</i> , <i>Acacia spp.</i> , <i>Alnus spp.</i> , <i>Casuarina spp.</i> , <i>Persea spp.</i> , etc. (75% of TOFs)	122 117	12 212	109 905
Sub-total	122 117	12 212	109 905
Grand Total (rounded to nearest 100 ha)	189 800	48 100	141 500

Notes: All *Pinus spp.*, *Cupressus spp.*, *Callitris spp.*, *Grevillea spp.* were considered for sawn timber while *Eucalyptus spp.* and other species were mainly fuelwood even though some of them (including even *Eucalyptus*) may be sawn.

Not all plantations are included in Table 6. Only those plantations for which information was found are provided.

Gishwati buffer zone UGZ6 (3 342 ha) - <i>Pinus patula</i> - <i>A. melanoxylon</i> - <i>Cupressus spp.</i> - <i>Eucalyptus spp</i> - <i>P. radiate</i>	2052 - 74 82 28		26 9 23 4 -		16	33	89	6 345	150 250	150 250									
PAFOR Project (mainly <i>Eucalyptus</i>) (16 764 ha)												3 665	1 321	1 693	1 545	1 260	3 105	2 247	
PAREF project Netherlands/Belgium: <i>Eucalyptus, Grevillea; Alnus acuminata, Acacia melanoxylon</i> (6 747 Ha)																	326	508	5 913

Notes: Not all plantations are included in this Table. Only those plantations for which information on age was found are provided in Table 7.

There is no statistics on encroachments and excisions of forest plantations in recent years. Generally, excessive encroachments were experienced in the 1990s during the war which culminated in the genocide of 1994 and afterwards during settlement of returning refugees in 1995-1997. Fortunately, most of the forest plantations that were clear-felled regenerated because they were mainly made up of *Eucalyptus* species. However, some of the protected areas were invaded leading to loss of about 2/3 of the Akagera National Park and almost all of the Gishwati Natural Forest Reserve (Figure 4). Currently, the situation has stabilised and due to increased law enforcement, no encroachment and excision have been reported in recent years.

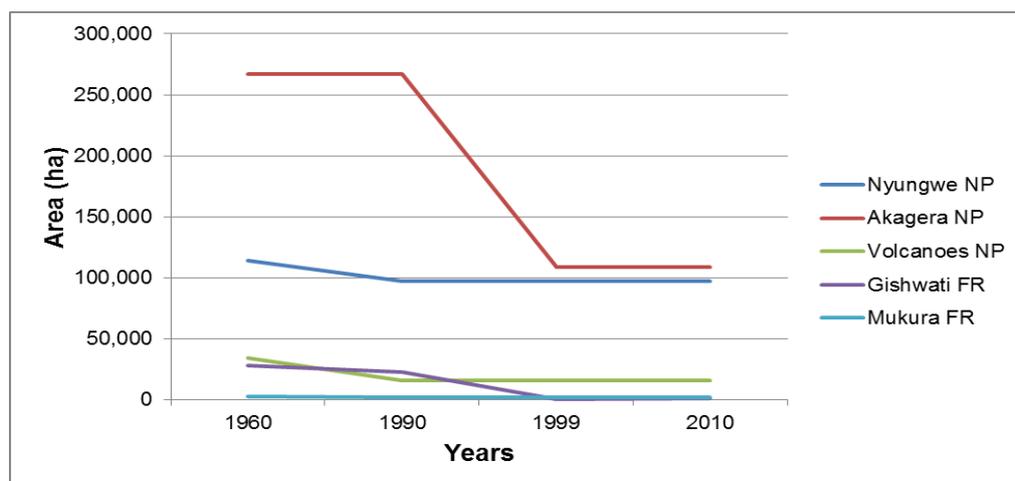


Figure 4: Protected areas change since 1960. Sources: REMA, 2009; ROR, 2009; Habiyaemye *et al.* 2011.

2.3 Plantation management

2.3.1 Establishment

In Rwanda, mainly due to shortage of arable land and environmental concerns, forest plantations are generally established on marginal sites, around rivers and lakes, along roads and in the buffer zones of protected areas. In general however, any land which is not utilized and not apt for agriculture, pasture, shelter and recreation is often considered as potential afforestation site. Marshlands are excluded from forest plantation areas due to their fragile nature and special conservation status in the country.

In early years of forest plantation establishment in the country each project or forest company had to import their seeds from varied sources. Tree seeds were imported from various countries including Australia, Brazil, South Africa, Burkina Faso, Ethiopia, Kenya, Tanzania and others. Although, some seeds are still imported, since the creation of the tree seed centre called CGF (*Centrale de Graines Forestières et Agroforestières*) in 1978, most tree seeds used in public and forest projects nurseries are supplied by CGF. In fact this tree seed centre which is managed by ISAR has been mandated to collect locally and to import quality seeds for supply to individuals, private and public institutions in Rwanda and outside the country. *Table 8* shows the quantity of seeds supplied by CGF from 1990 to 2009 while *Figure 5* illustrates the distribution of supplied seeds per customer from 1990 to 2009.

Table 8: Quantity of seeds supplied by CGF from 1990 to 2009. Source: CGF (ISAR Ruhunde).

Species	Amount of seed sold kg	Price US\$/kg	Species	Amount of seed sold kg	Price US\$/kg
<i>Grevillea robusta</i>	13 025	45	<i>Pinus spp</i>	320	69
<i>Alnus accuminata</i>	1 059	79	<i>Eucalyptus spp</i>	1 728	13
<i>Cedrela serrata</i>	3 421	23	<i>Terminalia menthalii</i>	946	19
<i>Maesopsis eminii</i>	25 701	2	<i>Mimosa scabrella</i>	175	60
<i>Moringa oleifera</i>	2 132	27	<i>Spathodea campanulata</i>	131	79
<i>Calliandra calothyrsus</i>	11 611	5	<i>Cupressus lusitanica</i>	701	13
<i>Leucaena spp</i>	5 043	10	<i>Markhamia platycalyx</i>	1 054	7
<i>Podocarpus falcatus</i>	7 006	4	<i>Polyscias fulva</i>	500	15
<i>Senna spp</i>	2 525	11	<i>Sesbania spp.</i>	1 366	5
<i>Jacaranda mimosaefolia</i>	1 072	22	<i>Croton megalocarpus</i>	514	13
<i>Casuarina equisetifolia</i>	1 008	23	<i>Acacia spp.</i>	268	22
<i>Callitris spp</i>	1 225	19	<i>Entandrophragma sp.</i>	131	13

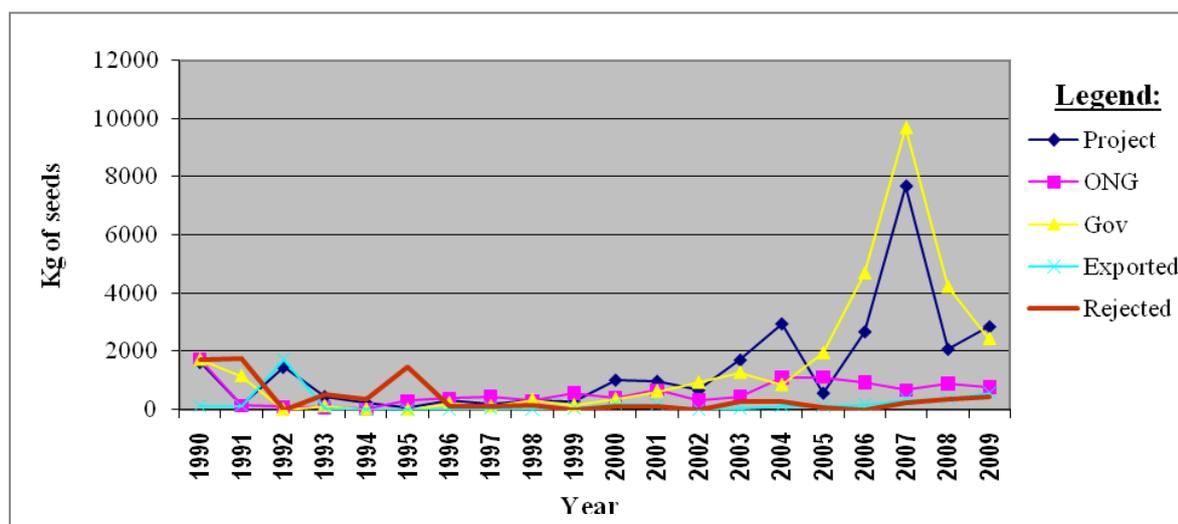


Figure 5: Quantity of seeds supplied by CGF per customer from 1990 to 2009 (ISAR Ruhande).

At country level, CGF has established various seed stands across the country in different agro-ecological zones. Seed cooperatives contracted by ISAR collect tree seeds. After collection, seeds of different tree species are brought to CGF for germination tests in the laboratory (to determine the germination capacity and purity of the tree seeds) and for storage before distribution to customers and conservation of remaining seeds after customer satisfaction. Most of the forest seed collected in the country, both by public and private plantation programmes, are from two categories of seed sources, namely *identified seed sources*, which are stands of trees which have not been subject to selection based on phenotypic characters but are used as seed sources within a seed zone, and *selected seed sources*, which are stands of trees selected for seed production based on superior phenotypes within a seed zone (OECD, 2006; ISAR Ruhande, NAFA staff, pers. communication). Many farmers collect seed from old clear-felled trees regardless of whether the source is known or not.

Even though Rwanda has banned the use of plastic bags, clear polythene tubes are still used in raising tree seedlings. There are many private and public tree nurseries in the country supplying tree seedlings for forest establishment, agroforestry and ornamentals. Open-ended tubes are commonly used to allow for free drainage. Other pots, such as black polythene tubes, are also used by horticulturalists whereas those in banana sheaths are occasionally used by farmers.

The most common soil mixture used in Rwanda is a mixture of topsoil from agricultural fields or forests, sand and compost with variable composition such as follows (Mutaganda *et al.*, 2010):

- For heavy soils: 5 units of topsoil, 3 of manure and 2 of sand;
- For medium textured soils: 6 units of topsoil, 3 of manure and 1 of sand; and,
- For light textured soils: 7 units of topsoil, 3 of manure and 0 of sand.

Various treatments are applied to seeds to reduce seed dormancy so that germination becomes more rapid and uniform. The most common types of seed pre-treatment in Rwanda are soaking in hot or cold water. Two sowing methods are used depending on seed size and time for germination, namely direct sowing into containers (filled pots) for large size seeds (e.g. Avocado, Mango, *Acacia*, etc.) and sowing into seedbeds (broadcast sowing) for smaller sized seeds (e.g. *Eucalypts*, *Casuarina*, *Alnus*, etc.). Other standard nursery practices include regular watering, pricking out of seedlings sown in seedbeds, weeding, shading, root-pruning, hardening off and grading before transportation to planting site.

Land preparation prior to tree planting normally involves clearing all unwanted vegetation. Since labour is abundant, land clearing is normally done manually. In Rwanda, vegetation removal by slash and burning is prohibited since the latter may induce rapid alteration in fragile soil properties. In fact, the ash layer following burning, which is rich in nutrients (exchangeable bases), is often

washed down after the first rain. If preparation of planting site require cutting of degraded standing trees, as is the case in old coppices of Eucalypts, stumps are eliminated either by debarking them completely or by covering firmly the notch of the stump with the grasses to avoid coppicing, or simply by digging out the stumps when funds allow.

The decision on tree spacing is one of the most fundamental one in the establishment of forest plantations because it is correlated to the success of the plantation regarding maintenance, stand stability, quality of wood and investment. Spacing varies with species, site, and the purpose of the plantation (Mutaganda *et al.*, 2010). Common practice is closer spacing in fuelwood plantations and wider spacing in timber plantations. Wider spacing is common in arid areas of Eastern Rwanda. The most common initial spacings practiced in Rwanda are:

- 2.0 m x 2.0 m with 2500 seedlings per ha (for fuelwood production);
- 2.5 m x 2.5 m with 1600 seedlings per ha (for timber or fuelwood production in drier areas); and,
- 3.0 m x 3.0 m with 1111 seedlings per ha (for timber or fuelwood production in drier areas).

Planting is generally done during the short rainy season (October-November) and the long rainy season (March-May). Two types of planting stock are normally used: bare-rooted plants, particularly used in good soils and high rainfall (Congo-Nile Ridge) and potted plants. Planting pit dimensions recommended are 40 cm x 40 cm x 40 cm. However, these dimensions are respected only in controlled plantation projects. Smaller sizes are often used by farmers leading to poor survival rate and/or poor early growth development.

In fact, each year, particularly during the tree planting week held annually during the October-December planting season, millions of seedlings are distributed and planted by all Rwandans in the "umuganda" community works. In the period 1995 to 2010, the national forestry service produced on average 23-24 million plants per year, which hypothetically would have been sufficient to establish between 12 500 and 15 000 ha of plantations per year (assuming a spacing of 1 600 plants/ha) (NAFA report, 2011). However, due to poor monitoring and planting methods, the survival rates of seedlings planted are always small (often less than 50%).

Beating up is usually done during the next planting season or the next tree planting week. During planning for seedling production, normal practice is to add an extra 10% (in high rainfall areas) to 20% (in low rainfall areas of the East) of plants to cover for beating up.

Prior to the war and the genocide in 1994, forest management activities were regularly performed in most public forest plantations by forest projects which were operational then, particularly in the different management units (UGZ1-6) in the western part of Rwanda around protected areas (buffer zones). All these forest projects stopped in 1994 and since then no management activity is taking place in these plantations. Thus, while weeding, pruning and thinning were regularly done in the past, none of these silvicultural treatments have been performed since 1994 in most of these UGZ 1-6 plantations. Most of these plantations have reached harvesting age but the government has not yet found someone to do it because it has no financial and human resource capacity to manage the plantations effectively. According to NAFA, the government is looking for potential private investors who would purchase and manage concessions from these management units (Bakundukize, pers. communication).

Since 2000, a ministerial order prohibited harvesting in all public forests and, although there is regular intensive annual tree planting (in connection with the 2010 "umuganda" planting, for example, more than 23 000 ha were planted, and in the PAREF project 4 650 ha), there is therefore practically no management activity in most public or state forest plantations. As a result, there is neither coppicing nor replanting area statistics available, except for some of the tea factory plantations. Another result is that all forest products, such as fuelwood (firewood and charcoal), sawn timber and building material, needed in the country are met from harvesting of private forest plantations and imports. GTZ (2008) reported that more than 80% of traded wood in Rwanda come from small private woodlots with less than 2 ha.

2.3.2 Weeding

All weeding operations are executed by teams of casual labourers employed by contracted associations or cooperatives or local NGOs. All tasks are usually done in the form of piece works. Three types of weeding techniques, namely *clean*, *spot* and *line* weeding, are practiced depending on tree spacing and vigour of weeds. *Table 9* provides recommended weeding frequency in Rwanda. In 2009, the two major projects, viz. PAFOR and PAREF, carried out weeding on 5 350 ha and 2 060 ha, respectively.

Table 9: Recommended annual weeding frequency. Source: PPF (1977).

Year no.	For slow growing tree species or on poor soils	For fast growing tree species or on fertile soils
<i>On abandoned grazing land</i>		
1st	2	2
2nd	2	1
3rd	1	Variable, liana cutting where necessary
4 th	Variable, liana cutting where necessary	
5th	Control	
<i>On previous forest land (competing ferns and/or bushes)</i>		
1st	3	3
2nd	3	3
3rd	3	2
4th	2	2
5th	2	-
6th	1	1
7th	1	-
8th	1	1
9 th	1	-
10th	1	-

2.3.3 Pruning

Before 1994, when the management units around the buffer zones in the west of Rwanda were operational, pruning was mainly performed on softwood species including *Pinus spp.* (mostly *Pinus patula*) and *Cupressus lusitanica*. *Table 10* shows the pruning schedules which were followed for the two species in UGZ management units. Currently, no pruning is practically done in public forest plantations. Actually, the Arboretum of Ruhunde managed by ISAR is the only public forest plantation which is technically managed with all silvicultural operations. Private forest owners have no specific pruning schedules.

Table 10: Pruning schedules (Barbier, 1992).

Tree species	1 st pruning		2 nd pruning		3 rd pruning	
	Age (yr)	Pruning height (m)	Age (yr)	Pruning height (m)	Age (yr)	Pruning height (m)
<i>Pinus spp. and Cupressus spp.</i>	3-4	2	After 1 st thinning	5	After 2 nd thinning	20-28

2.3.4 Thinning

There were two thinning models practiced in Rwanda before 1994, after which year practically no thinning has been done in public forest plantations. In private forest plantations no formal thinning schedules are followed. Normally for private forest plantations or woodlots, selective harvesting of individual trees is done depending on market or domestic needs. *Table 11* shows the thinning schedules that were followed for mainly *Pinus patula* in UGZ1 and UGZ2 management units. However, Barbier (1992) recommended the silviculture model presented in *Table 12* for *Pinus patula* plantations.

Table 11: Thinning schedules at UGZ1 and UGZ2. Source: Barbier, 1992.

Tree species	1 st Thinning		2 nd Thinning		3 rd Thinning		Clear felling	
	Age (yr)	Intensity	Age (yr)	Intensity	Age (yr)	Intensity	Age (yr)	Intensity
<i>Pinus patula</i> (UGZ1)	7-10	650	10-14	350	14-19	250	28-38	250
<i>Pinus patula</i> (UGZ2)	5-6	450	9-10	200	13-14	100	25-35	250

Notes:

Initial density: 1600 stems/ha in UGZ1 and 1111 stems/ha in UGZ2

Intensity refers here to removed stock

Table 12: Recommended silvicultural model for *Pinus patula* plantations. Source: Barbier, 1992.

Intervention age (years)	5	8	12	25
Type of intervention	1 st Thinning	2 nd Thinning	3 rd Thinning	Clear felling
Total production (m ³ ha ⁻¹)	50	110	188	397
Thinning percent	50%	40%	24%	-
Extracted volume (m ³ ha ⁻¹)	25	34	31	307
Fuelwood (m ³ ha ⁻¹)	25 (100%)	30 (89%)	23 (75%)	127 (40%)
Timber (m ³ ha ⁻¹)	-	4 (11%)	8 (25%)	180 (60%)

2.3.5 Forest health

In general, there are no forest health threats reported in the country in recent years. The dominant tree species in Rwanda, e.g. *Eucalyptus spp.*, *Pinus patula*, *Grevillea robusta* and *Acacia melanoxylon*, are normally not attacked by diseases and insects. *Cupressus lusitanica* plantations, which were strongly affected by the *Cinara cupressii* aphids in the late 1980s and early 1990s, are so far considered the only vulnerable plantation species in the country. However in some places some plantations (on the Congo-Nile divide) are still resisting the aphids.

Termites are the biggest problem for plantation establishment in most arid areas in the eastern parts of the country. Termite resisting species are therefore recommended there, otherwise tree planting (e.g. of *Eucalyptus spp.*) is normally done with insecticides in order to be successful.

Forest fires were frequent in Rwanda until stringent measures were taken against bush fires in the late 1970s. Thus, the occurrence of fires was considerably reduced in the 1980s but dramatically resurged during the war of the mid 1990s. There is no statistics on areas and species affected, but ROR (2004) reported that 6 130 ha, 2 658 and 4 344 ha of forests, respectively, were destroyed by fires in 2000, 2001 and 2002. However, in recent years, no fires are reported in forested areas except in the dry Akagera National Park. No statistics on forest extent and species affected were available for the period 2005-2009. There are no invasive species or any other disturbances reported in forest plantations/woodlots during this period as well.

2.3.6 Maintaining long term site productivity

Harvesting regulations are prescribed in the licenses issued by the forestry services to those who want to harvest forest plantations. All natural forests are protected and therefore no harvesting takes place there. Local governments are allowed to issue harvesting licenses only for forest plantations or woodlots up to 1 ha. Beyond this size, it is NAFA which issues harvesting license. No one is allowed to harvest even woodlots without a harvesting license.

The harvesting license describes all the harvesting instructions to be followed by the applicant. All kinds of forest harvesting must take place under the supervision of the forestry extension officer in the Administrative Sector and has to be done in a way that enhances optimum utilisation of wood. Some of the rules that a harvesting license holder has to comply with are (MINAGRI, 1990):

- All trees have to be cut at ground level. Under no circumstances, stump height should exceed 30 cm above ground or above tree buttress. In coppice systems, the stem has to be cut just above the stump that carries it;
- Necessary precautions must be taken to avoid damage of standing or felled trees by falling trees;
- All trees marked for cutting and those damaged by falling trees during exploitation must be harvested though the products may be different from those expected;
- It is the responsibility of the harvesting license holder to use all wood produced by trees. Hence, he must carry out the skidding of the bole in order to use it in any form. All woody material over 4 cm in diameter must be used;
- Sawing trenches (in case of pit sawing) must be filled with soil when they are no longer needed for use;
- The license holder is responsible for hauling harvested products (including boles down to 4 cm in diameter) within the validity period of the license;
- The license holder is responsible for the protection against bush fires within the harvesting area. During charcoal making, necessary care should be taken in order to control fire;
- During construction or rehabilitation of tracks, the harvesting license holder has to take all protection and conservation measures needed in order to avoid the creation or aggravation of erosion, the degradation of soils or destruction of vegetation around the construction sites, the alteration of water quality and the modification of watercourses;
- Tree harvesting in borders of roads, tracks, lakes, rivers and sites of public interest, must be done in accordance with restrictions established by related laws;
- Clear-felling is strictly forbidden on slopes greater than 45 degrees;
- Clear-felling is strictly forbidden in a band of 10 m around lakes and along permanent watercourses; and,
- Harvesting is not permitted between 6:00 pm and 6:00 a.m.

These harvesting instructions are usually attached to the licences and staff of NAFA normally supervises the harvesting process in order, among other things, to ensure that tree harvesting has less impact on soil and biodiversity. When harvesting trees, care is taken to minimise damage to the site and to expose soils to erosion, particularly on steep lands. The most common tools used when felling trees are axes, machetes and hand held saws. Occasionally, chainsaws are used depending on the financial capacity of the owner of the forest harvested (or the one who purchased the stand). After cutting trees, extraction must be done carefully in order to reduce soil compaction, minimise disturbance of the site and avoid damage to the remaining trees and regeneration. Since extraction is usually done manually by labourers, cutting and extraction are well coordinated and usually start from the back of harvest area so that labourers don't have to walk over fallen logs or stems that might lead to injury or reduce efficiency (Mataganda *et al.*, 2010). Given the topography of most forest sites, the slope of the site is used during extraction to roll down the logs. In such case, care is taken to avoid damage to the ground, vegetation and remaining trees.

In Rwanda, vegetation removal by slash-burning is prohibited by law because it may induce rapid alteration in soil properties as the ash layer following burning is rich in nutrients and is often washed down by runoff after the first rain. The slash is therefore normally left in the forest or carried away by neighbouring people to be used as fuelwood or as mulch in coffee plantations.

2.3.7 Growth, yield and rotation age

The productivity of forest plantations in Rwanda is generally reported to be rather low, and varies with planting location and tree species. *Table 13* shows the overall mean annual increments of major plantation tree species reported by MINIRENA/ISAR (2008). In many cases, the productivity rate is as low as 6 m³/ha/year. The low yields of forest plantations are mainly due to low site quality (only marginal lands are allocated to forestry), poor species and provenances selection, and inappropriate management techniques during planting, thinning, and harvesting. Actually, with the exception of the Arboretum of Ruhande, no forest plantation in the country has a management plan. Nevertheless, *Eucalyptus* plantation yields of up to 60 m³/ha/year have been reported in the country (Burren, 1995).

Table 13: Overall average productivity of major plantation tree species. Source: MINIRENA/ISAR (2008).

Tree species	Productivity (m ³ /ha/year)	Tree species	Productivity (m ³ /ha/year)
<i>Acacia melanoxylon</i>	15.0	<i>Eucalyptus species</i>	6.9
<i>Callitris robusta</i>	5.8	<i>Grevillea robusta</i>	10.0
<i>Cupressus lusitanica</i>	6.8	<i>Pinus spp.</i>	13.1

Meanwhile, if regular silvicultural prescriptions were followed and using the thinning models described above, yields predicted for plantations of *Pinus patula* for UGZ1 and UGZ2, respectively, would be as presented in Table 14.

Table 14: Yields of plantations of *Pinus patula* at proposed rotation ages for different sites. Source: Barbier, 1992.

Fertility level	UGZ 1 Model			UGZ 2 Model		
	Age (years)	Total production (m ³ /ha)	Productivity (m ³ /ha/year)	Age (years)	Total production (m ³ /ha)	Productivity (m ³ /ha/year)
High	28	440	15.7	25	416	16.6
Average	32	348	10.8	30	307	10.2
Low	38	285	7.5	35	239	6.8

In the case of Eucalypts plantations, many coppice stands in the country are old and have lost their growth vigour due to repeated cutting. In fact, the rotation periods for harvesting coppice stems of eucalypts are short, between 6 and 7 years depending on species and site. The demand for fuelwood (charcoal, firewood) and building poles being very high in Rwanda, trees are generally harvested when the stems still have small diameters. The growing stock in forest plantations and woodlots as of 2009 (Table 15) were estimated basing on the area covered by forests as reported above in Table 5. The production per hectare (m³/ha) was based on figures reported in the 2007 National Forest Inventory (MINIRENA/ISAR, 2008). The increment (m³/ha/year) was estimated as a weighted average value for each category of species as shown in Table 13.

Table 15: Growing stock, yield and increment of forest plantation species* (m³) in 2009. Source: MINIRENA/ISAR (2008), Table 5 above.

Type of forest plantation	Area (ha)	Average growing stock (m ³ /ha)	Growing stock* (m ³)	Increment* (m ³ /ha/year)
Eucalyptus plantations	63 600	161	10 240 000	6.2
Young plantations and coppice (mainly <i>Eucalyptus spp.</i> and <i>Acacia spp.</i>)	63 000	132	8 316 000	10.3
Softwood plantation (<i>Pinus spp.</i> , <i>Cupressus sp.</i> and <i>Callitris spp.</i>)	12 100	184	2 226 000	8.6
Woodlots and trees outside forests (<i>Eucalyptus spp.</i> , <i>Grevillea spp.</i> , <i>Pinus spp.</i> , <i>Cupressus spp.</i> , <i>Callitris spp.</i> , <i>Acacia spp.</i> , <i>Alnus spp.</i> , <i>Casuarina spp.</i>)	162 800	151	24 583 000	10.8
Grand Total	301 500	-	45 365 000	-

Note: Standing volume of trees with a DBH of at least 5 cm

2.4 Forest plantation expansion

2.4.1 New areas available for forest plantation expansion

Generally, due to population pressure and the resulting shortage of arable land, there is practically no land remaining for forest plantation expansion. Only marginal areas and protection areas which are not forested are normally considered as afforestation sites in the country. Such sites include

buffer zones to natural forests and national parks, bands for protection of rivers and lakes, and roadsides. These sites need to be planted with appropriate species to avoid negative impact on soils, water, hydrology, fauna and flora.

The vision 2020, targets the country to have 30% forest cover by the year 2020 while agroforestry systems should cover 85% of cultivated areas. Therefore, in order to achieve this target, the new forestry policy targets to expand forest plantation area between 2010 and 2020 with 350 000 ha (ROR, 2010). However, in the context of land scarcity, this target is far too ambitious, unless alternative sources of livelihood are created to provide out of farm jobs, thereby enabling farmers to use significant areas of farmland for afforestation.

During mapping of forested areas with 0.5 ha or more in the country, MINIRENA/CGIS-NUR (2007) also analysed the potential area remaining for afforestation. Based on the recommendation of the environmental law (ROR, 2005) of planting buffer bands around rivers (10 m), lakes (50 m) and roads (10 m), MINIRENA/CGIS-NUR (2007) came up with an area of c. 215 000 ha of land with a potential for afforestation, preferably with indigenous species (bamboos, *Entandophragma excelsum*, *Polyscias fulva*, *Markhamia lutea*). This is about 10% of total land area of the country.

2.4.2 Stakeholder views on establishment, expansion and improved management of forest plantations

The forest and tree resource base of the country is characterised by the predominance of individually owned trees planted mainly as small plots (woodlots), lines (farm boundary and contour lines) and scattered individual trees on farm. These private forest resources constitute the main supply of forest products needs in the country, particularly since the ban of public forest harvesting in 2000. In fact, the BEST survey (2008) reported that 89% of all traded forest products come from woodlots of less than 2 ha.

The interest of farmers to plant trees is manifested in their enthusiasm in participating in plantation establishment during the annual tree planting week. Thus, despite limited farm sizes in Rwanda, farmers incorporate trees and shrubs within small farms by choosing appropriate locations for planting multipurpose tree species. About 66% of households in Rwanda own 0.6 ha or less of land (ROR, 2007).

As far as public forest plantations are concerned, the new National Forestry Policy envisages "systematic phasing in of the private sector to play the dominant role especially in forest management and forest products processing, the public sector retaining only the regulatory function, research and quality assurance". The policy also stipulates that classified forests shall be managed in accordance with decentralised governance prevailing in Rwanda through the "Management Contract (*Contrat de gestion*)" modality proposed in the forest law.

Many actors in Rwanda are encouraged by the National Forest Policy and there is a general wish for its implementation. Despite the challenge of land shortage, farmers are willing to establish woodlots on their tiny lands or practice agroforestry. However, investing in forestry is still risky due to lack of incentives with respect to the nature of long term return on forest investments and the lack of freedom on harvesting products of choice. Participation of local people in the management of public forests and adequate forest extension are also seen as pre-requisites to improved forest plantation and woodlots management (LTS, 2010).

2.4.3 Constraints and opportunities for plantation expansion

The practice of forestry in Rwanda is constrained by land scarcity in general and extreme poverty of the people. The other problems include low productivity of existing plantation forests and poor quality of forest genetic material, wasteful conversion (the bulk of tree conversion for timber is by pit-sawing), insufficiency of data on the forestry sector, dominance by one genus (*Eucalyptus spp.* accounts for >80%), scarcity of land for reforestation, and inadequate extension services (due to lack of competent personnel and budget), and under-estimation of the economic importance of forestry (ROR, 2010).

However, there are opportunities that could enhance forestry business. Such opportunities include the ranking of environmental protection among national priorities; the existence of decentralised

civil governance structures; the existence of the National Forestry Fund (NFF); high level political good will illustrated by putting in a place Institutions with a clear mission for developing the forest sector (e.g. NAFA, Ministry of Forests and Mines); many national policies, programmes and projects, especially those dealing with environment, food security, energy, water, land management and soil conservation prioritise forestry as a key intervention; the existence of international conventions and agreements on forests to which Rwanda is signatory and the increasing international interest in using forests as a carbon sink to reduce global warming (ROR, 2010).

Furthermore, the new National Forestry policy contains statements that promote improvement of management of forest plantations and the involvement of private enterprise in the forestry sector. Indeed, in the preferred options 2 and 6 of this forestry policy, it is stressed that efforts shall be directed towards promotion of profitable and productive forest plantation business and promotion of forest-based industries (ROR, 2010). According to the policy, forestry operations shall be undertaken in a business-like manner, with a clear focus on result-based management.

Accordingly, the government will invite the private sector to invest in wood processing and value-addition in all mature plantations. There will be a progressive phasing in of the private sector to play a dominant role, particularly in forest management and forest products processing so that the public sector will retain only the regulatory function, research and quality assurance. It is believed that a forest-based industry will have a decisive effect on the maintenance of forest cover and encourage people to plant more trees. Moreover, since public forests will provide raw material for new forest industries, at least in the beginning, the policy recommends that the government establishes an attractive investment environment including comprehensive legal mechanisms to enable the private sector to invest and manage public forests (ROR, 2010). *Table 16* provides an overall perception of risks for private sector investment in commercial forest plantations.

In general, there are apparently very high risks for forest investment in the country. This is probably due to the lack of financial incentives that could attract large investment in forestry ventures. The shortage of land makes it also impossible to establish large scale commercial forest plantations that would attract major forest investments in Rwanda. Governance issues and inadequate fiscal policies also have negative implications on forest investment in the country, e.g. because of corruption at the level of local government and the license requirement for harvesting even private forest plantations or woodlots.

Table 16: Perception of risks for private sector investment in industrial forest plantations. Adapted from ITTO (2009).

Risk factors	Risk for forest investment		
	Low	Medium	High
SUPRA (Macro economy)			
Growth of GDP			X
Exchange Rate	X		
Interest rate			X
Free Trade Agreements			X
Political Stability and Government Transparency			X
Governance issues			X
Fiscal Policy			X
INTER SECTOR			
Economic infrastructure			
– Transportation			X
– Energy/Utility			X
Social infrastructure: (water, sanitation, education, health)	X		
Licenses and permits			X
Labour			
– Laws and labour contracts			X
– Wages			X
– Labour productivity			X
– Labour qualification			X
Access to credit		X	
Justice and law enforcement			X
Capital gain policy			X

Land and resource tenure			
– Land tenure			X
– Land market			X
– Land use as collateral			X
Sectorial policies			
– Environment policies and restrictions			X
– Agricultural policies and restrictions			X
INTRA-SECTOR			
Forest Resources (availability)			X
Subsidies and Financial Mechanisms		X	
Trade Restrictions (on forest products)			X
Markets			X
Entrepreneurial Development Service			X
Forest Vocation Land (land suitable and available for forest)			X
Legal and Institutional Basis			X

3. OUT-GROWER SCHEMES AND OTHER WOODLOTS

3.1 Extent and impacts of out-grower schemes/other woodlots

Most private forest plantations are small woodlots owned by individual farmers and businessmen, and institutions like churches, schools, cooperatives and tea plantation companies. In fact, much of the landscape of Rwanda is predominantly dotted with trees in small groups, rows or single trees on farm. Preliminary results of surveys carried out by FAO (2010) to determine the extent of tree resources outside forests (including woodlots below 0.5 ha) show that these resources cover about 6.6% of total land area. The most common tree species planted in these woodlots are *Eucalyptus* spp. (mostly *E. camaldulensis*, *E. tereticornis* and *E. maidenii*). Small *Eucalyptus* woodlots, making up an estimated 80% of all woodlots, are practically found in all farming systems of Rwanda (Figure 9). Other species found in woodlots and other agroforestry systems in Rwanda include *Grevillea robusta*, *Casuarina equisetifolia*, *Acacia melanoxylon*, *Acacia mearnsii*, *Alnus acuminata*, *Maesopsis eminii*, *Senna spectabilis*, *Senna siamea*, *Leucaena leucocephala* and *Calliandra calothyrsus*.

Farmers who own woodlots generally target fuelwood production and to some extent building poles (Den Biggelaar, 1996) for domestic and commercial purposes. The BEST survey (GTZ, 2008) found that 89% of sampled plantation owners who supplied traded wood in Rwanda had woodlots of less than 2 ha. GTZ (2008) in a partial study on charcoal trade between six towns and five wood producer districts carried out in 2008 showed that the commercialisation of charcoal alone contributed 2.6 billion US\$ representing about 5% of the GDP. This study did not cover all the income generated from wood used in the building, firewood (domestic and other consumers), wood working and furniture businesses. Bearing in mind that no harvesting is done in public forest plantations, virtually all wood products traded in Rwanda come from woodlots owned by individuals, institutions or cooperatives. There are no reliable statistics on the extent of out-growers/other woodlots in the country, but based on personal communication with various forest professionals, they make up 60% of all forest plantations in the country, which would be equal to c. 180 000 ha. Assuming an average standing volume of 150 m³/ha, this represents a total volume c. 27 million m³.



Figure 6: Despite high population density, trees and woodlots are well present on Rwandan landscape.

3.2 Factors shaping growth of out-grower schemes and other woodlots

One of the objectives of the new Forestry Policy is to “*promote farm forestry to produce timber, wood fuel and to supply wood and non-wood forest products*”. In fact, the problem of land scarcity makes industrial forest plantation not a feasible option in Rwanda. Nevertheless, recognising that trees and forests constitute one pillar of the economy and the ecological balance of the country, the government considers the enhancement of farm forestry as extremely important.

Tangible results are expected to be achieved through establishment of a strong and efficient forestry extension service. Thus, the forestry policy outlines the following operational strategies which will likely promote farm forestry (ROR, 2010):

- Promoting and supporting creation of cooperatives of forest growers;
- Supporting writing up and implementation of forest management plan of private forests;
- Mainstreaming farm forestry in agricultural policies and strategies;
- Disseminating best practices in farm forestry in all farming systems in Rwanda;
- Enacting and enforcing agricultural bye-laws designed to conserve the life support systems and protect agricultural biodiversity;
- Building capacity of farmers and private sector in favour of farm forestry;
- Intensifying research into suitable farm forestry technologies, niches and tree species for various agro-ecological zones;
- Promoting growing and/or husbandry of multi-purpose trees in all farming systems;
- Re-orienting frontline agricultural extensionists into farm forestry;
- Developing and amplifying farm forestry content in extension packages and integrating these into a unified extension system for all farming systems in the country;
- Supporting farmer groups to establish and manage tree nurseries for commercial purposes;

- Encouraging schools and other youth organisations to grow and conserve trees;
- Including agroforestry into primary school curriculum;
- Developing training programmes and field manuals for front-extension agents; and,
- Training, re-training and disseminating information to farming households.

In addition to the forest policy strategies, another positive feature which is likely to favour the development of a vibrant out-grower/woodlot plantation business in Rwanda is that environmental protection has been ranked among national priorities. This has led to many national policies, programmes and projects, especially those dealing with environment, food security, energy, water, land management and soil conservation prioritising forestry as one of the key interventions (ROR, 2010). Moreover, the increasing interest of the international community in forests, which are seen as a major contributor to carbon sequestration for reducing global warming, is also likely to influence positively the growth of out-grower/woodlot schemes.

Constraints that may limit such development in Rwanda are generally centred on land scarcity, extreme poverty of many farmers, low productivity of existing plantations and poor quality of forest genetic material because there are no seed orchards to provide quality seeds to forest growers. The wasteful conversion of timber by pit-sawing which results in low volume recovery from felled trees, the dominance of *Eucalyptus spp.* in plantation and the lack of sufficient competent personnel and budget for adequate forest extension are also other challenges that may constrain the growth of out-grower and woodlot development in the country.

4. FOREST AND TREE TENURE

4.1 Current forest/tree tenure systems

In Rwanda, forest and tree tenure is regulated by the same legislation as land tenure. According to the 2005 Organic Land Law, land is classified as either individual (private) land or state land. Individual (private) land can be obtained under principles of customary law or under formal law. State (public) land includes: (1) state land in the public domain (e.g. lake shores, national parks, roads, tourist sites), which generally cannot be alienated; (2) state land in the private domain of the state (e.g. vacant land, swamps, forest and tea plantations, expropriated land), which can be alienated; and (3) district, town and municipal land, which is controlled by the local government (ROR, 2005).

There are three major categories of forest ownerships in the country:

- State forests;
- Local government forests (District and sectors); and,
- Private forest plantations/woodlots.

State forests include mainly forest land on protected areas, remnant natural forest reserves, plantations in the buffer zones of protected areas (including national parks, natural forest reserves, lakes, rivers, marshlands and national roads) and large plantations established by government afforestation projects since the 1970s such as those funded by the World Bank, the European Union, Switzerland, Netherlands and Belgium. The law prohibits settlement within, and cultivation of, state forest land (ROR, 1988). The state can contract with districts, associations or cooperatives, private forestry companies, groups and public institutions for management and exploitation of state forest land. Contracts, including timber concessions can be issued for periods of 30 years but cannot be subcontracted. Contracts are subject to the development of approved 5-year management plans (ROR, 1988).

Local government forests include forest plantations under municipal control such as those established during communal works of “*umuganda*” or by local forest projects support, line plantations along district roads, municipal land designated for reforestation and forest land under

contract for district level management. Local governments or municipalities can contract with communities or cooperatives for management of local government forests (ROR, 1988).

Private forest plantations comprise individual plantations (owned by individuals or families) and institutional plantations (owned by churches, schools, cooperatives, tea plantation companies, etc.). Except for imported forest products, almost all forest products used in the country since the ban of harvesting public forests in 2000 are extracted from private forest plantations/woodlots.

State and local government forests are public forests (owned by the state or the local governments) and they are managed as classified forests in accordance with instructions prescribed by the forest law of 1988 (ROR, 1988). Nevertheless, in Rwanda forests are considered as public goods and therefore all forests including those under private ownership are subject to close monitoring of the forestry authority. This is to say that, no commercial harvesting should take place even in private forest plantations without prior authorisation or licence. In fact, the forest law of 1988 stipulates that each forest plantation more than 2 ha whether public or private should have a management plan (although this is yet to be implemented).

The extent of the above ownership classification in terms of forest size and composition is however still unknown. Due to time and financial constraints, the national forest inventory of 2007 did not establish the proportion of each type of forest ownership in the country. PAREF, a project supporting NAFA, is planning to soon update the forest mapping and inventory including even small woodlots up to 0.25 ha and initiate the forest cadastre, at least in the 15 Districts covered by the project. Nevertheless, using statistics extracted from PAFD (*Plans d'Aménagement Forestier de Districts*, i.e. District Forest Management Plans) which were prepared with funding from the PAFOR and PAREF projects, the ownership distribution and management systems of forest plantations with 0.5 ha or more is as provided in *Table 17* (even though their reliability is largely contended because no comprehensive inventory was done).

Table 17: Forest ownership and management structure (tenure) (> 0.5 ha) in 2010. Source: PAFD documents (30 Districts).

Category of owner/management	Area (ha)	Percent
Central government owned and controlled	35 583	27%
Local government owned and controlled	15 783	12%
Privately owned and managed (individuals/institutions/companies, etc.)	78 545	61%

4.2 Impacts of forest/tree tenure on poverty alleviation and SFM

According to GTZ (2008), the success of planting trees on all types of land in Rwanda is setting an example for the rest of Africa. This was probably a result of clear land tenure rules allowing for private ownership. Generally, most countries apply common land policies where no-one is the explicit owner except the State. Thus, probably as a result of allowing private land ownership, trees can be seen everywhere. In fact, people have an incentive to plant trees when they know that the trees will still be their property when they mature, which is not the case on common lands. GTZ (2008) has shown that trees benefit farmers at about the same level as maize – but they do not need to provide the same labour inputs. Therefore, trees form a kind of security for farmers that they can turn to cash in case of need in the limits allowed by the rules governing their exploitation.

GTZ (2008, 2009) and LTS (2010) analysed the income realised by smallholder farmers from forestry business and concluded that the sales of forest products such as firewood, charcoal, roundwood and sawn wood are contributing substantial income to the farmer (*Figure 7*). In relation to small farmer woodlots business, the BEST survey found that the smallest size plantations yielded the largest share of non-fuelwood (non-energy wood) sales (*Figure 8*). This may be explained by the fact that because non-energy wood (i.e., poles, construction wood) fetches higher prices than energy wood, smaller woodlots have significantly higher revenue per hectare than larger ones (GTZ, 2009).

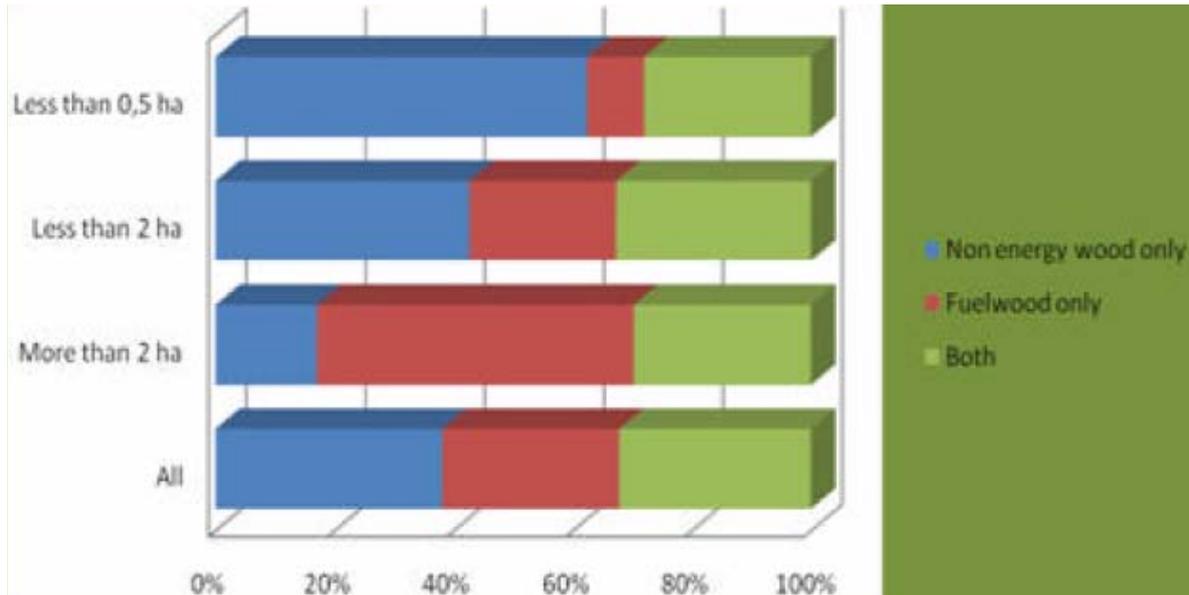


Figure 7: Sale of wood products by size of plantation (GTZ 2009, BEST survey).

GTZ (2009), further analysing the income from wood products selling smallholders, discovered that the average earnings per hectare are larger for smaller size plantations which reflect both the tendency to sell more products and to sell higher valued products in the country (Figure 8).

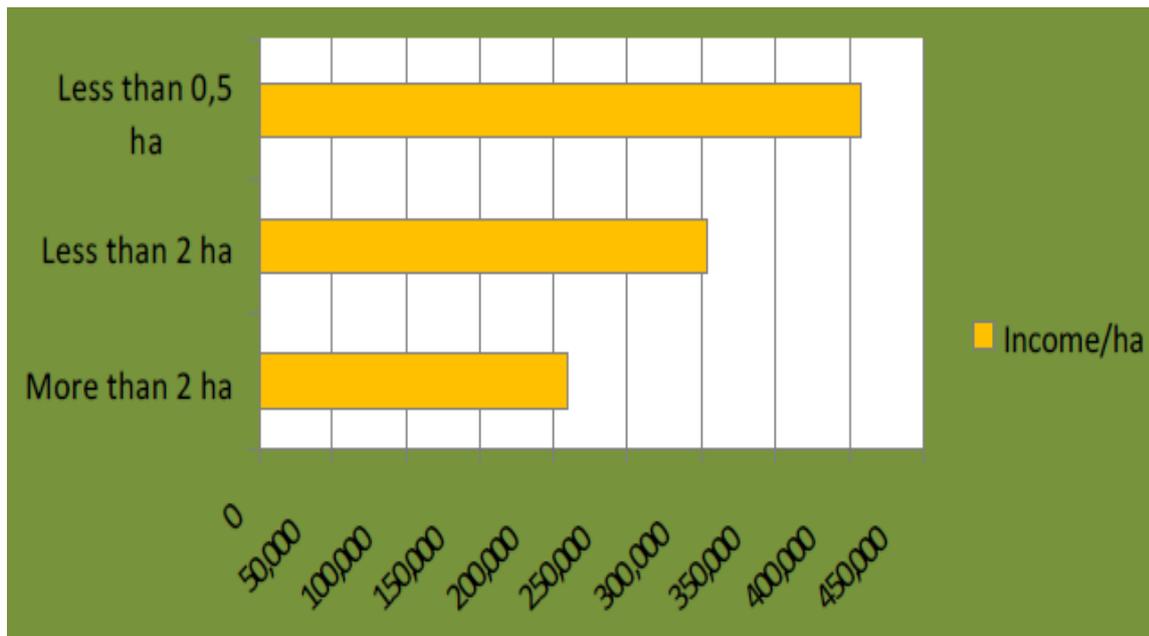


Figure 8: Average wood income (Rwf) per ha and plantation size (GTZ 2009, BEST survey).

Based on the National Agricultural Survey 2009 and the BEST reports (GTZ 2008 & 2009), LTS (2010) estimated the farm sales from wood products in 2008 in the four Provinces of Rwanda and the City of Kigali (Figure 9). As can be noted, the Western Province made more sales of sawnwood (up to US\$ 900 000) while the Southern Province made more income from charcoal sales (up to US\$ 800 000).

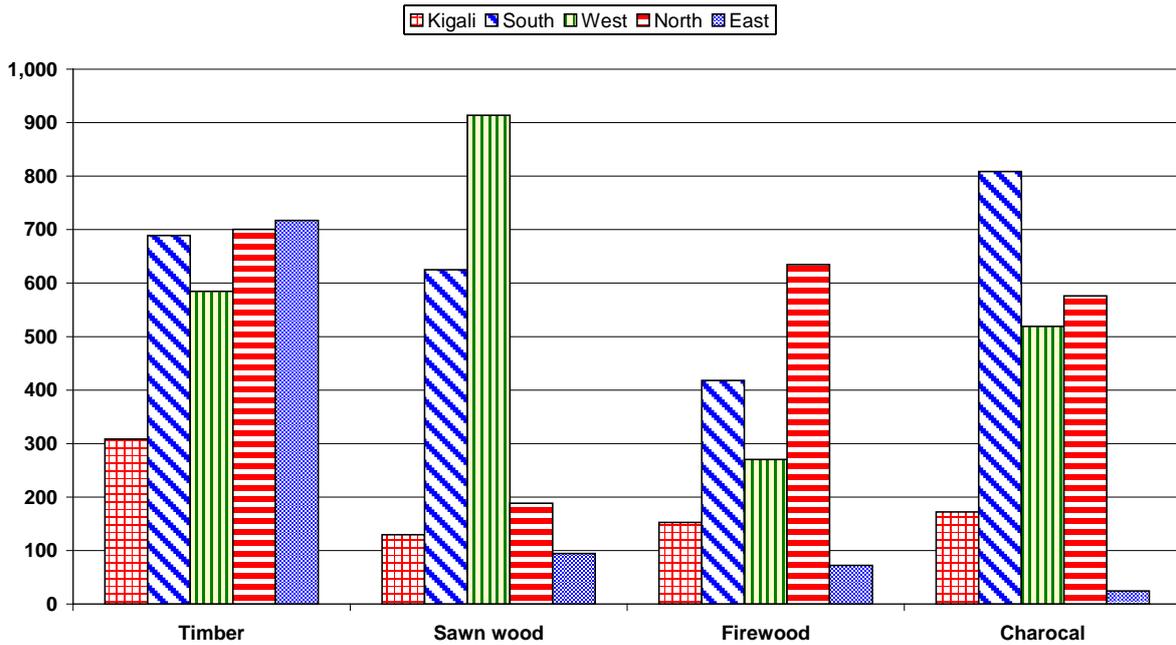


Figure 9: Farm forest sales breakdown in Kigali City and the four Provinces of Rwanda 2008 (x US\$ 1000) (LTS 2010, Forest business baseline study).

Unfortunately, the need for harvesting licenses by private forest owners has recently resulted in many cases of abuse and corruption at the level of local government authorities. In fact, in line with the decentralisation process, local governments have been allowed to issue harvesting licenses to woodlot owners (below 1 ha) since 2006. This principle, although for national interest, has removed the right to freedom of choice in using private property. The perpetuation of this situation may not be conducive to the promotion of private involvement in forest planting and management.

4.3 Suggestions for improvement of tenure system

Forest governance in Rwanda currently put emphasis on control and close monitoring of forest harvesting activities. This approach is neither conducive to tree planting nor to sustainable forest management. A better approach would probably be that of facilitation rather than control, a bottom up approach rather than top down. LTS (2010) suggests that people should be assisted in establishing, and managing plantations, harvesting and marketing their forest products, instead of interfering only at the harvesting stage. The freedom of choice what to harvest and at what time, especially for woodlots owners, should be reinstated as soon as possible. In fact, according to the forest law of 1988, only cutting of trees or clearing private forest lands over 2 ha in size requires a permit/license (ROR, 1988). Even though this law is being revised and updated, it should remain in force until the new law is enacted.

5. FINANCIAL AND HUMAN RESOURCES FOR PLANTATIONS AND OUTGROWERS/WOODLOTS

5.1 Current financing mechanisms

Tree planting has been supported by the government since the colonial period. However, new impetus was given to tree planting in the 1970s with the establishment of compulsory communal works called “*umuganda*” in 1975 and the institutionalisation of a tree planting day in 1975. The launching of many rural development projects which had a forestry component in the late 1970s and early 1980s also greatly contributed to the increase of forested areas in the country. Many forestry projects were still operational until 1994 but were then stopped because of the war and the genocide. Afterwards, there was no big forestry project until 2002 when a forestry support project, PAFOR, was launched. It was funded by ADB at a level of US\$ 11.5 million (2002-2009) and ended in 2009.

Table 18: Major local and international NGOs operating in the Forest Sector in Rwanda. Sources: USAID (2008), SSEE & ROR (2011), NAFA staff (pers. communication).

Name	Main field of Interventions
Local NGOs	
ARECO, Rwanda Nziza	Conservation (e.g. Mukura Natural Forest conservation; Women Apiculture; etc.)
ACNR	Conservation, environmental education and forest legislation
RENGOF	Conservation (e.g. Gishwati Land Use Planning – Rehabilitation plan)
RWABASO	Plantation of bamboos and promotion of bamboo products (art crafts)
NBDF	Capacity building of Civil Society Organisations on climate change adaptation
DUHAMIC-ADRI	Marshland reclamation to increase agriculture production by irrigation and drainage, tree planting and carpentry
REASON	Conservation and tree planting
SERUKA	Gender and environmental protection; plantation of bamboo at Nyungwe buffer zone
RECOR	Conservation, agroforestry, eco-tourism and environmental education
Forest Comp. Volcanoes Gorillas	Forest inventory and management
Rwanda Green Foundation (RDF)	Agroforestry and capacity building in Bugesera District
AREDI	Environmental protection integrated development
RDO	Rural development and reforestation
APIB	Tree planting and community livelihoods
ARJE	Promotion of environmental reporting in different media in Rwanda
ISUKU	Environment protection and tree planting
ADENYA	Tree planting and community livelihoods
ADARWA	Sawn timber marketing and carpentry
MIG	Afforestation projects, forest and wetland management projects
International NGOs and institutions	
CARE International	Environment conservation
ACDI/VOCA	Agroforestry programme in partnership with ICRAF
World Vision	Increasing agriculture production through terracing and marshland reclamation (drainage and irrigation) and seedling production
Gorilla Organization (GO)	Gorilla conservation focusing mainly on community conservation activities
Helpage Rwanda	Agroforestry programme
IFDC Catalyst	Reforestation projects including woodlots promotion
Agro-Action Allemande	Reforestation with woodlots
Vi-life	Agroforestry
ADRA Rwanda	Agroforestry
ICRAF	Agroforestry research and development

Currently, the government from its own budget and with the support of a number of NGOs (*Table 18*) and development partners continue to support tree planting through free distribution of seedlings to farmers during the annual tree planting week. Key development partners include the governments of Belgium and the Netherlands which, through a forestry support project called PAREF (US\$ 3.9 million from Belgium for the period 2008-2012, and US\$ 12.5 million from the Netherlands for the period 2009-2013), direct investments primarily towards reforestation activities as well as capacity building at Central and District levels within public and private forests (SSEE, 2011). PAREF was launched in 2008 and is operational in 15 Districts. Other current projects with forestry components but working mainly with farmers (reforestation on private lands) and local NGOs include CARPE, CATALIST/IFDC and SEW (US\$ 8.3 million for 2009-2012). Budget figures above from PAFOR and PAREF reports, Bonaventure (SEW/Catalist/IFDC project) and NAFA Staff (pers. communication), and MINECOFIN budget reports (2006, 2007, 2008, 2009, 2010-11).

5.2 Potential financing mechanisms

The draft Forestry Act under review (already passed by the government cabinet and now under Parliament scrutiny) proposes two major financing mechanisms for forestry activities in Rwanda: the National Forestry Fund (NFF), already mentioned in the former 1988 law (No. 47/1988), and the creation of District Forestry Funds (DFF) in each District. Furthermore, the draft Forestry Act makes provision for various taxes (concession charge in case of forest concessions, harvesting tax and export tax). Their rates would be set out by a ministerial decree. Concession charges and tax products would fund the NFF, and then be split between the NFF and DFF of Districts of origin.

Other potential financing mechanisms of forestry activities include the Climate Change Adaptation Fund, Least Developed Countries Fund (LDCF), the Green Fund, the Clean Development Mechanism (CDM) under the United Nations Framework on Climate Change Convention (UNFCCC), as well as the Voluntary Carbon Market (VCM) (SSEE & ROR, 2011). Already, the forestry policy of 2010 (ROR, 2010) proposes the introduction, support and promotion of innovative financing mechanisms such as trusts, eco-taxes, service licenses and payments for environmental services (PES) including carbon trade (carbon sequestration is a service and therefore carbon trade is part of PES) in the country in order to ensure sustainable sources of operational funds.

5.3 Human resources

There are about 64 forestry professionals trained at university level currently working in the forest administration, research, education, NGOs, projects and as consultants. Most of these foresters studied outside Rwanda. Forestry in Rwanda is generally taught at secondary school level although recently an undergraduate degree in agroforestry has been launched at the Higher Learning Institute of Agriculture and Animal Husbandry (ISAE) while a Master of Science in Agroforestry and Soil Management programme has been running at the National University of Rwanda (NUR) since 2006.

There are many but unknown numbers of technicians who have been trained in Rwanda in Nyamishaba, Kibisabo and Rutsiro secondary schools. The total number may be roughly estimated at around 600 certificate level technicians. But only a few of them are employed in Rwanda, many having died or fled outside the country during the war and genocide of 1994. Nyamishaba used to be considered a good school for technician training but it has not operated after 1994. The other two schools have often been criticised for having neither qualified teachers nor appropriate technical materials for practical courses. Nevertheless, the two remaining schools produce around 60 technicians every year who either proceed to higher learning institutions and often change field of study or are employed in education or agricultural projects.

The Higher Learning Institute of Agriculture and Animal Husbandry (ISAE – Busogo) also offers two levels of technicians with some theoretical knowledge in tree husbandry namely, A1 (3 years post-secondary training – considered as Diploma) and A0 (5 years post-secondary training - considered as B.Sc.). The school has operated an agroforestry department since 2005 and the number of those who have graduated is estimated at 200 people, 160 A1 and 40 A0. In 2010, the school had

70 A1 and 35 A0 graduates (LTS, 2010). It is not clear whether all these technicians are employed or not, and where. However, most of them have recently been recruited as District Forest Officers (DFOs) or Sector Extension Forest Officers (*Animateur forestier*) (NAFA staff, pers. communication). However, due to huge shortcomings in their training, these technicians need additional training in order to serve as effective forestry professionals.

Below university and technical level there is very little training for artisans other than at a few trade schools, and these focus on carpentry rather than tasks such as pitsawing and charcoal making. The training for artisans in these two fields could improve timber and charcoal conversion efficiency and ultimately lead to increased quantity and quality of supplied fuelwood and timber. Table 19 shows the number forest actors inventoried in 2010 by the National Forestry Authority (NAFA).

Table 19: Number of forest actors inventoried by NAFA in 2010. Source: NAFA (unpublished report, 2010).

Category	Tree nursery	Charcoal making	Charcoal trade	Sawing/ carpentry	Timber trade	Firewood trade
Cooperatives	825	205	4	534	6	0
Associations	81	4	1	32	1	1
Private individuals	442	324	205	1072	117	76

Even though the inventory of human resources employed in the forestry sector (Table 20) may not be exhaustive, there is still lack of staff in terms of quality and quantity whether in the forest management, research or extension functions. A recent study by LTS (2010) revealed that even those professionals holding a degree have gaps in their training especially those trained in the country. Also those trained outside need to learn the practice of forestry in the context of Rwanda. Therefore, the study recommended that, in addition to further capacity building of forest human resources, particularly in the field of skilled workers and forest extension, on the job training of all forest professionals in the country to update and adapt their knowledge should be included in the training plan of NAFA. The establishment of a forestry vocational training centre was also recommended in this study.

Table 20: Forest sector human resources (2011). Source: NAFA staff (pers. communication), LTS (2010), Own survey (2011).

Institutions	Degree holders	Diploma holders	Certificate holders	Gaps in the various cadres
Public sector				
NAFA	38	9	220	204
NUR	3	-		4
ISAR	4	5		6
ISAE	2			8
IRST	1			
PAREF	1	2	5	4
Sub-total	49	16	225	226
Private sector				
Local NGOs	6	3		
International NGOs	5	4		
Consultants	4			
Sub-total	15	7		
Grand Total	64	23	225	226

5.4 Other resources

There is abundant cheap unskilled labour for performing forestry activities from nursery to forest harvesting and products processing. In the 1980s, a project called PSTP-HIMO had simply the objective of forest plantation establishment and management based on intensive employment of unskilled labour. Another force that is available for forestry activities is the labour by genocide convicts (TIGE) as a requirement in the process of completing their prison terms outside. The compulsory communal works ("*Umuganda*") in the country every last Saturday of the month is also another resource available particularly for tree planting and plantations tending activities around settlements.

The forestry service has been shifting from one Ministry to another (see *Table 1*) and the newly created institution (NAFA) has no office of its own yet but is hosted in a rented building. The service has also no transport vehicles. Like all other government units in the country they have to rent vehicles from registered companies whenever they go outside Kigali or shuttling within the city during official duties. NAFA field work staff (Forest guards and extension officers [*Animateur forestier*]) have also no means of transport except for the 28 out of 30 DFOs who have recently acquired motorcycles. Twenty two motorcycles were bought by PAFOR (a forest support project which ended in 2009) while 6 were offered by PAREF (the on-going forest support project). The latter project also own nine vehicles and 15 motorcycles which eventually will be transferred to NAFA at the end of the project in 2013. Moreover, PAREF has about 30 computers including desktops and laptops. All NAFA professional staff at headquarters and all DFOs have also laptops and some offices have desktop computers.

6. INCENTIVES FOR PLANTATION ESTABLISHMENT BY PUBLIC/PRIVATE SECTOR AND OUTGROWERS

6.1 The rationale behind incentives

In Rwanda, incentives for tree planting and forest management are important because due to land shortage there is competition between forest use and agricultural use of land. More than 90% of the population practice subsistence agriculture and therefore need land for survival. Since landholdings are so small - more than 60% of households have less than 0.6 ha of land (USAID, 2011) - priority is logically given to agricultural production.

Another common rationale for incentives is the long term investment nature of the forest plantation business. In Rwanda, it will take at least 5 years before harvesting depending on the plantation objectives. During this period, the land could have produced agricultural crops for about ten growing seasons. The farmer should therefore be gently convinced through adequate incentives that it is worthwhile to invest in long term ventures rather than short term rewarding businesses.

Forests benefit not only the owners in terms of products harvested but also the public in terms of environmental services such as soil conservation, water catchment, carbon sequestration and recreational values emerging from the presence of forests. Indeed, in Rwanda, forests are considered a public good. Incentives are therefore extremely relevant in order to motivate forest plantation development and management.

6.2 Current incentives: impacts and effectiveness

In Rwanda, there are two major incentives provided by the government and supporting projects, namely distribution of free seedlings during the annual tree planting week and initial woodlot establishment support (*Table 21*). The national forest policy of availing tree seedlings to all interested farmers during the tree planting season has largely contributed to the transformation of

Rwandan landscape which is greatly dotted with trees and woodlots scattered on farmlands (*Figure 10*).

Another incentive recently introduced by some NGOs and Carbon credit projects is the facilitation of woodlots plantation on private lands. The farmers usually avail land and the project provides labour for initial woodlot establishment and tending. For example, the Sustainable Energy Production through Woodlots and Agroforestry in the Albertine Rift (SEW)/Catalyse Agricultural Intensification for Social and Environmental Stability (CATALIST) project funded by IFDC (SEW/CATALIST/IFDC) pays 80% of initial woodlot plantation and tending costs while the owner contributes 20%, generally in terms of labour. The Clinton Hunter Development Initiative (CHDI) which is operational in some districts makes contracts with farmers for the purpose of buying carbon sequestered through agroforestry and establishment of woodlots.

Table 21: Incentives for plantation development. Sources: SSEE & ROR (2011), NAFA staff (pers. communication), Nduwayezu Bonaventure (IFDC/SEW staff, pers. communication).

Type of incentive	Brief description of incentive	Source and period	Target group	Outcomes/impacts & shortcomings
Annual free seedlings distribution	Free seedlings are distributed especially during the annual tree planting week.	Government and projects annually	All interested people particularly smallholder farmers	Many trees planted annually. However due to poor follow up there is low survival rates. Some seedlings are also not planted and thus wasted
Assistance to establish woodlots	Farmers provide land and about 20% of initial woodlot establishment and tending costs (in the form of labour).	SEW/CATALIST/IFDC since 2009. The project works also in DRC and Burundi.	Farmers in selected Districts where the project is operational	Farmers are enthusiastic about the scheme and about 3 000 ha have been established since launching in 2009.
Assistance to establish woodlots	Farmers make contract with CHDI on keeping planted trees and are paid for it.	Clinton Hunter Development Initiative (CHDI) since 2008	Farmers in selected Districts where the project is operational who accept to make contract	The CHDI has so far assisted planting of about 2 million seedlings since 2008.



Figure 10: Trees and woodlots are scattered on farmlands.

6.3 Suggestions for improvement of incentives

The incentive schemes of supporting woodlot establishment and carbon trade should be clearly and largely explained and publicised widely in order to reach all targeted people. These schemes should also be extended to all districts in the country. Furthermore, the Forestry service should make efforts to monitor the planting and initial tending of seedlings freely distributed annually.

7. SUPPLY AND DEMAND OF FOREST PRODUCTS

7.1 Supply scenarios and projections

It has not been possible to get reliable statistics on annual wood removals from plantations because there are no records kept by most forest actors. Therefore, even compiling the few records obtained during survey of wood processing mills in January 2011 would not be realistic. Nevertheless, assuming that all forest products produced are consumed and bearing in mind that all forest products consumed in the country are produced by the private sector, and further that the sawn wood conversion efficiency is 25% (most timber is pit sawn), and that 10% of sawn wood is imported (LTS, 2010), yields for 2010 are estimated in *Table 22*. However, not all woodfuel is obtained through forest clear felling; some firewood is collected from pruning and thinning products (both natural and artificial) or from alternative sources than trees such as shrubs, crop residues, sawdust, etc. Therefore woodfuel consumption estimations are often overestimated when compared to the reality.

Table 22: Wood removals (m³, rounded to nearest 1000) from plantations and natural forests 2010. Sources: Various reports on wood consumption, survey 2011 and FAO (2010).

Forest category	Industrial round wood*	Domestic poles	Woodfuel (firewood and charcoal)	Total
Tea factories			38 000	38 000
Institutions (prisons, schools, churches, etc.)	24 000	18 000	67 000	109 000
Sub-total	24 000	18 000	105 000	147 000
Out-grower/other woodlots	408 000	160 000	3 966 000	4 534 000
Grand total	432 000	178 000	4 071 000	4 681 000

Note: In the case of Rwanda industrial round wood = Sawlogs/sawtimber because the match box plant has been closed since 2008.

The Annual Allowable Cut (AAC) based on the estimated Mean Annual Increment (MAI) from all forest plantations is provided in *Table 23*. However, as mentioned earlier, public plantations are still excluded from harvesting. Moreover, not all tree resources outside forests (TROF) can be harvested because some of them belong to the public domain. Therefore, for the purpose of estimating the potential supply of wood products, it was assumed that woodlots and other TROF, which are available for harvesting, make up about three quarters (75%) of this resource. Moreover, private forest plantations (0.5 ha or more) that are available for harvesting are estimated to constitute 60% of the total forest area in this category.

Table 23: Annual wood production (m³, rounded) based on MAI and forest areas (2010).

Forest plantation/ management unit	Area (ha, rounded)	Average Increment (m ³ /ha/yr)	Annual Allowable Cut	Available Annual Allowable Cut
Eucalyptus plantations	63 600	6.2	394 000	236 400
Young plantations and coppice (mainly <i>Eucalyptus spp.</i> and <i>Acacia spp.</i>)	62 700	10.3	645 800	387 600
Pine plantation (<i>Pinus spp.</i> , <i>Cupressus spp.</i> and <i>Callitris spp.</i>)	12 100	8.6	104 100	62 300
Woodlots and tree resources outside forests (<i>Eucalyptus spp.</i> , <i>Grevillea spp.</i> , <i>Pinus spp.</i> , <i>Cupressus spp.</i> ; <i>Callitris spp.</i> , <i>Acacia spp.</i> , <i>Alnus spp.</i> , <i>Casuarina spp.</i>)	162 800	10.8	1 758 200	1 319 000
Grand Total	301 200	-	2 902 000	2 005 000

Note: Available Annual Allowable Cut means Annual Allowable Cut in prevailing conditions of ban on harvesting public forests which make up 40% of plantations with 0.5 ha or more and about 25% of woodlots and tree resources outside forest (TROF).

The projections of current potential wood supply and in the future (*Table 24*) are estimated on the basis of average MAI values computed from the ISAR Forest Inventory in 2007, the political target of attaining 30% forest cover in year 2020 and thus annual forest area increment until 2020 of 10.1% and no area increment afterwards. Scenario 1 refers to Annual Allowable Cut (m³) on the basis of total forest area while Scenario 2 refers to Available Annual Allowable Cut (m³) i.e. allowable in prevailing conditions of the ban on harvesting public forests which make up 40% of plantations with 0.5 ha or more and about 25% of woodlots and TROF. The peak of 7.6 million m³ of potential wood supply will be attained by 2020 with Scenario 1 while it is fixed around 5.25 million m³ with Scenario 2.

Table 24: Projections of potential and sustainable supply of forest products (1000 m³).

Type of forests	2010		2015		2020		2025		2030	
	Scen 1	Scen 2								
Plantations >0.5 ha	1 144	686	1 851	1 110	2 994	1 796	2 994	1 796	2 994	1 796
Woodlots <0.5 ha	1 758	1 319	2 845	2 134	4 603	3 452	4 603	3 452	4 603	3 452
Total	2 902	2 005	4 696	3 244	7 597	5 248	7 597	5 248	7 597	5 248

7.2 Demand scenarios and projections

Based on various reports on wood consumption, wood markets and a sawmill survey 2011, BEST survey (2008), FAO (2010) and BNR (2010), the demand for wood products in 2010 is provided in *Table 25*. It is clear that comparing the Annual Allowable Cut in *Table 23*, there is a great deficit and if the estimates are true, the risk of rapid depletion of forests is evident. However, it is worth noting that most domestic woodfuel is not actually harvested through clearcutting but simply through using prunings, thinnings and other alternative fuel sources such as crop residues and shrubs that are not usually included in the estimation of wood supply potential. It would therefore be reasonable to say that the virtual wood deficit may not turn out to be real.

Nevertheless, during the market and saw mill survey in January 2011, most of the timber businessmen (82%) said that there is a great shortage of sawn wood particularly in Kigali city. Furthermore, the locally produced timber is of low quality due to poor processing facilities (most wood is sawn manually with pit saws and even some use chain saws). Therefore, there is high wood wastage such that the conversion efficiency is as low as 18-30% (LTS, 2010).

Table 25: Production, trade and consumption of wood and wood products (2010). Sources: Various reports on wood consumption, survey 2011, FAO (2010) and BNR (2010).

Forest products, all from plantations and woodlots	Production	Imports	Exports	Consumption
Woodfuel (firewood and charcoal) (1000m ³)*	1 395	-	<1	4 071
Industrial roundwood (1000m ³)	432	1,686	0.1	434
Sawnwood (1000m ³)	108	12,000	0.1	120
Pulp for paper (tons)	NA	244	NA	-
Paper and paperboard (tons)	NA	4 245	2 550	-
Domestic poles/construction material (1000m ³)	178	-	-	178
Honey (tons)	3 422	-	-	-

Note: Woodfuel (firewood and charcoal) production is estimated as total Available Annual Allowable Cut subtracting the Industrial roundwood processed to sawnwood at 25% conversion efficiency and domestic poles consumption (assumed equal to production).

The projections of demand for wood products is based on a 2010 baseline and Vision 2020 targets of current population increment of 2.6% per annum, going down to 2.2% by 2020 and afterwards, and increasing wood conversion efficiency from 25% to 35% sawn (*Table 26*). The apparent wood deficit will continue therefore to rise despite measures to increase forested areas and sawn wood conversion efficiency. However, measures to reduce woodfuel consumption to 50% by year 2020 (Vision 2020) will likely contribute to reducing the gap between the supply and demand for wood products in the long run.

Table 26: Current and future demand of plantation and natural forest wood.

Forest product	2010	2015	2020	2025	2030
Woodfuel (firewood and charcoal) (1000 m ³)	4 071	4 583	5 160	5 753	6 414
Industrial roundwood (1000 m ³)	434	513	578	644	719
Sawnwood (1000 m ³)	120	135	152	170	189
Domestic poles (construction material) (1000 m ³)	178	200	226	252	281
Total	4 802	5 432	6 116	6 819	7 603

7.3 Consumer prices 2010

At present, there are no large commercial wood processing operations in the country. The main traded forest products are fuelwood, charcoal, construction wood (such as poles and posts) and sawnwood. Sawlogs are mainly sawn by hand.

The forest trade flow in Rwanda is a mix of direct consumption, barter and sales. For commercialised products, the prices vary from one place to another (generally being higher in major towns and the city of Kigali), from one species to another and from one diameter class to another. The official prices were set by the forestry service by grouping species into different categories and diameter classes depending on the product. For example for sawn wood, species were grouped and priced as shown in *Table 27* (MINITERE, 2006). Firewood and building poles had also their specific prices depending on class diameter.

Table 27: Fixed prices of standing wood for saw timber (MINITERE, 2006).

Diameter class	Species group; price per m ³ in Rwf (US\$)			
	<i>Pinus spp./Grevillea robusta</i>	<i>Cypress, Cedrela, Jacaranda</i>	<i>Eucalyptus, Acacia, Araucaria, Polyscias</i>	<i>Indigenous hardwoods (Entadrophragma excelsum/Markhamia)</i>
16-19 cm	1000 (2)	1200 (2)	-	-
20-29 cm	2000 (4)	2500 (5)	4500 (8)	5200 (9)
30-39 cm	3000 (5)	4000 (7)	4700 (9)	5300 (10)
40-49 cm	4000 (7)	4500 (8)	5000 (9)	5600 (10)
50-59 cm	4500 (8)	5500 (10)	5300 (10)	6500 (12)
60-69 cm	5000 (9)	6000 (11)	6000 (11)	7500 (14)
>70 cm	5500 (10)	6500 (12)	6500 (12)	8000 (15)

Note: Exchange rate in 2006: 1 US\$=550 Rwf

Government fixed prices have not changed since 2006 and, in many cases, they are not respected neither by buyers nor sellers. Normally, prices are determined through free market principles from source to consumption sites. Average prices for sawn timber from locally grown and sawn wood in Kigali in 2010 range from 100-112 US\$ per m³ for Eucalyptus, Grevillea and Cypress, to 190 US\$ for pines. Imported fine hardwoods fetch much higher prices, from 260 US\$ per m³ for Markhamia to as much as US\$ 680-750 for mvule (*Milicia*) and mahogany (*Entadrophragma*). A bag of charcoal (c. 35 kg) sells for US\$ 11.

It should be noted that timber traders interviewed during the survey by the author indicated a general shortage of sawn wood in the market. The demand is much greater than the supply. With the exception of imported forest products, private forest plantations and woodlots supply the bulk of forest products traded in the country. Most of the imported timber (about 10% of sawnwood consumed in the country) comes from the Democratic Republic of Congo (DRC).

7.4 Forest products trade

Statistics for wood and wood products trade gathered from FAOSTAT (2011), own survey and literature are provided in *Table 28*. Since there is no harvesting from natural forests (in principle all are protected) all the forest products are extracted from forest plantations and woodlots.

Table 28: Trade in wood and wood products 2005–2010. Sources: FAO (FAOSTAT 2011, Survey 2011, RwandaSTAT (2011).

Year	Woodfuel m ³	Sawnwood m ³	Industrial roundwood m ³	Woodbased panels m ³	Pulp for paper tons	Paper and paperboard tons
Imports						
2005	25	62	279	2,131	171	3 730
2006	-	85	137	2,351	171	3 730
2007	88	59	940	2,698	171	3 730
2008	56	8 508	6 368	8 416	171	4 156
2009	426	4 048	1 686	3 313	244	4 245
2010	-	12 000	1 686	3 313	244	4 245
Exports						
2005	-	86	143	-	-	240
2006	-	86	143	-	-	240
2007	-	86	143	-	-	240
2008	20	135	92	69	-	240
2009	20	104	110	192	-	2 550
2010	20	104	110	192	-	2 550

8. FOREST ROYALTIES AND OTHER REVENUES

8.1 Forest royalties and licences

8.1.1 Structure and amount of forest royalties and licenses

Since the ban on harvesting of public forest plantations in 2000, no licences have been issued. However, prior to 2000, the forest law prescribed payment of 1% of total value of cut products from public forests and from private forests bigger than 2 ha and a flat fee of Rwf 2000 (about US\$ 20 in 1988 but now less than US\$ 5) by applicants for harvesting and forest products transportation permits. All these fees are still paid by private plantation dealers. Generally, until last year (2010) even owners of woodlots less than 2 ha had to apply for a harvesting permit and pay various fees to the local government and national forest fund (FFN).

Nevertheless, even though private forest plantation owners pay taxes and other contributions in order to obtain harvesting permits from local governments, these payments cannot be easily separated from other taxes due to poor recording systems of sources. Even penalties paid for contraventions related to forestry business such as transportation of illegal timber, illegal harvesting and transportation of forest products, etc. are entered in the general basket “*recettes*” (revenue) account. Such penalties vary normally between US\$ 88 to 120. Therefore it is not easy to know exactly which income is accruing from forestry related activities or from other activities.

8.1.2 Suggestions for improvement of forest charges and licences

Regulation and fiscal incentives are among the tools that could help enhance perception of forest charges and licences. For example, currently most contraventions are reported in charcoal production and transportation. If the Government explicitly declares that charcoal is not an illegal commodity and that the production of charcoal is allowed for all people, more taxes and other fees could be recovered than today. Instead of restriction, the government could direct more efforts towards developing the charcoal business into a more professional pursuit. Such a policy could also improve the quality and efficiency in charcoal production and hence reduce quantity of wood used. GTZ (2008) recommends also the establishment of a unique charcoal transport tax, which is to be levied on every bag of charcoal transported instead of the current system where multiple taxes are paid on forest products from the producer to the consumer. This would reduce the time for processing permit documents. Moreover, this would likely reduce possibilities for fraud at all levels (from producer to consumer) in the search of escaping some taxes.

8.2 Forest concessions/permits

8.2.1 Current concessionaires/permit holders

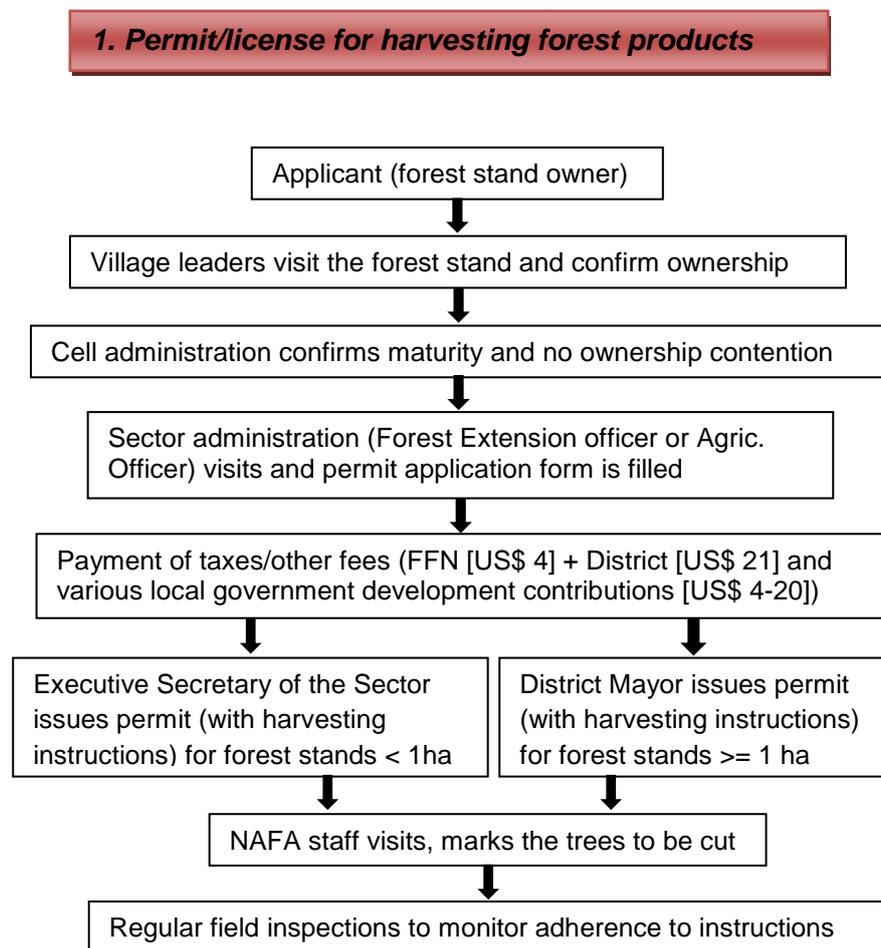
There are currently no concessionaires in the country because all harvesting in public forest plantations is prohibited since 2000. Currently, harvesting permits are issued either to private forest plantation/woodlot owners or to forest dealers who have purchased private forest stands. However, the ban on harvesting public forest plantations is likely to be lifted soon after the adoption of the new Forest Act which has passed the government cabinet and is now at the level of parliament. In fact, there is one UK based company which is currently negotiating the acquisition of a concession of forest plantations in the buffer zone around Nyungwe National Park. Another pre-requisite to lifting the ban on harvesting of public forest plantations is the requirement of the old Forest Act that each District should first develop a forest management plan (PAFD). All Districts (30) have recently finished the elaboration of their PAFDs with support from the PAFOR and PAREF projects (NAFA staff, pers. communication). However, they have not been approved yet for implementation as this should go hand in hand with the new Forest Act.

8.2.2 Monitoring of compliance

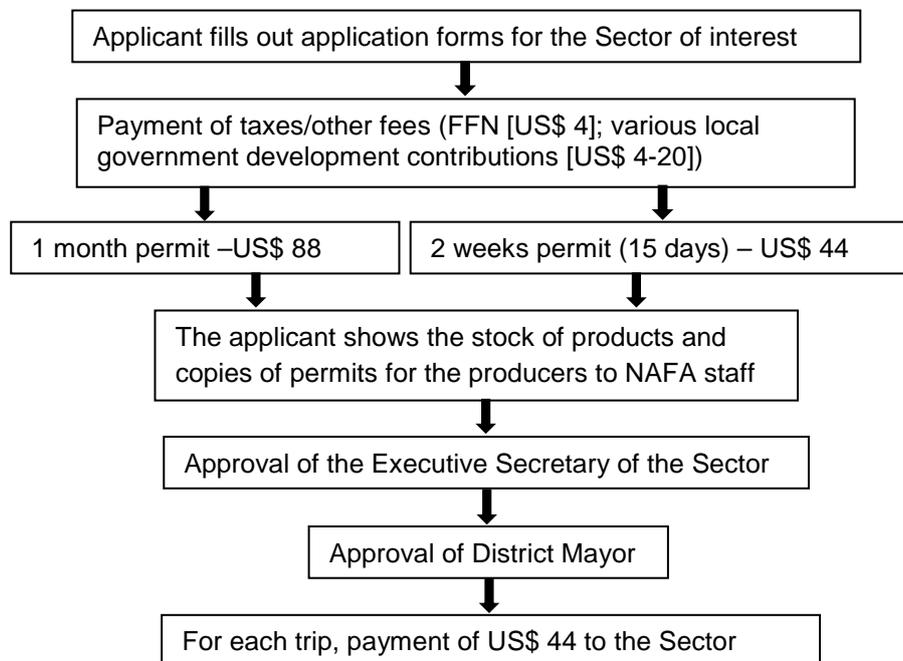
As said earlier, since a forest is considered as public good in Rwanda, even harvesting in private forests/woodlots is subject to permit regulation. In fact, although the old Forest Act talks about private forests above 2 ha, until 2010, even to harvest woodlots below 0.5 ha, the owner needed a permit. The process of acquiring a permit for harvesting or transporting forest products in Nyaruguru District (a District in the Southern Province) is shown in *Figure 11*. Prior to 2006, most of the forest regulation decisions were made by the central government. After the decentralisation process of 2006 which reorganised the administrative structures of the country into fewer administrative units more decision making powers were entrusted to local governments. It is in line with the decentralisation process that even the process of issuing permits for harvesting, transporting and commercialisation of forest products was delegated to local governments in 2006. However, according to the Field Programmes Unit Director at NAFA, in order to reduce reported abuses, a recent ministerial order has reclaimed the issue of harvesting permits on forest stands of one ha or more or on stands with an estimated value exceeding one million Rwf (about US\$ 1 700).

The process of applying and getting a permit can take from one month to even two years or indefinitely depending upon the queue of people on the waiting list or the will of the forest officer. This is because the number of permits issued per month in the Sector is far less than the number of applicants. In fact, in Nyaruguru District, charcoal makers reported that people with low incomes have renounced applying for permits because *"they can't afford to wait that long"* (LTS, 2010). Therefore, poor woodlot owners usually opt to sell their stands to businessmen at a low price instead of applying for a permit as they are not sure when the permit would be issued. Sometimes they can't afford to pay for the required taxes and development contributions required in order to be given the permit. This situation is likely to create an environment of corruption and may ultimately reduce the enthusiasm for planting new trees and may undermine the practice of good silviculture and management.

Figure 11: Permit and Licensing processes and related payments in Nyaruguru District, Southern Province in 2010 (1US\$= 572 Rwf) (LTS, 2010).



2. Permit/license for transportation of forest products



8.2.3 Suggestions for improvement of concessions/permits

Most forest dealers involved in the production and commercialisation of forest products are complaining about the process of issuing permits by local governments. The current system is neither transparent nor consistent and many forest actors are not happy about it. Therefore, the issue of permits for harvesting and distribution of forest products needs to be reviewed, improved and harmonized throughout the District (and the country) to take account of the needs of the applicants while ensuring that policy and law are effected. Small woodlots up to 2 ha should be exempted of harvesting permits as it is clearly stated in the old forest law. The control of production should be left to market regulations instead of refusing harvesting permits to needy woodlot owners.

8.3 Administration of forestry revenue system

8.3.1 The process of setting forest royalties and taxes

In order to reduce reported abuses at the level of local government, a recent ministerial order has reclaimed back the power to issue harvesting permits on forest stands with one ha or more or with estimated value exceeding one million Rwf (about US\$ 1 700) from the District and entrusted it to NAFA. Generally, in most districts, the practice was to allow administrative Sectors to set taxes and other contributions from the permit applicant with a woodlot below one ha while from one ha and more the District Council would decide the taxes and other payments related to various development contributions in the District before the Mayor issues the permit (*Figure 11*). That is to say, each Sector and each District had different tax and payment rates. However, the only payment common to all local governments is the FFN contribution fee (royalty fee) which is legally 1% of the value of the produce (ROR, 1988) although the practice is a flat rate of about 4 US\$ (at

2011 exchange rate) per permit. Each person requesting for a harvesting or a transportation (of forest products) permit is required to pay this flat fee in favour of FFN.

Before the harvesting ban in 2000 royalties for harvesting in public forests were set by ministerial orders/ instructions (issued by the Ministry in Charge of Forestry Service). It should be noted that the Forestry Sector has been shifting between many Ministries (which also complicate the search of forestry statistics) including MINAGRI (until 2003), MINITERE (2003-2007), MINIRENA (2007-2009 & 2011) and MINIFOM (2009-2010).

8.3.2 Monitoring and collection of revenue

The NAFA staff and ordinary traffic police normally follow up the adherence of forest dealers to regulations in the Administrative Sector and the District including control of harvesting instructions and harvesting, transport and commercialisation permits. Any contravention is generally fined, the amount depending on the type of offence, including confiscation of products and payment of fines. For example, when a forest dealer is found transporting forest products without licence, the Ministerial instruction of 2006 prescribes payment of a fine of 50 000 Rwf (US\$ 88). But some Districts have different rates. For example, in Nyaruguru District, Southern Province, instead of charging the fine of 50 000 Rwf (US\$ 88), they charge 70 000 Rwf (US\$ 120) to transporters of forest products without licence (LTS, 2010).

In order to restrict corruption, all payments are normally done in a nearby bank and a receipt is issued upon exhibition of a deposit slip for corresponding charges. No police or NAFA staff is allowed to receive cash.

8.3.3 Total forest revenue collection

It is not easy to know the exact amount of revenue generated from forestry business due to the nature of the business which is a mixture of direct consumption, barter or other informal exchange mechanisms and market sales. Another difficulty in getting correct statistics is the fact that in many reports forestry revenue is reported combined with other sectors such as agriculture or environment. In a recent study, LTS (2010) estimated the annual turnover from forestry business to about US\$ 180 million (*Table 29*).

Table 29: Estimated turnover from forestry business (LTS, 2010).

Product group	Basis of estimate	Annual estimated turnover (1000 US \$)
Charcoal	Assume 100% ultimately commercial	46 985
Firewood	Assume 25% commercial	96 413
Sawn wood	Assume secondary and further processing adds 2.5 times basic primary value	20 000
Round timber, poles	Assume 50% of overall value is traded turnover	16 000
Total		179 398

It is not easy to separate government revenues from wood products business due to poor recording system on sources of income. Forest products are generally grouped with agricultural products, mainly because Forestry has long been under the Ministry of Agriculture. Therefore, only total revenues in the form of contribution to the national GDP are reported (BNR annual reports, 2003, 2004, 2009 and 2010). This shows that, whereas annual contribution of the forest sector between 1995 and 2003 ranged between US\$ 18 and 23 million, it started to increase in 2004, to 45 million, and the last three years (2008-2010) it has been between US\$ 123 and 132 million. The increased contribution of forestry products to national economy may be due to reforms in the revenue collection systems especially with the introduction of the value added tax (VAT) and increased policing on different routes to Kigali city.

Considering that most royalties/licenses fees are deposited in the FFN, *Table 30* was compiled on the basis of bank statements for the FFN account from July 2004 to June 2011 (NAFA, Finance Department). Given the current recording system of revenues, no attempt was made to assess

income penalties because it is not easy to differentiate fines directly imputed to forestry infractions or illegal forestry dealers from those collected from other closely related sectors such as agriculture, environment and other natural resources.

Table 30: Evolution of the National Forest Fund account from 2004 to 2011. Source: NAFA, Finance Department

Year	2004	2005	2006	2007	2008	2009	2010	2011
1000 US\$	145	195	589	697	699	835	977	1 012

8.3.4 Suggestions for improvement of revenue collection systems

The current situation where each sector or District establishes its own rules and taxes needs to be reviewed and amended in order to have a more transparent and consistent revenue collection system. More uniform regulations that apply country-wide together with a clear system and a defined performance level should be adopted and monitored by NAFA.

9. PROCESSING OF PRODUCE

9.1 Ownership and types of industries

In Rwanda, there are no large commercial wood processing operations at present. The main commercial forest products are firewood, charcoal, construction wood (poles, posts and saw timber), and sawn wood for furniture. Wood is generally sawn by hand using the pit sawing technique with a frame constructed from poles set on a slope to allow access underneath the log (*Figure 12*). Some sawlogs are even sawn using chainsaw! Sawing and wood working machines are only found in Kigali City and some major towns for processing and finishing already sawn timber before actual consumption in carpentry, woodcraft and construction industry.



Figure 12: Pit sawing Eucalyptus sawlogs.

The wood processing business sector is generally characterised by individual businessmen and informal groups. There is no industrial scale processing. Pitsawyers, secondary processors and charcoal makers are informally organised into cooperatives and self-formed associations (Table 18). One of the famous cooperatives processing sawn timber operates in Kigali is called ADARWA (*Association pour le Développement de l'Artisanat au Rwanda*). ADARWA was initiated in 1988 but its legal constitution was approved in 1998 and signed by 80 members and in 2010 the membership increased to 114 timber businessmen. Most sawn timber used in Kigali is handled by ADARWA, which imports or purchases, processes and distributes timber in Kigali City. In 2009, (Records, ADARWA), it handled (processing/resale) 1 700 856 pieces of sawn timber equivalent to 44 222 m³ (at average conversion ratio of 0.026 m³/piece). ADARWA also provided employment to 3 500 people in 2009 through various activities including carpentry, casual labour and timber transportation.

Before 1994, there was one Match making plant called SORWAL (*Société Rwandaise des Allumettes*) which used to produce match boxes but after 1994 its performance deteriorated and it was closed in 2008 pending payment of Government taxes and staff salaries amounting to c. US\$ 3 million. The plant has a capacity of processing 2 160 m³ of wood, but in 2001 it was processing only 760.5 m³ (Mihigo, 2001). Negotiations are currently on-going in order to operationalise the plant and increase its production to full capacity.

Table 31 shows the current and potential capacity of forest product processing industries in the country.

Table 31: Current and potential capacity of forest industries utilizing plantation and natural forest wood and NWFPs 2009. Sources: Own survey (2011), Mihigo (2001).

Owner	Type of forest industry	Current capacity (m ³)	Integration with forest plantation	Potential capacity (m ³)
ADARWA	Sawmills, wood processing	40 000	Middlemen for sawn timber transportation	70 000
SORWAL*	Match production plant	760.5	Outgrowers/ Woodlots	2 160

Note: SORWAL is currently not operational

9.2 Raw material supply and quality

Sawing efficiency is very low with conversion figures around 15% to 20% from round volume to sawn product (LTS, 2010). The low sawing efficiency mainly results from the relatively small size logs, the sawing to standard length regardless of log characteristics and the use of hand technology without any aids to ensure quality. Furthermore, the handling of sawn timber is poor with poor stacking techniques used. With the exception of Kigali City and a few other towns where some second hand wood working machines are found, secondary wood conversion is carried out mainly with hand tools. Much of the wood used in final products has therefore relatively low quality requirements since the handling and conversion process is inefficient with considerable degradation. However, wood wastes are efficiently used in urban areas as fuelwood by individuals and institutions with large population such as prisons, schools and restaurants.

During the survey of January 2011, most workshops and timber dealers visited complained that there is insufficient supply of sawnwood in general and more inadequate for the imported premium timber in particular. This justified the high prices particularly in Kigali City for quality timber like Libuyu (Mahogany species), *Markhamia lutea* (Umusave) and *Milicia excelsa* (Mvule) which are imported mainly from DRC and Uganda.

9.3 Constraints facing the sub-sector

The major constraints facing the wood processing sector include inadequate human and financial capacity, predominance of hand tools in wood processing (even though replacing employment opportunities by mechanised systems may not be desirable in a country with abundant unskilled labour), poor accessibility to most big forest plantations and lack of exploitable large block forest plantations. All these constraints limit the span over which large scale wood processing industry may be relevant and profitable in Rwanda. For example, the management of NAFA revealed to me recently that a major forest industry investment opportunity (for sawmilling and replanting) in

forest plantations around Nyungwe National Park is being negotiated with a UK based company. The issue here is that steep topography and hence extraction costs may limit the company to operate competitively against pitsawn material with current timber prices even though there should be gains in efficiency, quality and value addition through proper seasoning.

9.4 Potential for future investment

Given the ever increasing demand of good quality forest products, multiple investment opportunities exist in the country, especially in sawn timber processing. However, there is a huge need for investment in human resources and social capital of the sector. This investment in human resources will eventually have great impact on quality of processed products and is probably more urgent than even the physical capital in Rwanda. *Table 32* provides estimates of future projections of capacity of forest industries in the country.

Table 32: Future projections of capacity of forest industries utilising plantation wood (2015, 2020, 2025, 2030).

Owner	Type of forest industry	Capacity in m ³ (rounded to nearest 100)			
		2015	2020	2025	2030
ADARWA	Sawmills (Sawn wood processing)*	59 300	75 600	96 500	123 200
SORWAL & Others	Match production plant/ Wood panel plant	3 200	4 000	5 100	6 600

Note: Assume 5% annual increase (from records since 2006).

10. SOCIO-ECONOMIC AND ENVIRONMENTAL CONTRIBUTIONS OF FORESTS

10.1 Income generation

10.1.1 Current income

The contribution of Forestry to the GDP is reported to be US\$ 132 million in 2010 (BNR, 2010). Nevertheless, based on a number of sources, field visits and interviews with timber businessmen, LTS (2010) estimated the overall business turnover from forestry business to be around US\$ 180 million per annum. In their estimates, woodfuel appeared to account for more than half of the value. Thus, the value of the forest processing sector would be making up around 10.6% of national GDP even though the actual financial contribution is very much less (on average slightly less than 2%). LTS (2010) further argues that adding the value of the forest resource base itself would bring the overall value of the sector well over 15% of the GDP. The recreational value of forests (tourism) being assessed separately, service values, although they have great potential contribution, were not included in the assessment of forestry contribution to the national economy.

10.1.2 Potential for income generation

Assuming that the value of US\$ 132 million in 2010 is the baseline and that due to fast economic development anticipated by vision 2020 (around 7% growth rate of the GDP) and the likely lift of ban on harvesting public forests, the income from forestry operations will eventually be boosted to an average of 5% increment per annum, potential income in the future is presented in *Table 33*. The potential income from forest industries is based on the assumption that the Match making plant in the country will soon be operational again at full capacity. One timber treatment and one

wood panel plants are also envisaged in the NAFA plans (NAFA staff, pers. communication), earning at least US\$ 10 million annually with at least 5% increment each year by 2015.

Table 33: Potential income in industrial forest plantations, natural forest management and processing industries (2015, 2020, 2025, 2030).

Sub-sector	Potential income (million US\$)			
	2015	2020	2025	2030
Forest plantations	168	215	274	350
Forest industries	10	13	16	21

10.2 Employment

10.2.1 Current employment

In the absence of clear statistics on employment in the forestry sector, it is worthwhile reporting estimates provided by LTS (2010) for the wood processing sector (*Table 34*). In total, the timber processing sector employs about 100 000 people. The actual employment in forestry activities including tree planting and tending, forest nursery, wood working and recreation is, however, well above this.

Table 34: Estimated employment in the wood processing sector 2010. Source: LTS (2010).

Products	Number of people employed				
	Primary Production	Transport	Selling	Secondary Processing	Total (%)
Charcoal	10 500	7 875	5 250		23 625 (23)
Firewood	5 935	18 375	12 250		36 560 (36)
Sawnwood	9 000	4 500		18 000	31 500 (31)
Round wood	1 000	4 000	1 000		6 000 (6)
Imported timber		450		3 006	3 456 (3)
Total	26 435	35 200	18 500	21 006	101 141 (100)

10.2.2 Potential for employment creation

Assuming 5% annual increment of employment in the Forest sector at the same pace with potential income increment, projections for future potential employment in forest plantations and industry is provided in *Table 35*. By 2015, the forest industries are projected to employ at least 1 000 people through various production chains (from harvesting to actual processing in the factory) with an estimated 5% annual increment afterwards.

Table 35: Potential employment in industrial forest plantations, natural forest management and processing industries (2015, 2020, 2025, 2030).

Sub-sector	Potential employment (rounded to nearest 100)			
	2015	2020	2025	2030
Forest plantation	129 100	164 700	210 300	268 400
Forest industries	1 000	1 300	1 600	2 100

10.3 Plantations in forest conservation

The main objectives of forest establishment and management in Rwanda are generally to achieve wood production for various uses and environmental protection on a sustainable basis. Accordingly, the integrated management for wood products and services is generally prominent in the planning of silvicultural operations and forest management. Other objectives may include the contribution to socio economic development of forest owners and other services such as recreation or carbon sequestration.

In Rwanda, trees and forest plantations are established on marginal sites not suitable for agricultural uses. Marshlands are excluded from forest plantation establishment due to their special conservation status. For ecological purposes, buffer zones to natural forests and national parks, bands for protection of rivers and lakes, and roadsides are also classified as potential afforestation land. The Forest Act stipulates that such sites need to be planted with appropriate species to avoid negative impact on soils, water yield, hydrological cycle, fauna and flora. Generally, besides meeting forest products demand, buffer zones serve as clear delimitations of protected areas and act as barrier to abuse of the core zone.

Some dominant plantation species such as Eucalypts and *Pinus* do not allow undergrowth, especially when they are planted at small spacing. Nevertheless, natural regeneration of indigenous tree species in the buffer zone of Nyungwe Forest has been recorded in cypress and pine plantations by Mbonyimana (1994), Mulindahabi (1994) and Gapusi (2007). In a study around Nyungwe buffer zones, Gapusi (2007) found that indigenous species that regenerate in the buffer zone forest plantations represent 10% of the tree species identified in the Nyungwe National Park. Species richness and abundance were highest in *Cupressus lusitanica* stands and least under Eucalyptus stands. Gapusi (2007) further carried out a survey in settlements around the Nyungwe buffer zone and found that 75% of respondents appreciated biological benefits from the buffer zone plantations against 65% for social benefits and 34% for economic benefits. Some of the forest products collected from the buffer zone plantations include firewood (48%), medicinal plants (41%), art craft raw material (41%) and honey (76%).

Most forest plantations with high growth rates, e.g. some Eucalyptus species, use large amount of water daily for their growth. This has led to the on-going debate on merits and demerits of plantations with Eucalyptus species. In Rwanda, it is prohibited to plant Eucalypts in marshlands. The current policy also promotes plantation of indigenous tree species which are slow growing and use less water along water courses and in catchment areas.

The role of forest plantations in carbon sequestration is also increasingly acknowledged and in the current context of climate change, several carbon trade initiatives as well as REDD projects are mushrooming worldwide. Rwanda has already developed a carbon policy and there are now several activities currently under way by the Clinton Foundation, ICRAF, VI-Life, FAO, IFAD (KWAMP project) and others, exploring the development of carbon credits through increasing soil carbon stores, agroforestry and other activities (SSEE & ROR, 2011). The Clinton Hunter Development Initiative has already assisted in planting of about 2 million seedlings since 2008 with the aim of buying carbon from private farmers.

11. CONCLUSIONS AND WAY FORWARD

11.1 Conclusions

The current situation of public and private forest plantations/woodlots in Rwanda was assessed with respect to the distribution and location of these plantations, species planted and sources of seedlings and seeds, age distribution of forest plantations, their management and quality of stands and other features. The country has made a lot of efforts to establish plantation forests since the 1970s. Tree planting was generally driven by urgent needs to achieve two major objectives, namely conservation of fragile landscapes and meeting the ever increasing demand of forest products by the growing population. As a matter of fact, Rwanda's landscape is now well dotted with trees and woodlots scattered on farmlands.

Nevertheless, statistics on forest plantations extent and ownership is unreliable at the best and non-existent as a rule because no comprehensive forest inventory has been carried out so far. Consequently, many scholars who have worked on the forest sector in Rwanda have used varying statistics on area, ownership, management systems and resulting production, consumption and projection estimates. This is one of the most critical bottlenecks that the National Forestry

Authority should address urgently in order to have an adequate basis for planning and development of the sector.

The study further assessed the existing incentive schemes that could favour rapid forest plantation establishment by the public and private sectors, and outgrowers schemes by individual farmers in the country. Particular attention was given to availability of land for forest expansion and of quality germplasm, financing mechanisms for plantation forestry, private sector involvement, policy and environmental issues, including land and forest and tree tenure issues, biodiversity considerations, and legislation and governance issues; and potential for additional revenues from carbon trade projects. The study also provided options for establishment, expansion and improved management of public and private forest plantations, including ways to overcome existing and potential constraints.

Through market and literature surveys, the study managed to estimate supply and demand scenarios of plantation wood volumes for 2015, 2020, 2025, and 2030. An in-depth analysis of the current revenue collection systems, revenues collected annually, licensing/concession procedures, forest and tree tenure, management arrangements and pricing mechanisms for roundwood and industrial forest products was also carried out. The study pointed out that the lack of adequate and systematic recording system of forestry business transactions is a great handicap to the development of forestry. Indeed, it was noted that taxes, penalties and other revenues from forests and related activities are recorded under the general basket of incomes from either the agricultural or environment sector. The current forest fiscal system, together with the recording systems of income sources, need to be revised if more revenues are to be collected from the forestry business and forestry be attributed its true economic value in the development of the country.

As much as possible, the current income and employment data were provided and estimates of the potential for income generation and employment creation for 2015, 2020, 2025, and 2030, were further established. The study also analysed the processing of industrial round wood from plantations in the country, ownership, its current and potential capacity, wood raw material supply (sources, types, and adequacy), product lines and quality of produce, potential for future investment in the sub-sector, constraints facing the sub-sector, future of the processing industry, growth and constraints. It was observed that there are no large scale forest industries in the country and still the supply of quality timber is inadequate. Most of the premium timber and other finished wood or wood simulated products are imported from neighbouring countries (mainly from DRC and Uganda) or Dubai and China. However, there are multiple opportunities for investment that would contribute to developing the forest sector in the country. Some such investments may include introduction of modern sawmills, wood based panel plants and timber treatment plants, ecotourism, etc. The country has also opportunity to tap from the mushrooming carbon trade initiatives in order to strengthen its forestry sector.

11.2 Way forward

The reforestation efforts manifested since the 1970s should be continued in order to meet the vision of attaining 30% forest cover by 2020. This would allow not only narrowing the current gap observed in the wood supply and demand function but also pursuing watershed management initiatives to protect fragile landscapes and biodiversity.

The lack of reliable statistics for proper planning is a great bottleneck to developing the forestry sector. Therefore, there is an urgent need for a comprehensive forest inventory and assessment of trees outside forest in order to get reliable planning statistics which is the basis for sustainable forest management in the country.

The forestry estate has not been clearly demarcated yet in the country and this makes it difficult to monitor encroachment and excision of forest lands. There is therefore a great need to establish a forest cadastre linked to a Geographic Information System (GIS) that would ensure that all classified forests are well managed and monitored. This would also facilitate collection of forest royalty and other forest taxes in the country.

The existing incentive schemes are not sufficient to attract more private investors in the forest sector and most people still find it too risky to invest in forest plantations. More incentive schemes,

including financial credit systems and special clearance of forest products and equipment, could possibly attract more investment in the sector.

The lack of an adequate and systematic recording system of forestry business transactions is a great bottleneck to the development of a profitable forest business in the country. Forest actors should be educated on record keeping so as ensuring easy monitoring and evaluation of the performance of the sector.

The revision and updating of the forest legislation need to be quickly concluded and implementation started in order to clear up confusion in the minds of many forest actors. The forest fiscal system should also be revised in order to collect more revenues from the forestry business but also attract more forest investors through equitable taxation and clean systems at all levels.

Despite the fact that the country is small and consequently large block forest plantations are not possible, limited industrial activities, such as the installation of wood based panel plants, timber treatment plants, introduction of modern sawmills and development of ecotourism can be promoted in order to raise more income from forest plantations/woodlots and also to limit dependence on imported finished forest products. The Match production plant should also be revived because it has good machinery that is now rotting under idleness

Given poor quality of forest products processed in existing wood processing workshops, there is need to introduce certification systems of forest products.

The country lacks human resources capacity in terms of quality and quantity and therefore more efforts should be invested in building the capacity of the forest sector in skilled human resources. The creation of a fully-fledged forestry vocational training centre would cater for this urgent need in the country.

There are many initiatives in the current context of climate change mitigation and adaptation, forestry carbon trade projects, especially the voluntary carbon market, should be initiated and up-scaled throughout the country.

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