A report prepared for the project

Lessons Learnt on Sustainable Forest Management in Africa

FOREST PLANTATIONS IN SUB-SAHARAN AFRICA

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by

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1.0 INTRODUCTION

Large-scale plantation forestry in various countries of Africa was preceded by many successful species and provenance trials, mainly of exotic species, from late 1800s to early/mid 1900s. In South Africa, the first commercial plantation of Eucalypts was established in 1876 (*Nordin, 1984,* in *Zobel et al., 1987*). However, the first extensive plantings of industrial tree crops in Africa occurred during the period 1900-1945, mostly in countries with little utilisable natural forest and where there had been an early influx of European settlers (*Evans, 1992*). In 1938, for example, South Africa had 520 000 ha of plantations of which 370 000 ha were privately owned (*SAIF, 2000*). For many countries, most species which later proved to be successful were introduced as trials in this period (*Evans, 1992*).

Further expansion occurred during the period 1945-65. Notable during this period was the establishment of over 80 000 ha of the Usutu forest in Swaziland. By 1965, there were 1 377 700 ha of planted forests in Africa (*Evans, 1992*), about 1 713 000 ha in 1980, and about 2 990 000 ha in 1990 (*FAO, 2001a*). With the exception of South Africa, most government investments in forest plantations in the period 1960's to 1980's was done with donor support. Rapid plantation expansion in South Africa and Zimbabwe has significantly substituted for supply from natural forests of industrial roundwood (*Kanowski, 1997*).

Despite the rapid expansion of plantation forestry from the 1960s, there were also failures. Valuable plantations were neglected or abandoned in some countries (e.g. Cameroon, Gabon, Liberia and DR Congo) due to budget cutbacks and inability to maintain an expansive resource (*Evans, 1992*) and to political instability. More recently, there has also been growing opposition from some environmental groups that plantation monocultures are unsustainable (see *Zobel et al., 1987, Cossalter & Pye-Smith, 2003*).

In 2000, the total plantation area in Africa was 8 036 000 ha comprising 3 392 000 ha industrial, 3 273 000 ha non-industrial and 1 371 000 ha unspecified plantations, which is around 4.3% of the global plantation area (*FAO, 2001a*). The annual rate of planting in Africa was estimated to be 194 000 ha. According to *FAO (2001a),* Africa's total plantation area and the annual planting area are the lowest among all the continents and appropriate policies and incentives need to be put in place to significantly increase these figures.

In Africa (*FAO, 2001a*), *Eucalyptus* is the most widely planted genus covering 22.4% of all planted area, followed by *Pinus* (20.5%), *Hevea* (7.1%), *Acacia* (4.3%) and *Tectona* (2.6%). The area covered by other broadleaved and other conifers is respectively 11.2% and 7.2%, while unspecified species cover 24.7%. Overall, the great majority of planted trees are exotic species chosen for their capability to grow rapidly to produce wood of desired quality (*Zobel et al., 1987, Tiarks et al., 1998*).

Ownership of plantations in Africa ranges from governments and large industrial corporations to individual farmers, and management varies considerably, from relatively simple and low-input to highly sophisticated and intensive systems (*Kanowski, 1997*). Industrial plantations are 52% publicly owned, 34% privately owned and 14% other or unspecified, while of the non-industrial plantations, 62% are publicly owned, 9% privately owned and 29% other or unspecified (*FAO, 2001a*). With the exception of South Africa (where about 72% of the plantations are owned by companies and small growers), plantations are mainly owned by governments (*CIFOR, 2000*). However, due to the many current restructuring programmes, it is quite likely that plantations will increasingly be under private or quasi-private ownership and management (*Kanowski, 1997*).

Although the plantation area in Sub-Saharan Africa (SSA) more than doubled during the last decade, the overall rate of increase is slow, particularly compared to the rapid global expansion of plantations (*FAO, 2001a*). All regions of Africa, with the exception of the North Africa, show small but positive trends in annual planting (*FAO, 2003a* and *2003b*).

Increased need for wood products, pressure for converting better forest lands to agriculture, destruction of indigenous forests by shifting agriculture and indiscriminate logging, increased areas being set aside for conservation or other purposes, and the difficulty in managing tropical hardwoods in fragile ecosystems, have all led to a realisation among responsible observers that proper use of plantation forestry is the only way to avoid shortage of wood in the near future (*Zobel et al., 1987*; *FAO, 1999a*). In addition, the increased need for wood for household and industrial energy, production of non-wood forest products, and afforestation for environmental purposes, such as windbreaks, shelterbelts, watershed rehabilitation, and, more recently, carbon sequestration call for the adoption of plantations as a viable option to meet these demands. The major argument for increased use of plantations, however,

remains to meet the increasing total and per capita demand for wood and wood products (*Cossalter and Pye-Smith, 2003*).

There have been very diverse wood production performances of planted forests ranging from over 30 $m^3ha^{-1}yr^{-1}$ to poor performances of 1-2 $m^3ha^{-1}yr^{-1}$ (*Zobel et al., 1987; Tiarks et al., 1998; FAO, 2001b; FAO, 2003a; FAO, 2003b*). This large variation in productivity is due to a number of factors, such as species/provenance selection, genetic improvement, species-site matching and cultural practices (*Kanowski, 1997; Vichnevetskaia, 1997; FAO, 2001a; FAO 2001b*). Productivity of plantations needs to be high and sustainable to be economically viable because of the large investment made (*Tiarks et al., 1998*). Also environmental and social impacts and functions of plantations must be considered when judging their sustainability (*FAO, 1999a*).

Despite the expansion and sometimes high yields of forest plantations in Africa, no comprehensive in-depth assessment of has been made of their long term sustainability. Such an assessment might provide an opportunity to learn about successes and failures and how successes can be replicated and failures avoided in future plantation investments. Thus, with particular reference to Sub-Saharan Africa, the objectives of this study are:

- To identify factors contributing to the long-term economic, social and environmental viability of forest plantations.
- To determine the extent to which forest plantations help to overcome the problem of wood supply.
- To determine the replicability of success stories and the necessary and sufficient conditions for promoting plantation forestry in Africa to achieve sustainable management.

This report is divided into eight main sections:

- background,
- issues pertaining to planted forests,
- case studies on public sector industrial and energy plantations,
- case studies on private sector industrial plantations,
- case studies on industrial wood production by farmers and out-growers,
- case study on environmental rehabilitation,
- lessons learnt on the development and performance of planted forests, and,
- summary of findings and recommendations.

2.0 KEY ISSUES PERTAINING TO PLANTED FORESTS IN AFRICA

2.1 Overall role of planted forests in the production of wood and other products and services

The increased demand for wood for domestic industries and for export and for fuelwood and charcoal, together with demand for an array of non-wood forest products (NWFPs), are some factors contributing to the pressure now exerted on natural forests in Africa. The pressure is escalating as a result of urbanisation, industrialisation and, above all, of human population growth.

Plantation forests have been often been considered as a “quick fix” solution to the perennial problems of over exploitation of the natural forest resources. The question is whether planted forests have the capacity to sufficiently and sustainably supply wood and non-wood products as well as other services, which the natural forests have hitherto provided to the industry and society. Estimates of global wood supply from planted forests range from 20% (*Sutton, 1999*) to 35% (*ABARE, 1999*). The sawlog estimate is less at 10% of global supply according to *Sutton (2003)*, who also admits that estimates of fuelwood supply from planted forests are not fully documented but that it is probably small. In general, the bulk of current fuelwood supply comes from natural forests and trees outside forests.

Plantations can augment and increase industrial and domestic wood supply, provided that the right species are planted in the right places and that proper management practices are put in place. The old practice of converting natural forests to plantations has had serious environmental implications as it causes loss of biodiversity, particularly in the case of the species-rich tropical rain forests, both lowland and montane systems (*Elliot, 2003*). From this particular point of view, plantations can thus not act as substitutes for natural forests. Instead, they should complement and mutually reinforce the environmental and production services of natural forests.

Several factors have contributed to the use of planted forests in Africa, e.g.:

- The rapid rate of exploitation of the natural forests, which is not matched by the rate of afforestation.
- The increasing demand for wood and wood products due to rapid population growth and increasing construction as a result of urbanisation.
- Increased rate of industrialisation in the post-independence years occasioned by the industry and import substitution-driven economic boom in the 1960's and 1970's.
- The slow growth and low yields of the indigenous natural forests, including of many valuable indigenous species when grown in plantations.
- The increasing export demand for timber and other forest products, which cannot be met from the natural forests.

Given the variation in climatic and ecological conditions on the continent, the relative difference in forest resource endowments, and the diversity in social, economic, cultural and political structures, some regional specificities and issues will be presented below.

2.1.1 West Africa

Countries included in this sub-region are: Benin, Togo, Ghana, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea Bissau, Senegal, Mali, Burkina Faso, Niger and Nigeria. Plantation forestry in West Africa started in the early 1900s. *FAO (2001a)* reports that the total area of tree plantations in the sub-region is 1 760 000 ha, which represents 21% of plantations in Africa. The annual planting rate is about 58 000 ha, mainly in Nigeria, Senegal, Côte d'Ivoire, Burkina Faso and Cape Verde (*AfDB, EC and FAO, 2003a*). Teak (*Tectona grandis*) has been extensively planted in West Africa, especially in Nigeria, Ghana and Côte d'Ivoire. In addition to its technical advantages of fast growth, high wood quality and resistance to fire, teak offers high commercial opportunities in the international commodity market.

The objectives of plantation establishment, the species planted and the intensity of management vary between the two ecological zones in West Africa, i.e. the humid and the Sahelian zones. In the humid zone, the emphasis is on high value industrial plantations, most of which are owned and managed by the public sector. They were mainly established to compensate for the rapid loss of natural forests. Today, the pace of plantation establishment has slowed down drastically because of financial constraints following declining donor support. In Côte d'Ivoire, attempts have been made to increase the area of plantations by requiring holders of natural forest logging concessions to replant their areas.

In the Sahelian zone, plantations are established mainly for fuelwood production and for providing improved environmental conditions, e.g. combating desertification through sand dune fixation and windbreaks. Eucalypts, neem (*Azadirachta indica*) and Australian acacias have been used in these schemes. It is estimated that 418 000 ha have been established for these purposes, mostly in Senegal where *Casuarina equisetifolia* is used extensively to stabilise dunes along the coast and for production of fuelwood. Green-belt plantations have also been established to protect cities such as Niamey from dust and to stop the advance of sand dunes.

According to *AfDB, EC and FAO (2003a)*, the current situation of forest plantations in West Africa can be summarised as follows:

- Plantations are unlikely to become a major source of wood supplies because the scale of plantation establishment is very low.
- Many plantations are under public sector ownership and management with attendant inefficiency in management, which affects their productivity and predisposes them to encroachment, illegal exploitation and damage by fire, pests and diseases.
- Domestic demand for high value plantations such as teak is very limited. This has resulted in dependence on overseas markets with consequent high costs of export. In this regard, Côte d'Ivoire has taken advantage of the increasing demand from markets in Asia.
- Attempts at privatisation of the plantations have met with very limited success because the public sector plantations were not based mainly on financial profitability criterion but have other social and environmental considerations.
- Forest plantations in the Sahelian zone aim at protecting the environment and to produce woodfuel. However, the scale of activities in the pursuit of these objectives is far from adequate. For example, in Senegal, that accounts for about 63% of plantations in the zone, the annual rate of establishment on government land started declining in 1991 and had fallen to only 0.8% of the total planted area in 1999 (*FAO, 2000a*). Often the survival rate of newly established plantations in the region is low, normally only around 50% (*FAO, 2000a*).

The supply of fuelwood in West Africa is still mainly from natural forests and woodlands. The establishment rate of fuelwood plantations, particularly in the Sahel, is still well below planned targets. However, planting for combating sand dunes and desertification is still pursued vigorously, with Senegal taking the lead.

With regard to industrial roundwood supply the proportion contributed by plantations is still fairly low. With the current low rate of plantation activities, the future role of plantations in the supply of industrial roundwood is not likely to be large (*AfDB, EC and FAO, 2003a*).

2.1.2 East Africa

East Africa includes Kenya, Uganda, Tanzania, Somalia, Ethiopia, Eritrea, Djibouti, Seychelles, Comoros, Mauritius and Madagascar. The forests are mainly dry savannah and, in Tanzania, *miombo* woodland, with denser forests in smaller mountain and coastal areas. According to *AfDB, EC and FAO (2003b)*, the quality of plantation management in many countries of the region has seriously declined in the last two decades, with neglected thinning and pruning, timber and forest areas lost to corruption, and an increased incidence of fire and pest/disease damage, all of which have caused significant damage to, and loss of, the plantations. The report further states that, as a result of limited availability of suitable land as well as increased incidences of land use conflicts, plantation forestry is unlikely to become a major source of wood supply in East Africa. Thus, dependence on natural forests and woodlands, and on farm-grown wood, will continue.

Plantation development in the sub-region has been dominated by the public sector, and the inefficiency and lack of financial resources of this sector have contributed to the degenerating management of plantations and lost opportunities associated with this. For example, in 1980, there were around 150 000 ha of well managed and productive plantations, mainly of pines, cypress and eucalypts, in Kenya that could supply the country's whole need of industrial wood. Today, a fraction of this remains and Kenya has to import most of its timber (cf. case study on Kenya on page xx).

Although the Forestry Departments still play dominant roles in plantation establishment in East Africa, with a current annual planting in the region of about 15 000 ha (*AfDB, EC and FAO, 2003b*), there is today much support for ideas in favour of privatisation of plantation establishment. Private sector interest in plantation development is reported to have slowly started to emerge in Tanzania and Uganda. For example, private teak plantations have been established in the Kilombero Valley in Tanzania and there is also recent establishment of large areas of privately managed Eucalyptus plantations in many peri-urban areas of Uganda.

The future of plantation programmes probably lies in breaking the domination of the public sector and in accelerating the pace of the private sector involvement. Current policy developments in many countries recognize this and are addressing some of the major impediments to private sector investments in plantation forestry, such as long term secure tenure of the land where plantations are grown, infrastructure and trade liberalisation.

If the public sector remains dominant, the following outcomes become likely:

- Plantation productivity and sustainability will be impaired because of lack of investments, insufficient human and technical resources, and lack of incentives for good management of the plantations.
- Encroachment into productive plantations in the form of illegal felling and excisions is likely to increase as the government will lack the capability and moral will to police the plantations.
- The lack of investments in wood processing industries, including by the private sector, is likely to continue under a public sector dominated forest plantation programme. This was a common mistake in the 1960s and 1970s when large industrial plantations were established without due investment in forward integrating industries.

It is, however, noted that in some countries (e.g. Uganda) there is a trend towards reforming public forest administrations into more businesslike entities, modelled, for example, on the Forestry Commission in Zimbabwe, which is acclaimed as a very successful parastatal (*SADC/FSTCU, 1997*). The fact that Zimbabwe has had a long history of well-managed plantation forestry is attributed to the Forestry Commission, which is praised for competing effectively with the commercial forestry sector.

The private sector involvement in plantation development is contingent on a host of issues that relate to profitability and its sustainability. At the small-scale private sector level, some East African countries, notably Kenya, have shown remarkable progress and success in private plantation development. Farm forestry has been successful in Kenya and is fast gaining grounds also in Uganda. However, the prospects for large-scale commercial private sector participation in densely populated countries (i.e. densely populated where ecological and economic conditions for plantations are favourable) such as Kenya are rather limited. It is only in sparsely populated Tanzania that such a prospect is high.

The viability and interest of private sector involvement will depend on:

- The possibility of acquiring existing public sector plantations with associated land ownership or long-term secure user and without the notorious public sector red tape and corruption.
- Some government plantations have been established in productive and densely populated areas where the pressure for using land for agriculture is high – such social pressures will have to be resolved (e.g. with compensatory arrangements for livelihoods for people bordering plantations) before the private sector would be interested.
- Increased global competition has reduced prices of wood, especially pulpwood, both in domestic and international markets. The high cost of transportation of wood from forest to industry and onwards to export outlets would need to be addressed before plantations are attractive to private investors.

In the East Africa sub-region, the bulk of fuelwood supply has traditionally come from natural forests and woodlands. However, today substantial numbers of trees are planted on private farm for fuelwood and to provide other services to annual and perennial crops and livestock in the area. Increasingly, such farm-produced trees also find their way to various wood-based industries.

Industrial roundwood production in the sub-region is generally low. The sub-region's output of 10 100 000 m^3 in 2000 is about 15% of total production in Africa (*AfDB, EC and FAO, 2003b*). While the contribution of forest plantations is not specified, it is generally believed that a good proportion of the wood output comes from natural forests.

2.1.3 Central Africa

This sub-region is made up of the following ten countries: Cameroon, Chad, Central African Republic (CAR), Rwanda, Burundi, Democratic Republic of Congo (DRC), Republic of Congo, Gabon, Sao Tome and Principe, and Equatorial Guinea. The total forest plantation area is around 648 000 ha accounting for only 8% of the plantations in Africa. About 40% of the sub-region's plantations are located in Rwanda. In Rwanda and Burundi, plantations account for 85 and 75 % of forest cover respectively. Eucalyptus and pines constitute the major species planted (*AfDB, EC, FAO, 2003c*) and they are established to meet local demand for fuelwood, poles and construction material. The high rates of plantation establishment in the two countries are due to:

- Favourable conditions for tree growth.

- High population density with patterns of settlements that favours intensive land use with trees as components of land use.
- Practice of establishing small woodlots and plantations to cater for local domestic and industrial demands.

In other countries of the sub-region, the need for plantation establishment is not as pressing because there is adequate supply of household wood from natural forests and the population density is low.

In Congo, large scale commercial pulpwood plantations of Eucalyptus have been established near Pointe Noire in the savannah area. This 50 000 ha plantation -*Eucalyptus du Congo ECO-SA* - was a joint project between the government and Shell with the latter owning 90% of the share. The project produced nearly half a million tonnes of pulpwood, sold mainly to Norway, France, Italy, Spain and Morocco. Today, declining pulpwood prices have reduced the profitability and threatened the viability of the whole project to the point that it has been closed down (*AfDB, EC and FAO, 2003c*).

In densely populated countries of the region, like Burundi and Rwanda, most of the fuelwood is obtained from farm plantings and government established woodlots, while in others most of the fuelwood is obtained from the forests and woodlands (*AfDB, EC and FAO, 2003c*). Almost all industrial round wood comes from natural forests.

2.1.4 Southern Africa

The countries included in this sub-region are: Angola, Namibia, Botswana, South Africa, Lesotho, Swaziland, Mozambique, Malawi, Zambia and Zimbabwe. Southern Africa currently has about 2 200 000 ha of forest plantations, which accounts for about 28% of total African plantations. Almost two-thirds of this, about 1 500 000 ha, are in South Africa. The plantations consist of fast growing exotic species, such as *Pinus patula*, *Cupressus lusitanica* and *Eucalyptus* spp. (*AfDB, EC and FAO, 2003d; Mwaura and Kamau, 1991*), which were established mainly for the production of industrial roundwood for export and in some cases for wood fuel. Only in the case of South Africa, Swaziland and Zimbabwe have plantation programmes been strongly linked to industrial utilisation. Limited markets and accessibility undermined the industrial use of Malawi's plantations, while the civil war affected the management of plantations in Angola and Mozambique.

Investments in forest plantations in the 1960s to 1970s were often done with donor financial support with the hope that the plantations would be the basis for domestic and export industrial developments. This did not immediately materialise and countries of the sub-region today experience an excess supply over demand of around 7 000 000 m^3 of plantation wood. An export oriented pulp-mill was planned in Malawi in 1964 and the 56 000 ha Viphya forest plantation was established to supply wood to the mill. In 1961, an Industrial Plantation Division was formed in the Forest Department in Zambia and charged with establishing forest plantations to supply the needs of the mining industry that was then the driving force in the national economy.

These plantations are now mature but the industrial demand is not there, either because the planned industries did not take off or are operating grossly below their built capacities. Bad public sector planning based on qualified supply/demand analyses and lack of incentives to the private sector to invest in long-term undertakings such as forest industries are to blame for this situation.

Ownership appears to be the most important factor that has affected the management of plantations in Southern Africa. In Zimbabwe, about 58% of plantations are under private ownership and in South Africa 72% is. In the case of Swaziland, plantations are 100% owned by the private sector. In contrast, plantations in Malawi and Zambia are almost entirely government owned, and, just like in East Africa, this has had a serious negative impact on the quality of management, productivity and links to the processing sector. At present, there are plans to privatise these plantations.

Out of the total roundwood production, excluding production from South Africa, 90% is used as fuelwood. Natural forests and woodlands (especially under communal ownership) are the most important sources of wood fuel, although it is also obtained from woodlots and trees outside forests. Some plantations have been established to meet urban fuelwood demand in cities such as Blantyre, Lilongwe, Harare and Gaborone, but they are far from adequate (*AfDB, EC and FAO, 2003d*). In the case of South Africa, fuelwood is obtained mainly from plantations.

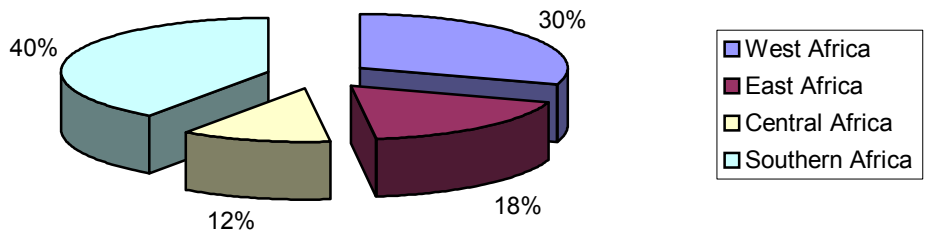
In 2000, industrial roundwood production in the region was around 24 000 000 m^3. Out of this, 68% was produced in S. Africa with other major producers being Swaziland and Zimbabwe (*AfDB, EC and*

FAO, 2003d). The dominance of these three countries is attributed to their well developed and managed plantations mainly of exotic species. Zambia, Mozambique and Angola are also leading industrial wood producers but mostly from indigenous forests (*AfDB, EC and FAO, 2003d*).

2.1.5 General SSA overview

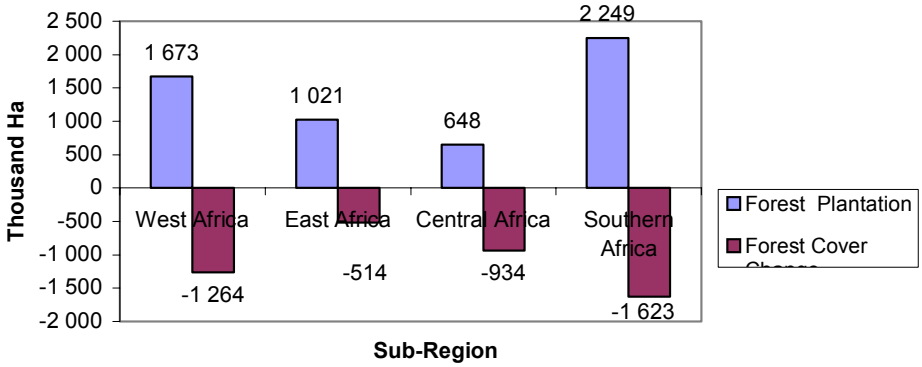
In general, the area of tree plantations compared to the natural forest area shows that plantations still remain a very small fraction of the total forest cover in many countries and regions in Sub-Saharan Africa and stand as follows: West Africa (2.3%), East Africa (1.2%), Central Africa (0.3%) and Southern Africa (1.2%). *Figure 1* shows the distribution of forest plantations in the four sub-regions with Southern Africa leading with 40% of total plantations and Central Africa having the least at 18%.

Figure 1. Forest Plantations by Sub-Region



In addition, the rate of plantation change shows deforestation overwhelmingly outstripping afforestation (see *Figure 2*). The figure shows actual plantation areas as at 2000 and the forest cover change for the period 1990 to 2000 as reported by *FAO (2003c).*

Figure 2. Forest Plantation and Forest Cover Change



2.2 Financial viability and profitability of plantations established for different purposes

The financial viability and profitability of a plantation programme depends very much on whether it is owned and managed by the public or the private sector. In the west, east and central African sub-regions the public sector controls most plantations and the inefficiency and lack of clarity of purpose have led to many cases of mismanagement and neglect. Illegal felling, low productivity, low wood quality arsing from the neglect, and damaging attacks from pests and diseases, are some frequent consequences. In addition, financial returns from mismanaged plantations are normally very low, and the systems used for setting prices on the products - be they timber, poles or fuelwood - are rarely based on conventional market economics of letting supply and demand fix competitive prices. Although there are cases where public sector plantations are grown for other than commercial purposes, e.g. with environmental, watershed or social goals, there is no reason why those public plantations that are predominantly grown to supply wood to the market should not be efficiently managed and profit-oriented. But, as argued here, there are very few, if any, examples of this today in SSA.

In contrast, the private sector dominated forestry plantations in southern Africa are normally financially viable and economically profitable, facts that are easily measurable. Due to the integration of the plantations to wood processing companies, that add value to the products, the forest industry is also profitable. South Africa, Zimbabwe and Swaziland are notable for this profit-oriented private sector driven forest plantation based industry. In South Africa, for example, profitability analyses performed on the industry showed that the value in nominal terms of roundwood sold rose from R165 million in 1980 to R2 574 million in 2000. This represents an increase in monetary terms of R2 409 million or a 1460% increase. Pulpwood registered the biggest increase among the forest products, or a 30-fold increase (*Goldsmark, 2000*). In 1998, Zimbabwe had a negative net export of approximately US$ 4 million from pulpwood production, and, in the same year, Swaziland recorded a net export earning of US$ 62 million from plantation-grown wood pulp (*FAO, 2001a*).

2.3 Economic and ecological sustainability

Making analyses of the economic *and* ecological sustainability of plantation forestry is not always easy and straightforward. The degree to which each or a combination of the two key areas is pursued will vary and depend on the ownership and objective of the plantation. From the private sector perspective, maximisation of profit or economic benefits over a reasonably long time is normally the primary objective. The public sector on the other hand does normally not express its goals with plantation development as profit maximisation, but rather in terms of social (employment, income generation, poverty reduction, etc.) and/or environmental (soil and water conservation, wind and erosion control, etc.) benefits.

2.3.1 Economic sustainability

Economic sustainability of forest plantations is contingent upon the fulfilment of a set of criteria and conditions, including:

- Reduced cost of production through achieving economies of scale from improved technical efficiency to lower production prices and increase output.
- Creating effective demand and obtain attractive prices for plantation-grown wood through linkages with, and knowledge about the requirements of, domestic and overseas markets.

The private sector pursues these objectives and measures the performance and economic sustainability of their investments on how best they meet the set objectives at a point in time.

In some countries, plantation forests contribute significantly to national economies by supplying wood for local domestic use and for export. Economic sustainability at the national scale is normally achieved when such uninterrupted supply of plantation wood of the right quality and quantity goes to

wood-based industries in the countries. Domestic wood-based industries constitute a major growth sector in many parts of SSA. By augmenting wood supply from natural forests, plantations also have the potential of maintaining economic viability and growth of wood-based industries, which have earlier been dependant on a diminishing supply of timber from natural forests, a situation particularly true for West Africa.

About 80-90% of fuelwood used in SSA comes from natural vegetation sources. With an increasing population and urbanisation, the area and accessibility of forests and woodland where fuelwood and charcoal come from are being reduced. Plantings for fuelwood started in the mid 1970s as one approach to deal with a forecasted alarming discrepancy between fuelwood demand and supply (*Arnold et al., 2003*). Most of these investments were donor driven and supported, and many were successfully established but could not be sustained when the support ceased. For example, between 1975 and 1994, a number of donors supported the development of peri-urban fuelwood plantations in Ethiopia resulting in the establishment of 40 000 ha of *Eucalyptus globulus*. Thereafter, the plantations have been poorly managed and have not been expanded. Generally, while rural and urban fuelwood projects normally did little to augment fuelwood supplies, it also became clear in many situations that shortages had been exaggerated mainly due to underestimating the supply (*Arnold et al., 2003*). So far, there are only a few examples where fuelwood plantations have proved to be economically viable and sustainable, but time and urbanisation work in favour of this trend.

There is also a host of non-wood forest products (NWFPs) that can be produced through tree plantations. They include cork stoppers, tannins, mushrooms, fruits, honey, silk secreting worms and gums. Others are wood-derived chemicals (essence, resins, food flavouring) as well as various other chemical substances (tannin latex, aromatic and medicinal plants). Tree plantations for such products can be vital sources of income generating employments for the poor and they can therefore help with poverty reduction. Finally, plantation forests may also enhance the aesthetic values of landscapes, a factor that may increase the value for tourism and eco-tourism (*Dyck, 2003*).

Many public sector forest plantation programmes in Africa have been supported by external donors, either as loans or grants. With shifts in donor interests and due to the often poor performance of Government Forest Services in handling such support, as well as the inability of Governments to make forward linkages between plantations and value adding industries, the flow of funds for plantation development has been significantly reduced in recent years. Therefore, the prospect of future sustainability of such plantation programmes, based on external funds, is rather bleak. Unless there is a radical shift in Government policies in favour of private forest and industry ownership, it is only in a few countries in Southern Africa that plantation forestry seems to have a potential for economic sustainability.

2.3.2 Ecological sustainability

Planted forests can serve numerous ecological and environmental roles, such as regulation of micro- and meso-climate (e.g. temperature, humidity and wind), soil and water protection (e.g. erosion control, water quality and flow, reducing sedimentation and landslide prevention), biodiversity preservation (in relation to many other forms of land use) and carbon sequestration (*Dyck, 2003*).

It is not easy to establish a generally accepted set of criteria and indicators for what constitutes an "ecologically sustainable" forest plantation – it will vary with the general ecological conditions of the area and very much with what you compare with in terms of alternative land uses. Some aspects related to ecological sustainability are discussed in the sections that follow.

Availability and suitability of new areas

Many ecological problems in plantation development in Africa are more pronounced in the drier parts of the continent where frequent droughts occur, like the Sahel. Problem normally stem from increased human and livestock populations, which contribute to increased exploitation and destruction of natural vegetation. This contributes to undermining the natural resilience of the dry-zone ecosystem. The severe droughts in Sahel in the 1970s, coupled with population growth contributed to serious degradation of the forest resources. Additional problems include lack of surface water (rivers and lakes), soil salinity problems, sand dune mobility and decreasing fertility of the soil, all of which contribute to difficulty in plantation development. In spite of this, plantation development to address social and environmental needs is still embarked upon, but at high economic and ecological risks.

Southern Africa is vulnerable to water stress and the situation is predicted to worsen, particularly in Botswana, Namibia and South Africa. In most of the dry areas of the region, high rates of evapotranspiration and competition for the limited water by other sectors of the societies (domestic, agriculture, industry) potentially limit plantation expansion (*AfDB, EC, FAO, 2003d*). Furthermore, government regulations in the sub-region often limit the establishment of new plantations to ecologically fragile areas such as riverbanks and upper water catchment areas, which are not necessarily providing optimum growth conditions for economically viable plantations. Such restrictions create a situation in which ecological considerations limit plantation developments.

Biodiversity in forest plantations

Contrary to the often repeated statements that plantations invariably are negative to biodiversity, it is important to realise that, under some circumstances, plantations have the ability of to improve biodiversity. A number of recent studies in SSA forest plantations have shown the catalytic effect that forest plantations may have on the regeneration of native woody species under their canopy as well as a gradual increase in the diversity of flora and fauna as the plantations grow older (*Evans, 1992; Bernhard-Reversat, 2001; Senbeta and Demel, 2001; Senbeta et al., 2002; Cossalter and Pye-Smith, 2003*). There are, quite naturally, differences between species with regard to this effect, and it is also obvious that plantations replacing in tact natural forests will have negative impacts on biodiversity.

Pests and diseases in forest plantations

It is often claimed that trees in plantations, and especially exotics, are inherently vulnerable to diseases, insects and climatic fluctuations. The topic has received wide review (see e.g. *Zobel et al., 1987; Evans, 1992; FAO, 2001c, d; Cossalter and Pye-Smith, 2003; Nair, 2003*). In a detailed review on pest outbreaks in tropical forest plantations, *Nair (2003)* posed the question *"Is there a greater risk for exotic species than for indigenous tree species?"* The author looked at the experience of nine species widely used as exotics and found that no generalisation is possible for exotics as a group although more exotic species actually seem to be at a lesser risk than indigenous species. The empirical data showed that pest outbreaks also occur in plantations of indigenous tree species and sometimes even in natural forests. The conclusion by Nair is that while plantations are at greater risk of pest outbreaks than natural forests, plantations of exotics are at no greater risk than plantations of indigenous species. In a review, *FAO (2001c)* noted that although there are some examples where plantations have faced major disease and insect problems, even to the extent that they have stopped the use of particular species, such problems have not caused such a widespread damage as to seriously question the growing of plantations *per se*. The economic advantages of plantation forestry by far outweigh the problems.

Susceptibility to pests and diseases has been shown to increase under the following situations (*FAO, 2001d*):

- Failure to give proper attention to species/site matching "offsite planting", resulting in trees growing under stress.
- Use of planting stock from a narrow genetic base.
- Failure to maintain optimum stocking levels and tree vigour through intermediate cuttings.
- Dependency on one or two species in plantation programme.

The latter point is probably the greatest concern - some SSA countries rely on one or two closely related species, and should a particularly devastating pest/disease appear, the results could be very bad (*FAO, 2001d*).

Plantations and water resources

The hydrological effects of trees, and particularly the effects of plantations (especially Eucalypts), have been the cause of much controversy. The relationships between forests and water resources are complex and will vary with topography, soil type, local climate, the type of tree involved and a variety of other factors which exert their own particular influence (*Cossalter and Pye-Smith, 2003*). It is alleged that large-scale plantations reduce the amount of water that flows through a water catchment, which is partly true under some circumstances.

When rain falls on tree vegetation, whether natural forests or plantations, some of it is immediately intercepted and evaporated back to the atmosphere, some is absorbed by the soil and the excess water runs off. Trees and other plants take up a portion of the rain that filters into the soil and some of this is

transpired back into the atmosphere. Some water not retained by the soil will reach the ground water table and head for watercourses and springs.

Studies show that run-off increases dramatically when new plantations are established after clearfelling a natural forest. Clearfelling also leads to more water downstream. Fast growing tree plantations, e.g. some species of eucalypts, soon use more water than primary forest, thus reducing the water available to those living downstream (*Cossalter and Pye-Smith, 2003*). However, plantations with a growth rate similar to a natural forest will not use more water than this. Neither will eucalypts use more water than any other pioneer tree species growing as fast as it does, e.g. some Acacias.

Invasive exotic species

Most exotic tree species that have been introduced to Africa are economically important and serve the purposes for which they were introduced. A few introduced species have, however, become established in the wild and have spread at the expense of native species thus affecting entire ecosystems, as well as causing serious problems in crop and pasture land (*FAO, 2003c*). Notorious examples of such invasion by alien woody species include *Acacia mearnsii* in South Africa, *Prosopis juliflora* in northern Kenya and *Leucaena leucocephala* in parts of Tanzania. Substantial costs have been incurred in South Africa to remove invasive species along watercourses. Great care is required to ensure that the damage caused by such species is reduced (*FAO, 2003c*).

Long-term site productivity under plantations

Although some new land will be opened up for plantation establishment, it will be increasingly common that new plantations will be established on the same sites as earlier rotations. The productivity of second and subsequent rotations will have to be maintained or increased to meet the increasing domestic and international demands for wood and wood products. This can be achieved by: confining harvesting of forest products to stem wood, which generally represents a small export of nutrients from a site **(***Zobel et al., 1987; Evans, 1992, 1996; FAO, 2001c*); proper harvesting planning, including careful re-use of extraction routes to minimise compaction and erosion (*FAO, 2001c*); slash retention on site after harvesting (*FAO, 2001c*; *Mugasha et al., 2003*); and appropriate soil conservation measures to reduce nutrient losses due to erosion (*Evans, 1982; Vichnevetskaia, 1997; FAO, 2001d, 2002a*). One of the few studies on productivity of second and subsequent rotations is that by *Evans (1996)* in Usutu, Swaziland. Evans found in three rotations of *P. patula* that there is no evidence of yield decline as a consequence of plantation forestry practices.

3.0 CASE STUDIES PUBLIC SECTOR PLANTATIONS

3.1 Industrial plantations Kenya

3.1.1 Background to the establishment of the plantations

Industrial forest plantations in Kenya started on a larger scale in the early 1940s, but had been preceded by trials of both indigenous and exotic species. The major objective was to supply raw materials to the wood based industry mainly saw milling and, later, pulp and paper (*MENR, 1994*). It had been realised that the indigenous forests with very slow growth rates would not meet future wood requirements. The natural forests, that were never very extensive in the first place, were also dwindling at a fast rate due to both illegal encroachment and to official conversion to other uses, illegal harvesting, charcoal production, overgrazing and incidence of fires. Another early objective of plantation management was to provide environmental services, particularly watershed protection.

3.1.2 Brief history of the case study

The first systematic planting programme was begun in the late 1900, by D.E. Hutchins, then Chief Conservator of Forests, 1907-1911. The first exotic plantations were of Eucalypts and *Acacia mearnsii* (black wattle), both from Australia, to supply firewood for the railway engines. Later on, with a view to producing saw timber, *Cupressus lusitanica* and *C. macrocarpa* were planted. The programme was abandoned in 1912 because Hutchins' successor was not in favour of using exotics (*MENR, 1994*). However, following recommendations by the famous silviculturist R.S. Troup, exotic tree planting was resumed in 1927.

At the end of the Second World War, an annual planting target of 2 430 ha was set, half of it to be planted with cypresses and the other half *Pinus patula* and *P. radiata* (*MENR, 1994*). This planting target was reached in 1949. The annual planting targets increased up to 6 000 ha in 1986, but, for various reasons, they were often not met.

The plantations were established by using the *shamba* or taungya system. The system offers an opportunity for reduced cost of establishment and improved survival rate on one hand and increased food production and employment on the other. Resident labourers work for wages for nine months of the year, and cultivate plots of land allocated to them (up to 2.4 ha per family). In the second year, the food crops are interplanted with forest trees which are looked after until canopy closure after which the farmers are allocated new plots. However, in 1975, due to political pressure, the resident labourers were given permanent employment on civil service terms, with monthly wages, but with no stated minimum daily tasks. They could no longer be dismissed or evicted at the discretion of the forest officers. They were required to ensure clean weeding of their plots but this was either not done or weeding was discontinued before trees were big enough to survive competition from weeds. In addition, the squatter status of the labourers becomes a source of strong political pressure to excise land for permanent agricultural settlement. The system was discontinued in 1989, with a decision to do planting and weeding using non-resident cultivators (NRC) from 1995 (*Bertram, 2003*).

The areas under industrial plantations grew from 15 000 ha in 1946 to 170 000 ha in 1990 (*MENR, 1994; Kenya FOSA, 2001*). Between 1969 and mid 1980's, forest plantations were funded with a World Bank credit totalling US$ 65.0 million (*Kenya FOSA, 2001*). Most plantations are established in high- and medium-potential areas. At present, the main species are *Cupressus lusitanica, Pinus patula* and *Eucalyptus saligna*. Auxiliary species include *Pinus radiata, P. caribaea, P.elliottii*, *E. grandis, E. globulus, Vitex keniensis* (one of the very few indigenous species that has been successful in plantations) and *Olea capensis.* The area of public industrial forest plantations is at present estimated at 120 000 ha; excisions and neglect have taken their toll (*Bertram, 2003*).

3.1.3 Current state of the plantations

Generally, plantations were well managed up to around the mid 1970s. Silvicultural rules based on research were set out in a series of Technical Orders covering aspects like seed sources, spacing, thinning, pruning and protection. The Technical Orders were effectively followed.

From mid 1970s, there has been a steady decline in the strength of the Forest Department as a public body responsible for the management of forest plantations (*MENR, 1994*). The underlying causes seem to have been a combination of declining political support, tight budgets, adverse changes in staff attitude, skills and motivation (probably associated with the general decline into corrupt behaviour in the Kenyan political and civil service spheres in the 1970s and 1980s) and also a discouraging switch away of external (donor) support for the industrial plantation sector. The Department's weakness made it increasingly difficult to up-date and implement management plans. In 1994, only 7 districts out of 51 had up-to-date operational management plans (*MENR, 1994*). Lack of regular forest inventories and other information collection for management planning contributed to this state of affairs.

The current condition of the forest plantations has not been quantified. An inventory carried out between 1989 and 1992 (*MENR, 1994*) revealed that:

- 54% of the area of plantations in the establishment phase is under-stocked,
- 96% of the area in the maintenance phase has backlogs in silvicultural treatments (pruning and thinning), and,
- 21% of the total area is occupied by over-mature stands.

Where prescribed pruning and thinning have not been carried out, or have been delayed, the quality of harvested wood is reduced. In addition, large areas were felled, especially in the 1990s, but not replanted. The unstocked estate is estimated to be about 20 000 ha (*Bertram, 2003*).

The average yield of forest plantations today is estimated at 347 m^3ha^{-1} (*MENR, 1994*). With an average rotation age of 25 years, this corresponds to an average annual increment is about 14 $m^3ha^{-1}y^{-1}$. With intensive forest management, a higher yield should be expected in view of the normally very good sites of the plantations.

A presidential ban on all felling in government forests was imposed in November 1999. Five years later, the ban is still in place. The ban has led to a backlog of areas due for felling (*Bertram, 2003*). These often become reservoirs for pests and diseases. The ban has also stopped thinning and pruning required to get good quality final crops and has increased the fire risk due to absence of forest hygiene (*Bertram, 2003*).

An economic analysis based on some generalisations and assumptions, including on various ownership regimes, showed that improved and intensified management systems, involving use of certified seed, nursery work by manual labour, an agroforestry planting system, prescribed pruning and thinning regimes and appropriate protection, of industrial forest plantation would be profitable with a wide margin (*MENR, 1994*).

3.1.4 Analysis of factors, which have contributed to success/failure

The following factors are considered to have contributed to the observed state of the public industrial plantations (*MENR, 1994; Bertram, 2003*):

Institutional issues

As already pointed out, a weak Forest Department from the mid 1970s has played a role in the current state of industrial forest plantations. As a result, plantation working rules were not applied nor was there any development of new management regimes. Other institutional shortcomings include failures to:

- Adopt modern managerial techniques, which seek to optimise the use of resources in relation to defined aims.
- Develop and apply new methods of forest plantation planning.
- Design and implement efficient inventory and management information systems.
- Find a workable and economically efficient alternative to the *shamba* system.

Budgetary constraints

After the expiry of the World Bank forestry development project, funding of the major plantation programme reverted to the government. Due to financial constraints, budgetary allocation dropped to about one tenth of the previous funding levels, with a corresponding drop in annual work. For example, the current planting rate is around 400 ha per year while during the World Bank project period it was 4 800 ha (*Kenya FOSA, 2001; FD, 2003*). The reduced annual work programme has led to a backlog in establishment and maintenance work; for example, the backlog in establishment stands at 20 000 ha (*Bertram, 2003*).

Most of the budgetary allocation is used to pay salaries, leaving inadequate funds to for infrastructure and plantation management. The low salaries to labourers, technical and professional staff have resulted in poor attitudes to work and leakages in revenue collection (*Bertram, 2003*). In October 2003, virtually all Forest Department staff members were suspended while investigation over alleged gross corruption against them is being carried out.

Revenue collection

Due to leakages, inefficiency in volume assessment and revenue collection, only 29% of collectable royalties were realised in 1994 (*MENR, 1994*). Realistic royalty estimation, efficient revenue collection and a retention scheme would improve the budget of the Department (*Bertram, 2003*).

Political shortcomings

It seems that the Forest Department does not always get as much political support as it needs to carry out its complex tasks, especially when the general national interest clashes with that of a particular group. Excision of about 50 000 ha of industrial forest plantation land was done for political reasons, for example (to buy votes in elections) (*Bertram, 2003*).

3.2 Industrial plantations Ethiopia

3.2.1 Background to the establishment of the plantations

Ethiopia, with a land area of about 110 million ha, is one of the largest countries in SSA. Historical sources indicate that about 42 million ha or equivalent of 35% of Ethiopia's land area might once have been covered with forest (most information for this section is from *EFAP, 1994* and *Bekele, 2001*, unless otherwise stated). In the early 1950's, the forests that remained covered 19 million ha or 16% of the land area and in the 1980's, coverage was reported at 3.6%. The latest estimate of the land covered with forests is 3.37% of the country (*WBISPP, 2000*).

The major cause of deforestation is rapid population growth, which leads to an increase in the demand for crop and grazing land, wood for fuel and construction. Lack of a viable land use policy and corresponding law aggravated the rate of deforestation. For example, new settlements in forests are increasing from time to time resulting in conversion of forested land into agricultural and other land use types. The establishment of public industrial plantations aimed at meeting timber demands in the face of declining natural forest resources.

3.2.2 Brief history of the case study

Ethiopia started large-scale industrial plantations in the early 1960's. The current total area estimate is 76 000 ha. Most of the industrial plantations were established with support from the Swedish government.

Eucalyptus and *Cupressus lusitanica* are the main species in these plantations covering 58% and 29% of the total area respectively, followed by *Juniperus procera* (4%), *Pinus patula* (2%), and other species (7%). The average planted area per year was about 12 000 ha, considered as being far below the required area for ensuring a sustainable supply of forest products.

3.2.3 Current state of the plantations

Seed for planting is obtained from older stands and sometimes from seed stands as there are no seed orchards. As a result the established stands are of poor quality.

Site preparation consists of manual clearing of natural vegetation and burning. Site preparation is thus not intensive and any delays in weeding, which are common, result in reduced survival and growth. There are pruning and thinning schedules for the cypress, pine and eucalyptus but they are not followed due to budgetary constraints (*JFCECF, 1997*).

The productivity of the plantations is modest with average increments of cypress and pines estimated at 9.6 m^3 ha^{-1} yr^{-1} and that of eucalypts at 14.4 m^3 ha^{-1} yr^{-1}. Overall, the plantations face problems of poor management, encroachment and illegal cutting. For example, a survey covering the period 1993/94 to 1997/98 showed that only 40%, 57% and 32% of the plantation areas had been planted, pruned and thinned respectively (*MoA/GTZ, 1999*).

3.2.4 Analysis of factors which have contributed to success/failure

Government policies

There is no comprehensive federal forest policy. "Proclamation 94" of 1994 was issued to provide for the conservation, development and utilisation of forests, and is currently serving as the forest policy statement of the country as well as an act. There is a draft forest policy and a draft act being finalised.

Government policies do not allow interaction and integration of natural resource conservation and development plans, and as a result, priorities, plans and strategies are formulated independently within different sectors and are often conflicting.

Institutional framework

The organisation responsible for the forestry sector has existed within the Ministry of Agriculture since about the mid 1940s under various capacities - as a section, an agency, a department and an authority.

Following regionalisation in 1991, the responsibilities for management and conservation of forest resources have been transferred to the regions. At federal level, forestry is a team, under the Natural Resources and Regulatory Department. Such frequent changes in organisational management has resulted in discontinuity in project planning and implementation and caused imbalances and inequities in the allocation of financial, human and other resources, all to the detriment of the development of the forestry sector (*MoA, 1999*). In general, both the central and regional forestry institutions are understaffed and under-equipped. They also lack proper structures to implement programmes and legal provisions including monitoring and follow-up to measure impact. As a result, both industrial forest plantations and National Forest Priority Areas (NFPAs) are in poor condition.

Land tenure and availability

Land is available for afforestation especially in the NFPAs and the state may provide land to private investors on a concessionary basis after ascertaining that this will not lead to evictions or affect the interests of peasants.

Research output

Access to information is poor and research work tends to be fragmented and narrowly focused. For example, there has not been much research in tree improvement resulting in plantation establishment using seed of poor quality. Trees used in plantings are also considered to come from a narrow genetic base, with accompanying risks of inbreeding, loss of vigour, and lack of adaptability to environmental variation.

State of technology

There are several sawmills, two plywood mills, two particleboard mills, one fibreboard mill and one paper-producing mill in the country. Sawmills generally have old machinery, resulting in poor recovery and quality of products. Except for a few mobile sawmills, the existing sawmills are not equipped to handle big logs.

3.3 Industrial plantations Côte d'Ivoire

3.3.1 Brief history of the case study

Industrial plantations started to be established in the northern and central regions already in the late 1920s using the taungya system. *Tectona grandis* (teak), *Cassia* spp., *Gmelina arborea, Terminalia ivorensis, T. superba* and *Azadirachta indica* were the main species planted.

Between 1935 and 1965, more than 8 000 ha of plantations were established by the government. In 1966, the *Societé de development des forests* (SODEFOR) was created to conserve and manage the country's forest resources and promote reforestation and plantation establishment (*FAO, 1999a*). At first the programme aimed at establishing 250 000 ha of plantation, at a rate of 10 000 ha per annum. However, due to lack of funds, the actual annual planting hardly ever exceeded 5 000 ha. In 1992, management of forest plantations was entirely committed to SODEFOR.

After 1970, planting in the northern and central regions mostly stopped. By the end of 1980, many of the old plantations had disappeared and the rest had been used to meet domestic demand. Up to 1996, 97 000 ha of plantations were established in government forests (*FAO, 2001a; National Trade Data Bank, 1996*). Before the establishment of SODEFOR, total planted forest in the country stood at a mere 10 000 ha.

By 2000, the estimated plantation areas in the country was 184 000 ha made up of the following principal species: Gmelina 5 500 ha (3%), rubber 68 250 ha (37%), teak 58 050 ha (31.5%), terminalias 32 200 ha (17.5%), and other broadleaved species 20 300 ha (11%). Gross forest plantation area in the country more than quadrupled within two decades from 1980 to 2000. In 1980, gross plantation area stood at 45 000 ha from where it doubled to 90 000 ha in 1990 and to 184 300 ha in 2000 (*FAO, 2001f*). All the plantations are publicly owned and all the species except rubber are industrial. It is worthy of note that it is only recently that rubber is introduced as a forest plantation species.

3.3.2 Current state of the plantations

The fact that most plantations in the country are owned and managed by the public sector has affected their performance and productivity. Thus, poor management has led to inadequate protection, cleaning

and thinning such that fire, illegal harvesting and encroachment have undermined the output of the plantations. This situation has been blamed mainly on limited funds. As a remedial strategy, the country tried to counter the decline by enacting regulations that require concession-holders to implement a replanting programme. The extent to which the concessionaires have adopted this strategy is not yet known

On the positive side, given that the primary aim of the plantations is to export wood, the country's success in opening up the Asian market, with India being a major importer of Ivorian teak, attests to the fulfilment of the export objective of the programme.

3.3.3 Analysis of the factors that have contributed to success or failure

Export market

There is a rapidly increasing import demand in Asia for African and Latin American teak, which costs much less than locally produced Asian (Myanmar and Indonesia) teak. In addition, local processing plants in Asia are much better equipped to process small-diameter logs of the form that are exported from Côte d'Ivoire (*Maldonado and Louppe, 2000*).

Research

Research efforts have led to the development of high-performance clones of superior quality and of vegetative propagation techniques to establish such clones. Clonal trials started by SODEFOR in 1996 have shown positive results in that rooting of cuttings reached 70% even for relatively old stocks of up to 30 years. These research successes have made it possible to grow teak at shorter rotations of 20-30 years with good yields.

Quality of wood

The serious shortage of wood raw materials to meet the demand of domestic processing industries has led to the cutting of trees with smaller diameters. Second, wood quality has not been given due consideration among the selection criteria even though manufactures have complained about considerable variation in timber quality. For example, it has been reported that teak from La Séguié is paler and less dense than the one from Bamoro. The latter is veined and golden. These are aesthetic qualities, highly appreciated by manufacturers (*Durand, 1984*). Furthermore, large differences have been noted in density and colour of wood from different plots and young Ivorian teak is considered to have too many knots. It is not yet established whether the variation in wood quality is due to genetic, site or silvicultural factors, but both qualitative and quantitative variations have been identified as impediments to the development of the teak industry in Côte d'Ivoire and European manufacturers have already raised some concerns in this respect.

Marketing of timber

SODEFOR experienced problems in marketing of teak logs towards the end of the 1970s when the volume of thinning timber increased. Several reasons contributed to this marketing problem:

- Domestic demand for small-diameter logs was limited to electricity and telephone transmission poles.
- Concrete and aluminium poles are already challenging teak as more cost effective and more fire resistant alternatives.
- Over a period of 30 years, the domestic consumption of teak timber declined steadily.
- Teak has a low domestic market value owing to its sale as fuelwood in urban markets near production centres.

Processing

Some of the problems facing the teak industry in Côte d'Ivoire lie with processing:

- The processing industry does not obtain sufficient supplies of logs to engage the mills at full capacity despite the industry's expansion in the range of species used.
- Existing processing units have outdated equipment.

- Investment in the processing industry has been hampered by the insecurity in the quantity and quality of logs (i.e. no guarantee of a regular supply or of a standard quality of processed timber).
- There has been a drastic reduction in the number of operators, from 400 in 1995 to 100 in 1999 (*Louppe, 1999*).

Political instability

Political instability has dealt a major blow to the plantation programme in Côte d'Ivoire. The recent political crisis in the country has significantly disrupted the teak plantation and log export programme. In particular the area around Bouaké, one of the areas in the country with large teak plantation, is outside government control.

3.4 Energy plantations Ethiopia

3.4.1 Background to the case study

About 40% of the area of Ethiopia, or 53 million ha, are estimated to have been forested at the beginning of 1900s. In the 1950's, the forest coverage had diminished to 16% and currently only about 3.5% of the country is covered with forests (*WBISPP, 2003*). The high rate of population growth coupled with low agricultural productivity, low living standard of the people and lack of alternatives are the underlying factors responsible for the decline of forest land in Ethiopia (*Bekele, 2000*). This leads to increasing demand for crop and grazing land, construction materials, fuelwood and charcoal.

Deforestation has led to serious fuelwood shortages in most regions of Ethiopia, resulting in communities using cow dung and agricultural residues as sources of energy. The critical fuelwood situation led the government to initiate energy plantations in urban and rural areas to supply fuelwood and building poles. This was expected to free up dung and crop residues for use in agricultural production.

3.4.2 Establishment, management and productivity of energy plantations

Initial establishment of energy plantations (of *Eucalyptus globulus*) dates back to 1895 (*Pohjonen and Pukkala, 1990*). In the 1970's, the energy plantation area around Addis Ababa was about 15 000 ha and in other areas of the country about 76 000 ha. Between 1975 and 1994, further establishment of energy plantations was undertaken, mainly in peri-urban areas with international support (WFP, UNSO, DANIDA, WB and AfDB). A total of 40 000 ha of peri-urban plantations have been established. However, these donor-funded projects could not sustain activities after the project periods were over (*Bekele, 2003*). The total area of public sector plantations including peri-urban plantations, for fuelwood and poles is today estimated to be about 100 000 ha, and the current annual planting rate is said to be about 17 000 ha (*Bekele, 2003*).

Silvicultural techniques include raising seedlings in polythene pots; site preparation by manual clearing of natural vegetation and burning; planting at a spacing of 2 x 2 m in pits of 40 cm diameter and 40 cm depth; and manual weeding at least once per year for the first two years. Productivity of the energy plantations is estimated to range from 9-12 $m^3ha^{-1}yr^{-1}$ (*Bekele, 2003*). Productivity is low due to poor seed sources, inadequate site preparation and weeding among others (*EFAP, 1994*). The average rotation age is 10 years.

3.4.3 Contribution of plantations to meeting energy needs

Although the planting of fast growing tree species appears to offer an efficient and cost effective solution to Ethiopia's woody biomass crisis, the volume of wood required is significant. Afforestation projects initially funded by donors have stopped expanding tree planting and sometimes even replanting clear-felled areas after the support came to the end. If current per capita consumption remains the same (about 0.75 m^3 per capita), the equivalent of more than 2 million ha of block plantations, producing 15 $m^3ha^{-1}yr^{-1}$ are required to meet current demand, and 6 million ha will be required by 2014 (*EFAP, 1994*). Currently, there is no significant new planting and only replanting of clear-felled areas is sometimes carried out. This rate of planting would not allow meeting the wood energy requirements in the foreseeable future.

3.4.5 Economic viability of fuelwood plantations

Some studies have been carried out on the economic viability of energy plantations. According to *Pohjonen and Pukkala (1988)*, the rotations that maximise the land expectation value of *E. globulus* plantations are 12-20 years for seedling rotations and 8-16 years for the coppice rotations, with discounting rates ranging from 2% to 8%. Thinnings were found to increase the land expectation value by a few percentage points. The authors further showed that with the price of wood assortments at that time, the land expectation value was usually much higher in forestry than in agriculture, except in very poor areas.

In an *ex ante* benefit-cost analysis based on community level survey data from Tigray, *Jagger and Pender (2000)* found out that under most conditions, planting eucalyptus trees yielded high rates of return, well above 20% under most circumstances.

3.4.6 Factors impacting establishment and management of public sector fuelwood plantations

The same factors that affect the sustainable management of public sector industrial plantations in Ethiopia, also influence the public sector energy plantations (see section 3.2 above).

3.5 Energy plantations Senegal

3.5.1 Background to the case study

Senegal falls in the Sahelian zone where plantations are established mainly for wood fuel production and to improve environmental conditions, especially for prevention of desertification and for sand dune fixation.

Desertification is a major problem in northern Senegal. The country has established significant areas of plantation forest, mainly for non-industrial (fuelwood and fodder) purposes. Senegal has a well-developed network of protected areas encompassing 12 % of the country's forest area.

Since the drought in the early 1970s, the establishment of plantations has been one of the effective ways to combat desertification and the government has carried it out with international assistance.

Until 1950, efforts were essentially devoted to natural forests exploitation for timber and fuelwood production. Fuelwood accounts for more than 60% of domestic energy consumption, mainly in the form of charcoal. Timber for construction is also an important forest product. Linear plantations have been established mainly using *Casuarina* spp. for both land protection and production of fuelwood and timber (*Gueye, 2000*).

Eucalyptus (*E. camaldulensis*), neem (*Azadirachta indica*) and Australian acacias, mainly *Acacia holoserucea* are the main species that have been used (*AfDB, EC and FAO 2003a; Boye, 2000*). Much use has been made of *Casuarina equisetifolia* for stabilisation of sand dunes along the coast. Green-belt plantations have also been extensively used to protect cities from dust and to stop the advance of sand dunes. Other species also planted for some of the above and other purposes include *Prosopis juliflora, Parkinsonia aculeata, Leucaena leucocephala, Acacia senegal* and *Faidherbia albida* (*Boye, 2000*).

Senegal is a country with low forest cover and tree planting is a *sine qua non* for provision of energy, for combating desertification, sand movement and drought, and for crop protection (*Consere, 1997*).

Pursuant of the above objectives, tree planting started in the early 1950's. By 2000, total area of plantations for energy and environmental rehabilitation stood at about 129 000 ha (*FAO, 2001a*), which accounts for about 50% of total plantation areas in the country. The plantations were established mainly with international assistance.

3.5.2 Extent of area of fuelwood plantations including the annual rate of planting

In the period 1950 to 1970, several plantation development initiatives were launched. They included the establishment of shade trees using *Azadirachta indica*, planting of *Casuarina equisetifolia* as shelterbelts to protect crops from sand and to prevent soil erosion and enhance soil productivity. The species is also the principal source of fuelwood in the country.

The drought in the early 1970s drew attention to the importance of combating desertification. This led to the launching of a programme aimed at establishing plantations and promoting the use of exotic species such as *Eucalyptus* spp. and *Acacia* spp. and aimed at the reforestation of areas where natural vegetation had been lost (*Consere, 1997*).

According to *FAO (2001a)*, the plantation areas for all purposes in Senegal by the year 2000 was 31 600 ha of *Acacia* spp., 63 200 ha of *Eucalyptus* spp., 34 600 ha of *Casuarina*, and 126 000 ha of other broadleaved species, for a total of 255 000 ha. Over the period 1980 to 2000, annual average establishment of new plantations was estimated at 11 000 ha (*FAO, 2001a*).

3.5.3 Contributions of fuelwood plantations to meeting energy needs

The production of woodfuel in the country has only shown marginal increases over the period 1990 to 1998. This trend shows a rise from 3.4 mill m^3 in 1990 to 4.1 mill m^3 in 1998 representing an increase of 23% over the period or an annual increase of 2.5%. The annual rate of afforestation for the period 1961 to 2000 consistently fell short of the planned annual rates and it is apparent that the plantation development programmes in the country are not meeting the energy requirements (*Boye, 2000*).

3.5.4 Economic viability of fuelwood plantations

The fuelwood plantation programme in Senegal is solely owned and managed by the public sector. Like all public sector projects, it seeks to satisfy social needs and is therefore not guided purely by market forces of demand and supply. The programme is very much dependent on government financial support which in turn is supported by aid agencies with much subsidisation from the local government.

It is further noted that only 9% of the fuelwood plantation programme is industrial the remaining 91% is non-industrial. The fuelwood programme is therefore mainly for domestic consumption. The demand for fuelwood remains on the increase due to rise in population and increased rate of urbanisation.

3.5.5 Factors affecting the establishment and management of public sector fuelwood plantations

The major factors that affect the establishment and management of public sector plantations in Senegal can be summed up as limited financial resources and the harsh environmental conditions. The former limits the annual rate of afforestation and therefore the failure of the plantation programmes to meet the fuelwood requirements in the country. The latter on its part makes plantation establishments technically and financially difficult and adversely affects the productivity of established plantations.

4.0 CASE STUDIES PRIVATE SECTOR PLANTATIONS

4.1 Industrial plantations Congo

4.1.1 Background to the case study

The *Unité d'Afforestation Industrielle du Congo* (UAIC), now replaced by *Eucalyptus du Congo Societé Anonyme* (ECO S.A.), a limited company, has the objective of developing low-fertility sandy savannah soils around Pointe Noire by introducing Eucalyptus in the form of high performance clones and hybrids for export as logs for the pulp industry. Pointe Noire (4^0 48'S, 11^0 54' E, 40 – 180 m a s l) is located in the southern coastal region of Congo. Annual precipitation averages 1250 mm, with four dry months from June to September and a mean annual temperature of 25^0C. According to the FAO/UNESCO classification the soils are Ferralic Arenosols, sandy in texture with a clay content of less than 5% in the top layer. They are particularly poor in nutrients and organic matter - the exchange capacity is 0.4 to 0.7 cmol kg^{-1} and the Carbon content is 0.7% in the 0-10 cm layer (*Bernhard-Reversat, 2001*).

4.1.2 Development of the plantation programme

Plantation establishment started in 1978 after intensive forestry research and experimental plantations carried out by CIRAD-Fôret (formerly CTFT) had resulted in a considerable improvement of the

genetic status and multiplication techniques of Eucalypts. The main hybrid planted is *Eucalyptus PF1*, a natural hybrid between *E. alba* and undetermined parents as well as *E. urophylla* and *E. grandis* and their hydrid. Currently, these plantations cover a total area of 45 000 ha (*ITTO, 2002*).

The common management practice is a first seven year rotation established from clonal rooted cuttings followed by a second and sometimes a third coppice rotation of the same duration. At seven years of age (age of harvest), an average Eucalyptus plantation will have a mean height of 28 m, a diameter at breast height of 14 - 16 cm, a basal area of 16 m^2ha^{-1}, a volume of 173 m^3ha^{-1}, a mean annual increment of 24.7 $m^3ha^{-1}yr^{-1}$, and a biomass production of 100 - 120 t ha^{-1} (*Bernhard-Reversat, 2001*).

4.1.3 Economic profitability and viability of the plantations

No information was available on the economic profitability of the enterprise. The annual yield of pulp wood is between 300 000 and 500 000 m^3 (*FAO, 2003c*), for export to Norway, France, Italy, Spain and Morocco. In recent years, declining prices have affected profitability, resulting in the closure of the venture. Limited internal demand led to the initial focus on the export market, where profitability depends on comparative advantages and on issues such as productivity, transport costs and political stability (*AfDB, EC and FAO, 2003c*).

These forests also meet almost 80% of domestic energy requirements of the population of Pointe Noire and thus help to reduce unauthorised extraction from the islands of natural forest in the zone (*FAO, 2003d*).

4.1.4 Ecological viability

The changing environment from savannah to artificial forests has been investigated and the main results according to *Bernhard-Reversat (2001)* are:

Natural vegetation with many pioneer species developed under the Eucalyptus plantations. The number of species of undergrowth under the exotic tree plantations ranged from 24 to 30, whereas the value for secondary forest was 100. The rate of vegetation change was slowed down by management practices or accelerated by high plantation density and by forest proximity. The observed natural vegetation biodiversity in the plantations could improve the soil properties by increasing the diversity of organic sources for soil biota and by decreasing the negative effect of eucalypt biochemicals such as polyphenols and terpenes, although undergrowth vegetation also competes for water and nutrients with the tree crops.

Soil organic matter increase cation exchange capacity leading to improved retention of nutrient inputs from rainfall, litter and fertilisers. An increase in soil organic matter is also assumed to be responsible for changes in microfauna, and an improved functioning is expected from increasing density of earthworms, termites and litter fauna.

The absence of N-fixation and the decreasing nitrogen content of the soil with plot age lead to mineral nitrogen deficiencies for tree growth, requiring fertiliser use by the second rotation or introduction of nitrogen fixing understorey crop.

4.1.5 Factors that have contributed to success and/or failure

Land availability and tenure

The company is using sandy savannah land considered unsuitable for agriculture. Generally, there is abundant land, given the low population density (except in urban areas).

Political instability and conflicts

Two civil wars between 1993 and 1999 which mainly occurred in the south of the country led to some population displacements and material destruction, affecting all sectors: administration, production, services and infrastructure leading to economic and social instability (*ITTO, 2002*). The wars had an impact on all sectors of the economy. However, their effect on the private forestry plantation sector has not been quantified.

There are intentional forest fires in the plantations now, a reflection of the discontent of neighbouring communities (*ITTO, 2002*). The problem poses the greatest threat to SFM and conflict resolution mechanisms should be worked out.

Linkage with down-stream processing and price fluctuations

As there are no local pulp production units in the country, all timber is exported. Timber production from these plantations is thus subject to market fluctuations and this can cause marketing problems (*ITTO, 2002*). As pointed out earlier, declining prices in recent years have affected profitability, resulting in the closure of the venture.

Legislation

A new forest law adopted in 2000 facilitates private plantations by granting owners the right of possession of the resulting products (*ITTO, 2002*).

Input from research

High quality research by CIRAD has provided appropriate recommendations on genetics and silviculture. For example, improved clones yielding 25-30 $m^3ha^{-1}yr^{-1}$are now replacing the relatively unproductive ones (12 $m^3ha^{-1}yr^{-1}$) (*FAO, 2003c*).

4.2 Industrial plantations South Africa

4.2.1 Background to the case study

The history of commercial exotic plantation development in South Africa dates back to the late 19th Century, when it dawned on the country that the indigenous forest species could not support the increasing industrial demand. The indigenous forests had been over-exploited and had low yields estimated at not more than 3 m^3 /ha/y. Significant investments in processing industries were only made after large areas of these plantations reached maturity in the 1940s.

The main species initially introduced were softwoods from Australia and United States such as araucarias and long leaf pine (*Pinus palustris*) respectively. Smaller plantations were established in the "mist belt" mountains of Natal. These plantations were experimental and trial plantations made up of *Pinus longifolia*, the Mexican pine *P. patula*, and *Cupressus lusitanica*. While the pines were mainly chosen for their wood quality, eucalyptus such as *E. saligna* and *E. maidenii,* were planted because of their fast growth.

Areas planted to the main species by 2000 are: Pines 705 400 ha (53%); Eucalyptus 505 758 ha (38%), wattle 106 475 ha (8%) and others 12 000 (1%) (*DWAF, 2002*; *Goldsmark, 2002*).

4.2.2 Development of the plantation programme

The development of plantation forestry in South Africa is industry-driven and very dynamic such that in a little over hundred years, South Africa had made the transition from a net importer to a net exporter of products with an internationally competitive wood industry. The developmental process can be divided into three main phases (*FSA, 2002*).

Phase 1: 1870-1914

Purposeful afforestation started in the late 1870s as both public and private concerns sought to provide an alternative to fast disappearing natural forests. By 1914, the afforested area was estimated to have reached 175 000 ha. Thus, early wood processing industries began to appear following the increased supply of wood. These early afforestation efforts demonstrated the capability of afforestation to meet the wood needs of the country.

Phase 2: 1914-1945

Afforestation efforts accelerated significantly during the years that followed the First World War. In this phase, the government assumed a lead role in pursuing a self-sufficiency policy in wood production. The policy to increase the domestic supply of timber followed the disruption of imports caused by the First World War coupled with the objective of providing employment for whites in the depression years. By 1945, the afforested area had reached around 600 000 ha.

Phase 3: 1945 to date

The years following the end of the Second World War have been characterised by continued expansion of the afforested area, which reached nearly 1.5 million ha in 2000 (*FSA, 2002*) . The period is further marked by an increased involvement of the private sector and the emergence of the domestic pulp and paper industry as a major driving force.

The major plantation owners and the areas of plantations held by them are: Mondi Paper Company Ltd (400 000 ha); the South African Pulp and Paper Industry (SAPPI) (265 000 ha); the South African Forestry Company (SAFCOL) (265 000 ha); Masonite (Africa) Ltd (18 000 ha); and the Hans Merensky Holdings (11 000 ha) (*SADC FSTCU, 1997*). By the year 2001, around 1.1% of the land area of South Africa is under commercial plantation. Of all the reported commercial plantations, 72% or 970 000 ha are under private sector ownership while the remaining 28% or 380 000 are under public ownership.

On the average, 80 000 ha are harvested annually and somewhat more is planted and replanted. Future yields are estimated to increase by 40%, partly because of an estimated area expansion of about 200 000 ha (mainly in the Eastern Cape Province) partly because of increased use of clonal, high-yielding plants. Currently, 56% of the plantations are managed for pulpwood, 38% for sawlogs, 4% for mining timber and 2% for other purposes (*DWAF, 2002*). Wood production in the 1997/98 season was 18.6 million m^3 while mean annual increment (MAI) was between 12 and 13 m^3 per ha (*AfDB, EC and FAO, 2003d*).

4.2.3 Economic profitability and viability of the plantations

The plantation development in South Africa is linked to the industrial revolution of the post world war years, which has seen an increased focus on overseas markets for both the forest industries in general as well as the major companies. Thus, self-sufficiency was achieved in value terms in the industry in 1985. Forest products, mainly paper-based, accounted for 4.7% of total export earnings and utilised about 35% of locally produced wood volume. At the same time, South African leading forest companies have become international players both through the export of products and the acquisition of overseas assets, e.g. in Zimbabwe, Mozambique and Swaziland and beyond. For example, SAPPI has links with United Kingdom. These international linkages create big markets and high demands for plantation wood. They therefore enjoy economies of scale, which help to reduce production costs by reducing overhead and marketing costs.

Over the period 1980 to 2000, profitability analyses of the forest industry showed that the value in nominal terms of roundwood sold rose from R 165 million in 1980 to R 2 574 million in 2000, although the value increase in real terms - at 2000 prices – was from R 1 569 to R 2 574 million. Pulpwood registered the biggest increase in value, while mining timber had the biggest decline in value (*Goldsmark, 2002*).

The factors that have provided the stimulus and contributed to the success of the plantations include the following:

- The existence of a strong demand for forest products from local industries combined with limited competition from overseas as a consequence of South Africa's isolation from the rest of the world during Apartheid and the imposition of protective tariff structures.
- The State initially played a direct investment role, which established a sizeable proportion of the overall resource that formed a basis for the development of the processing industries.
- The early establishment of a strong research, technology and education system.

4.2.4 Ecological viability

The Water Act of 1998 requires, among other things, that plantations should not be established in areas with serious water deficits. To this end, it imposed conservation requirements through the planting permit in which planting distances from water courses and wetlands are specified. This is further compounded by the more recent requirements that soil surveys and environmental impact assessments (EIA) be conducted before planting. This has resulted in the percentage afforestation being reduced in some case to less than 70% of available area. In the case of Mondi Forests, the net effect is that out of 650 000 ha owned by the company, 200 000 ha will never be planted (*Pott, 1997*).

4.2.5 Factors that have contributed to the success or failure of plantation programmes

Overall environment for private investments

The private sector is the dominant force behind the success of plantation forestry in South Africa. The years immediately following the cessation of the Second World War saw very rapid expansion of afforestation through the involvement of the private sector. The private sector investment efforts were further supported by the emergence of the domestic pulp and paper industry as a major driving force in the industrial wood plantation programme. More recently, the industry has become more internationally focused with increasing export sales and acquisition of overseas production capacity.

The overall environment for private investment in South Africa is considered favourable due to a host of attractive investor considerations which government has put in place (*SADC FSTCU, 1997*). Some of these incentives are:

- Government promotes and encourages foreign investments. For this reason, depending on merit, applications for foreign investment projects are treated with much flexibility.
- Emphasis is placed on establishing new industries in labour-surplus areas.
- Government operates favourable dual exchange rates, which can translate to high rates of return to foreign investors.
- Local branches and subsidiaries of parent foreign companies are treated as residents with attendant benefits.
- There are no restrictions limiting repatriation of capital investments in financial rand.
- There are no restrictions on transfers of dividend or profits by local branch in commercial rand, provided they were earned after January 1984.

Research output

Plantation development in South Africa cannot be complete without due mention of the role of research in the programme. South Africa is reputed for the intensity and commitment to research on tree improvement and management techniques. Through research, the country has developed genetically improved germplasm, matching of species to sites and the establishment and management techniques, which have boosted the productivity and output of different tree species used for various purposes.

Meeting the certification standards

With most of its plantation wood products destined for the export markets, South Africa quickly complied with the certification requirements and stands out as one of the few African countries to fulfil the Forestry Stewardship Council (FSC) certification standards. As of May 2000, the country had 780 000 of forests certified by the FSC, which placed it 4th in the world in terms of total area of forests certified (*CIFOR, 2000*).

Problems in plantation establishment

The following are the main problems with regard to plantation establishment:

- Decreases in mining activities, as well as use of alternative underground support systems have led to low demands for hardwood mining timber. However, hardwood timber has found alternative use in the woodchips industry.
- In 1982 and 1983, South Africa suffered a very serious drought, which had far reaching consequences on the timber growers. Lack of sufficient rains affected timber yields in the medium term, which in turn reduced timber availability.
- Much of the potential annual volume increments of plantations are often destroyed by fire which is a common occurrence especially in the vicinity of parks where controlled burning is used to initiate growth of luscious vegetation for wildlife and game grazing. Other hazards include adverse climatic factors such as drought and frost, pests and diseases. In the 2000/2001 fiscal year, plantation areas thus damaged or lost amounted to over 20 000 ha (*DWAF, 2002*).

Land availability and tenure

South Africa owes its success in plantation development to availability of suitable and sufficient land which supported rapid expansion of plantations that yield high quality wood at low cost. Furthermore,

there exist ecologically friendly conditions necessary for the rapid expansion of plantations in many provinces.

It is reported that there is as much as 800 000 ha of land left to develop for potential new plantations. However, it is also recognised that much of this available land is not the best for plantation growth.

In recent years, the rate of new afforestation in South Africa has declined considerably due to a number of factors, among which is competing needs for land for other uses.

Political instability and conflicts

South Africa has had about a decade of independence since emerging from the Apartheid era. It is not clear how much the political conflicts and the fight for independence hurt the forest industry. It is evident though that the sanctions on the country during the Apartheid era limited exports, and therefore earnings, as the country was isolated from the rest of the world. However, due to the economic isolation of the Apartheid government, and the lack of access to updated machinery, there has been a low timber recovery rate in sawmills. For sawmills in the country to remain competitive, there is a need to modernise machinery and technology to achieve higher than the current 50% recovery rate.

It is probably the political instability in neighbouring Zimbabwe, rather than in South Africa itself, that might indirectly affect the forest industry because some South African companies have plantations and subsidiary companies in that country. In the past, the political instability in Mozambique affected the export of logs and other sea route bound forest products. The insecurity in the country then caused delays and diversion of products to the detriment of the forestry industries. These impacts were more felt among companies in Mozambique whose parent industries are located in South Africa.

Pricing policies

One of the contributors to South Africa's success in plantation development lies in the strong domestic competition between producers within the sector on the one hand and between sectors on the other. This forced them to develop efficient structures and clear strategies for success like the development of overseas market for products whose domestic demands dropped. A good example is the chipping of hardwood pulpwood like *Eucalyptus* and wattle and exporting them as wood chips.

There has been a long history of low government sawlog prices for private sawmillers in South Africa. The price was controlled to protect the domestic sawmills. Furthermore, there were long-term contracts by government plantations to supply logs to the private sector sawmills. There are plans to change this pricing and marketing mechanism to a tender system so as to make the log prices competitive and compatible with the world market prices.

Market conditions determine actions and willingness of plantation owners to convert portions of their plantations from one species to another or convert plantation land to other uses. During the 2000/2001 season, 4 725 ha was reported to have been converted from one species to another while 6 500 ha were converted from timber to agriculture (*DWAF, 2002*).

4.2.5 Restrictive legislations

Investment regulations

There are several regulatory controls that spell out the types and range of investments that can take place in South Africa. According to *SADC FSTCU (1997)*, some of these legislations considered to be restrictive and therefore inhibit growth in the plantation industry in South African fall under the "Exchange Control Act" or the "Income Tax Act of 1962".

The Reserve Bank is the main operative of the Exchange Control regulations. Strict exchange controls intended to protect the local currency and economy tend to adversely affect exports and the transfer of benefits by company operatives and between parent and subsidiary companies.

The income tax is the main tax in the country. Companies are taxed at fixed rates while individuals are taxed at progressive rates. With effect from 30 September 1991, general sales tax was replaced by an invoice-based VAT at a single rate of 14%. In addition to normal tax, the following taxes are imposed under the income Tax Act, which might hurt the plantation programme.

- Non-resident tax on shareholders who are resident outside South Africa. This is payable on accruals of dividends to non-residents.

- Donations or gift tax. This is payable on donations by individuals and domestic private companies at a flat rate subject to an annual non-cumulative exemption of a stipulated amount in the case of individuals.
- Secondary tax on companies. This is a levy on all dividends declared by a company.

The plantation programme in South Africa also benefited from the protective policy, which emphasised self-sufficiency, and industrial development through import controls and export incentives.

The adoption of the Afforestation Permit System (APS) in 1972 is believed to have slowed down the pace of afforestation in the country. However, over one million hectares of plantations, or 70% of the current plantation estate, were already established prior to the implementation of the system.

The tightening of the procedures for the granting of the necessary water licences is reported as one of the factors that affects establishment of new plantations.

Environmental issues

Water-conservation requirements are imposed by the planting permit in which planting distances from watercourses and wetlands are specified. This is further compounded by the more recent compulsory practices of having to conduct soil surveys and environmental impact assessment (EIA) before planting. This has resulted in the percentage afforestation being reduced in some case to less than 70% of available area. In the case of Mondi Forests, the net effect is that out of 650 000 ha owned by the company, 200 000 ha will never be planted (*Pott, 1997*).

Linkage with downstream processing

Among the key factors that have contributed to the success of forest plantation development in South Africa is the role played by the state in direct investments in the sub-sector. It formed the basis for forward integration and value adding through the development of processing industries.

Some of the incentives that promoted expansive and rapid plantation establishment in South Africa include the favourable policy environment in which the companies operated. The policy promoted and emphasised self-sufficiency and industrial development. A range of supporting measures was implemented in pursuit of this policy, including heavy subsidisation of timber from government-owned plantations to support the development of private sector processing industries. There were also some decentralisation benefits, for example export incentives were provided to processors in the form of subsidies and processors were also given tariff protections.

Plantation tree growing in South Africa was initially organised to meet the needs of four industrial sub sectors: the wattle bark tannin, the mining, the sawmilling, and the pulp and paper industries. The wattle and mining industries provided the foundation for the commercial plantation sector in the early 20th Century.

The abundance of strong domestic processing and manufacturing companies that are familiar with the types of species grown in the country's forest plantations and their linkages with the plantation owners and developers is an added advantage to the utilisation of plantation-grown wood and therefore to the success of the plantation programme in South Africa.

4.3 Industrial plantations Swaziland

4.3.1 Background to the case study

Industrial plantation establishment in Swaziland started in1949 by the Commonwealth Development Corporation (CDC), mainly to supply wood to domestic industry and for export to South Africa (*Nylén, 1999*). There are no productive indigenous forest reserves in Swaziland.

All plantations are owned by the private sector, mainly wood processing companies. The role of government is limited to that of providing an enabling environment for the privately owned forest industry to operate efficiently. The total area of plantation forests amounts to 160 500 ha with the bulk (c 65%) being *Pinus spp* (*P. patula* and *P. radiata*) in the Usutu and Pigg's Peak forests, *Eucalyptus grandis* (c 20%) and *Acacia mearnsii* (c 16%) (*FAO, 2001a*).

There are four main private sector companies involved in forestry development in Swaziland - the Usutu Pulp Company (54 000 ha), the Shiselweni Forestry Company (12 000 ha), the Peak Timbers

Ltd or Mondi Forests (32 000 ha) and the Swaziland Plantations Company with an area of 5 000 ha (*SADC FSTCU, 1997*).

Productivity of plantations is known to be high and similar to the performance in South Africa. *Evans (1996)* reported that in three rotations of *Pinus patula*, there was no evidence of decline in yield of the plantations.

4.3.2 Economic profitability and viability of the plantations

The Swaziland plantation industry is considered viable and profitable because it is linked to South Africa private industry. Consequently, South Africa is the major export destination of Swaziland-grown wood. In addition, pulp and unbleached Kraft from Usutu Pulp Mill are major export products. Raw Kraft is sent to South Africa for processing and 90% of that is then exported to Europe. Usutu also has international links to major markets in Asia. Mining timber and Eucalyptus oil are also exported to South Africa. The oil is processed into Cineol and exported to Australia where it is used in the pharmaceutical and perfume industries. Wattle is also exported to South Africa where it is processed into tannin and glue. The wood is used as pulp and as mining timber in South Africa (*SADC FSTCU, 1997*).

Sawlogs produced by the main timber companies are sold both locally and in South Africa. The Peak Timber Ltd. exports sawn timber to South Africa, Mauritius, the Seychelles, Europe, the Far East, Botswana and Lesotho. In total, 75% of the sawn timber is exported, of which 80% is construction timber. The sawn timber comes almost entirely from pines with only a small quantity from Eucalyptus.

The FRA 2000 report indicates that by 1998, Swaziland had a net export earning of US$ 62 million from the export of wood pulp (*FAO, 2001a*).

4.3.3 Ecological viability

One of the major constraints to expanding the plantation programme in Swaziland is the government policy that requires forestry plantation to be restricted to sloping land and not be allowed on good agricultural land. There is still land available for future plantation development in Swaziland. In this regard, the Commonwealth Development Corporation (CDC) had expressed interest in developing a further 7 000 ha of commercial plantations. The project was intended to supply mining timber to South Africa. However, the decline in the mining industry put the project at abeyance.

4.3.4 Analysis of factors that have contributed to the success (or otherwise) of private sector industrial plantations

The overall environment for private investments

Swaziland's forest policy is focussed on promoting private sector involvement in forestry. In addition to supporting private sector investments in forestry, the Government recognises that the Forest Policy, from other points of view, is out of date and not well defined. The Government therefore wants to update it and has sought the assistance of donors through the SADC Forestry Sector Technical Coordinating Unit in Malawi in the pursuit of the objective.

Swaziland has a considerable investment incentive package aimed at attracting both domestic and foreign investments. The Swaziland Industrial Development Company (SIDC) plays a crucial role as the principal development agency that finances private sector projects in the manufacturing, mining, tourism, commerce and service sectors. Highlights of the investment incentives include the following:

- Provision of duty free export processing zone (EPZ).
- Provision of corporate tax holiday in some cases.
- Freedom to repatriate dividends, interest, and profits.
- Provision of export finance guarantee.

Pricing policies

There are two regulatory agencies for the forestry sector and plantation development in Swaziland - the Forestry Section of the Ministry of Agriculture and Cooperatives and the Trade Promotion Unit of the Ministry of Commerce and Industry,.

These two agencies act in tandem to pursue the production and marketing of plantation wood. At the same time, they specialise in and control specific objectives in the forestry sector. For instance, while the former handles the policies and strategies on primary production such as plantation establishment, management and exploitation, the latter deals with identifying and creating markets for the products. This market-oriented strategy in structuring the sector is a commendable model for adoption in forestry management.

Restrictive policies

The government policy requiring that forestry plantations should not be allowed on good agricultural land is a major hindrance to new plantation development. The policy reserves plantation development only on sloping lands for obvious reasons. They are more prone to environmental damage when actively worked and cultivated and the idea is that planting the right species of trees on such lands will help stabilise them and reduce environmental damage. However, trees, just like agricultural crops, perform much better on flat, fertile land.

An important feature of Swaziland's monetary system is the country's membership of the Common Monetary Area (CMA), formerly the Rand Monetary Area. Other members of the CMA are Lesotho, Namibia and South Africa. With this system, there are no exchange control restrictions in effect among the member countries and they all apply similar exchange control measures. However, exchange control measures are imposed on all non-CMA countries (*SADC FSTCU, 1997*).

Companies or persons that are directly or indirectly more than 25% non-CMA controlled require Central Bank approval before raising loans or bank overdrafts within the CMAs. Non-residents are required to arrange a fair share of required fund from their own private resources.

Approval for exports should be obtained from the Central Bank for permissible products and disbursements incurred in respect of exports. Export permits must also be sought and obtained from the Ministry of Finance. Although no restrictions are placed on imports into the country, yet certain items require import licences before they can be brought into the country.

Linkage with down-stream processing

The success of the Swaziland plantations development is attributable not only to its link with the local processing companies but also to the fact that the major companies are subsidiaries of parent enterprises in South Africa. For example, Peak Timbers is a subsidiary of Mondi Forests, which is the largest forestry company in South Africa with a planted area of 400 000 ha. Usutu Pulp Company is also a subsidiary of South African Pulp and Paper Industries (SAPPI), which is the second largest forestry company in South Africa. Thus, the plantations in Swaziland are owned and managed by big industrial forestry concerns with high utilisation capacity for wood both locally in Swaziland and overseas in neighbouring, technologically advanced and highly industrialised South Africa.

4.4 Industrial plantations Zimbabwe

4.4.1 Background to the case study

Zimbabwe is moderately forested with about 22% of the land area under rather dense woodlands and with small remnants of subtropical high forest in the Eastern Highlands. Significant areas of plantation forests have been established in the country with *Pinus patula*, *Eucalyptus* spp. (particularly *E. grandis*) and *Acacia mearnsii* as the most common species (*FAO, 2000b; SADC FSTCU, 1997*). These plantations form the main source of wood for the sawmill and pulp and paper industries in the country.

Plantations are mainly managed to produce industrial roundwood. About 70% are managed for sawlogs, 14% for pulpwood, 7% for woodboard raw material and 9% for poles (*AfDB, EC and FAO, 2003d*). The area of commercial plantations were 140 800 ha by 2000 (*FAO, 2000b*).

4.4.2 Development of the plantation programme

The private sector - forest companies and individual private owners - has a larger share of the commercial forest plantations (58%) than the state (42%). The breakdown of the ownership by the type of tree species is presented in *Table 1*.

Table 1. Zimbabwe: Commercial plantation areas by species in 2000

Species	Total (Ha)	Private (Ha)	State (Ha)	Percentage
Pines (*P. patula*)	94 400	54 750	39 650	67
Eucalyptus	12 700	7 400	5 300	9
Acacia spp (Wattle)	21 100	12 200	8 900	15
Other pines	7 000	4 000	3 000	5
Other hardwoods	5 600	3 250	2 350	4
Total (%)	**140 800**	**81 600 (42)**	**59 200 (58)**	**100**

Source: Adapted from *FRA, 2000* and *SADC FSTCU, 1997*

The large organised private sector has a commanding percentage of the forest plantations with as much as 54% of the total while the individual or small private sector has only 4%. It is not known exactly to what use the small private sector puts its plantation grown trees. The larger private sector comprises the manufacturing companies, e.g. sawmills, veneer and ply mills, particle and fibreboard mills, pulp and paper, a match factory, mining timber and a wattle tannin factory. Thus, the plantations are forwardly integrated to the companies with a view to providing wood raw material on a sustainable basis to the industry.

The Border Anglo company is the largest owner with 29 000 ha of plantation and had negotiated the purchase of another 10 000 ha of land for plantation development. The Wattle Company has 26 000 ha of plantation and was negotiating the development of a joint venture plantation project in Mozambique (*SADC FSTCU, 1997*). Total annual production by the private sector from the plantations is estimated at 440 000 m^3 of wood. Plantation statistics for pine and eucalypts in 1997 are summarised in *Table 2.*

With the plantations being predominantly privately owned, they are generally well managed. The productivity of the plantations is reported to be high due to use of fast growing, high yield superior seedlings for replanting (*AfDB, EC and FAO, 2003d*).

Table 2. Zimbabwe: plantation statistics by species in 1997

Description	Pines	Eucalypts	Total
Standing Volume (m3)	10 500 000	2 125 000	12 625 000
Available annual cut (m3)	825 000	250 000	1 075 000
Allowable annual cut (m3)	255 000	170 000	425 000
Surplus (deficit)	570 000	80 000	650 000

Source: Adapted from *SADC FSTCU, 1997*

4.4.3 Economic profitability and viability of the plantations

The viability and profitability of the industry is depending on its linkages to processing companies, both locally and overseas, and to export markets.

Zimbabwe is finding some export supply opportunities in South Africa following the deliberate reduction of the supply of logs to commercial sawmillers in South Africa by the forest companies.

Zimbabwe, in an attempt to fill these gaps, has been exporting softwood logs to South Africa at 10% lower than the domestic log price in South Africa.

At present, it is not certain what the financial status of the enterprises is given the current political and economic instability in the country.

4.4.4 Analysis of factors that have contributed to the success (or otherwise) of private sector industrial plantations

The overall environment for private investment

The primary aim of an individual or company to invest in forest plantations is to reap some financial benefit either directly or indirectly. Direct benefits from the investment will come in form of increased income from the sale of roundwood. Indirect benefits that can accrue to a private investor will be in one or more of these forms:

- The guarantee of a steady supply of wood raw material in the case of a wood processing company.
- Security of tenure on land whereby the investment in plantations as a long gestation enterprise affords the investor a long-term right to the use of the land.
- Financial security from owning a tangible asset such a forest plantation that can easily be converted into cash.

The ability to reap these benefits is guided by a host of factors that shape the investment environment and make it conducive for private investment. Some of the factors are state laws, the extent of infrastructural development such as transportation on land and sea as well as economic and political stability. At present, the investment climate in Zimbabwe does not meet many of these stated criteria. The land reform programme in Zimbabwe does not guarantee security of tenure. Second, the political crisis has triggered off a wave of economic downturn, which is an unhealthy environment for investments, especially long term and long gestation investments such as forestry plantations, which is characterised by much uncertainty about the future.

Land availability and tenure

The private companies in Zimbabwe have limited land of their own left to establish new commercial plantations. The main avenues open to the timber companies to expand their wood supply through plantations is either through out-grower schemes or by establishing plantations in neighbouring countries. The Timber Producers Federation is developing an out-grower scheme with the assistance of Border Timber and some other timber growing companies in the country. The scheme aims at assisting commercial and communal growers to establish softwood and hardwood plantations. Since the out-grower schemes involve landowners bringing their land into plantation development for wood production, the scheme offers a profitable and sustainable opportunity for further plantation development.

In the face of the land crisis in Zimbabwe, it is not certain how viable and feasible this programme has become since land would have changed ownership and management since the 2002 elections in the country. The feasibility and success of out-grower schemes will depend on the extent to which new owners or users of land would favour plantation development in the face of a looming food crisis in the country. It is assumed that poor native Zimbabweans who gain access to land through the land reform programme might elect food security as their primary objective and priority investment rather than plantation establishment. Only farmers with a good wealth and income situation can afford to wait for the 8-10 years gestation before plantation maturity in out-grower programmes.

Political instability and conflicts

The political instability in Zimbabwe is known to have adversely affected the economy especially in the agricultural sector. It is not known how much the forestry industry sector is affected. However, it is noted that most of the private sector forestry companies are linked to parent or subsidiary companies in South Africa. Given that the epicentre of the political crisis in question is the issue of land redistribution or reform, it is obvious that the industrial forest plantations in the country cannot go unscathed by the crisis.

Strongly related to the political instability is the issue of funding. Most forestry plantation development programmes were funded through bilateral and multilateral agreements by donor countries or

international financial institutions. Under a state of political turbulence, these agencies are not keen to commit their funds for investments in Zimbabwe. Thus, virtually all bilateral donors are withholding or terminating their investments because of the political debacle in the country.

Pricing policies

The pricing policy in the forest plantation industry in Zimbabwe is influenced partly by the activities of the Forest Commission, which is a government parastatal, and partly by the market forces. For example, it was reported that owing to ineffective demand for plantation-grown roundwood in the country, logs from over-mature forests had to be exported to South Africa.

The export prices very largely guide the activities of the plantation and with South Africa as the major export destination of wood products from Zimbabwe, the pricing system is very much determined by the competitiveness that prevails in the international commodity export markets within the region and beyond.

Restrictive legislation

Forestry is a closed or designated industry in Zimbabwe, which means that outside investors need special permission to invest in the industry, especially with respect to the purchase of land. Likewise, foreign controlled businesses may not invest in local equity, unless Exchange Control approval is given before the investment is made. With limited land available to private investors to establish new plantations an out-growers scheme intended to help in resolving the forestland scarcity problem has been proposed (see above)..

Income tax is levied at fixed rates on companies and at progressive rate on individuals. Foreign companies with branch operations in Zimbabwe are subject to branch profits tax in addition to income tax on taxable income attributable to Zimbabwean operations. Withholding taxes are imposed on interest, royalties, dividends and fees paid to non-residents.

Any person who wishes to invest in the Export Processing Zone (EPZ) is expected to obtain an investment licence. Exchange Control approval is required for the crediting of any sums to non-residents in the books of the company. In all cases, unless applications for approval are made promptly, it is possible that remittance will be refused.

Foreign-controlled businesses are restricted in the amount of money that they may borrow without any further restrictions being placed on dividend and profit remittances. The borrowing limits are determined by a formula based on the degree of foreign ownership and quantum of shareholders funds including shareholders' loan accounts.

Linkage with down-stream processing

With 58% of the plantations in Zimbabwe owned by private sector processing companies, it is obvious that the plantations are fairly well linked with down-stream processing. On the other hand, the report that timber plantations are over-mature and are now seeking markets in South Africa at 10% less than the price in South Africa is a proof that the industrial base is not strong enough and lacks the capacity to effectively absorb all the wood produced by plantations in the country.

There are indications that the domestic processing industries in Zimbabwe are no longer interested in investing in the country. For example, the reported new expansion programmes from the Forestry Commission and from the Wattle Company are geared towards forming partnerships with outside companies or making investments in Mozambique respectively. However, with Border Timbers also showing interest in plantations in Mozambique and processing in Zimbabwe it paints a different picture of the situation and seems to admit that the processing capacity exists in Zimbabwe and that it is the carrying capacity of the land for more plantations that has been reached.

5.0 CASE STUDIES ON FOREST PLANTATIONS AND WOODLOTS BY FARMERS

5.1 Industrial wood production by small farmers in the central highlands of Kenya

5.1.1 Background to the case study

The case study area is the Central Highlands of Kenya, a coffee and tea-coffee zone lying at an altitude of 1300 - 1800 m a s l. The area is humid and sub-humid with bimodal rainfall. Average rainfall ranges from 1200 mm to 1500 mm per year. The short rains fall between mid October to December and the long rains are from mid March to June. Average annual temperature ranges between 18 and 21 ^{0}C. The main soil type is a deep nitosol of medium fertility.

The highlands have a very high population density, which ranges from 230 to 730 persons per km^2 with an average of 450 persons per km^2. The land is held in private family farms. There is wide variation in farm size with an average of 1.5 ha (*Minae and Nyamai, 1988*). The farms are mixed cropped with maize, beans, potatoes, bananas, dairy cows and different tiers of plants and trees providing various goods and services. Many tree species are planted on farms, the dominant ones being: *Grevillea robusta, Vitex keniensis, Cordia africana, Cupressus lusitanica, Eucalyptus saligna, Ocotea usambarensis, Prunus africana, Pinus patula* and *Newtonia buchananii* (*Betser et. al., 2000; Holding et. al., 2001*). Coffee and tea have been the main cash crops, but with the slump in the price of coffee, farmers are welcoming new enterprises like contractual growing of green beans and selling of wood.

5.1.2 Tree establishment, management and productivity

Farmers have traditionally been growing trees as shade over coffee. While nursery raised seedlings are sometimes planted, especially of exotic tree species, trees are mainly established from transplanted naturally regenerated seedlings (wildings) on farm.

Tree management on farm involves pruning, pollarding and sometimes thinning for overcrowded trees, which excessively shade food and cash crops. Silvicultural advice is limited, and thus most of these operations are based on the farmer's own experience. Consequently the quality of the trees for use especially for timber is generally low.

Inventories have been carried out on farms in the study area by *Njuguna et. al. (2000)*, who found that the number of trees had increased from 250 trees per hectare in 1993 to 397 trees per hectare in 1998. During the same period, the wood volume per hectare increased from 9.6 m^{3}ha^{-1} to 19.9 m^{3}ha^{-1}. Based on the number and diameter distribution of the trees on farm, the study showed that many trees were recently planted.

In 1994, the Kenya Forestry Master Plan estimated that 65% of the total wood produced in the high and medium potential districts came from farms. The plan further estimated that sustainable wood supply from farmlands and settlements in Kenya in the 2005 would be 1 465 000 m^3 of timber, 513 000 m^3 of poles and 9 418 000 m^3 of fuel wood (*MENR, 1994*).

5.1.3 Economic viability of small scale private planting

Economic analyses of cropping and tree enterprises have been carried out in some locations in the central highlands. *Njuki (2001)* found for Embu and Kirinyaga districts that trees contributed 3% to the total value product. A study carried out between 1995 and 1997 by *Njenga et al. (2000)* in Nyeri showed that the average gross margin from trees per farm per year was Kshs 57 808. This figure includes the contribution of coffee and tea, which was 65% of the total. Fruits contribute 28% while timber and firewood contribute 8%. Trees grown on farms function as major sources of fuelwood for households. About 70% - 80% of the households obtain firewood from their farms. The remaining percentage of households obtains their supply of firewood from neighbours or nearby forest.

Following a temporary ban in 1999 on the sale of timber from government-owned forest plantations and natural forests, there has been an increase in the sale of timber from farms and some farmers have formed associations to facilitate the marketing of timber. Information on the profitability of this new timber enterprise is not available. However, both the farmers and sawmillers have indicated the problems they face in the business. Farmers have indicated lack of valuation techniques, lack of knowledge on tree management, lack of knowledge of the market, poor prices received, trees growing

in places that are difficult to harvest, conflicts with family and neighbours while felling trees, permits required from the administration before trees can be felled and transported and transportation (*Holding et. al., 2001*). The authors listed the problems faced by the saw millers as: accessibility, red tape from administration, economic distance to farms, presence of nails and other obstacles in the logs leading to damage of machinery.

5.1.4 Factors influencing tree cropping in farming systems

The study by *Njenga et. al. (2000)* in Nyeri showed that an increase in distance to the nearest market resulted in a decrease in the number of trees on a farm, and an increase in farm size, distance to the nearest forest, education status of the household head and slope of land led to an increase in number of trees on a farm. Another factor that was found to constrain tree growing was lack of appropriate technical knowledge. *Njuki (2001)* working in Embu and Kirinyaga Districts also observed a positive relationship between land size and number of trees planted per farm. The author further observed a positive correlation between land registration and total number of trees. In Murang'a district, *Patel et. al. (1995)* found a positive relationship between incomes, labour as well as farm size with number of trees planted in the farm.

5.2 Industrial wood production by industry-supported out-grower schemes in South Africa

5.2.1 A brief description of the case study

The out-grower, or small grower, schemes in South Africa owe their genesis to the desire to create employment and income in the economically disadvantaged but ecologically favoured rural areas. This development emerged from the realisation that production of sawn timber could be a profitable investment that should not be left solely to the State or big commercial forest industries. Private investors realised that with the fast growth of some species, profitable harvests could be obtained from tree plantings from as short rotations as 10-20 years (*Edwards, 2000*). This incentive was further heightened by the increasing demand of boxwood for the rapidly expanding fruit trade. The Monterey pine (*Pinus radiata*) became a favoured species for this type of planting since it yields wood that is adapted to the box production and it is fast growing. However, its susceptibility to disease in the moist sub-tropical regions became a problem in the Natal mist belt localities and its place is now being taken by *Eucalyptus saligna*. The latter has faster growth and its young wood is sufficiently light and soft for boxwood.

The schemes were started at different times by different companies. Companies using out-growers, and their respective dates of inception of the schemes, are Mondi (1988), Sappi-Project Grow (1983) and Sappi-Lima (1989), the South African Wattle Growers Union (1993) and the Natal Cooperative Timbers (1994). The latter started in 1970 but was only formalised in 1994 (*IIED, undated*). Estimates of the number of individual small-holders involved in some sort of tree-growing scheme with company support range from 11 300 to 14 800 with a total area of land planted from 25 500 to 37 800 ha (*IIED, undated*).

These schemes in South Africa are interesting models of industry-landowner partnerships in which the small growers are guaranteed access to the market for their products while the industry is guaranteed a steady supply of raw wood materials. The partnerships provide an indication of the viability and potential for tree growing on farm even at very small scales. Forestry South Africa (FSA), the umbrella organisation that represents the interest of commercial timber growers in the country, refers to the small timber growers' schemes as the catalyst for rural development. The schemes benefit from the strong economic base of the forestry industry in South Africa. With a capital base of R 25 billion and an annual turnover of R 20 billion, the industry is strongly able to support the development of small-grower schemes to help meet future timber demands of South Africa.

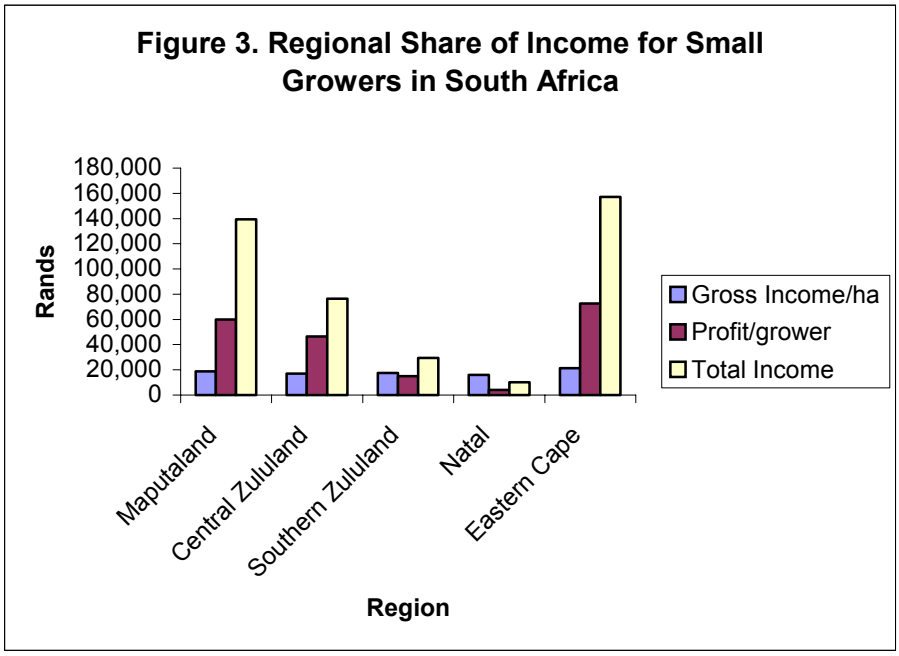
The potential benefits and profitability of these schemes, especially to the small growers, are best illustrated with the "Project Grow" initiated and managed by SAPPI. The project started with three growers farming eight hectares in 1983 and has grown to 9 700 growers farming approximately 15 000 ha today, representing a total investment of R10 million. The project provides SAPPI with nearly 100 000 tonnes of timber per annum with a total value in excess of R20 million (*SAPPI, 2004*). Per ha income for farmers over an 8-year rotation period is between R16 000 and R18 000; the profit is in

between R4 000 and R73 000 and gross income falls between R10 000 and R157 000 per grower (see *Figure 3*).

The out-grower schemes seek to surmount some of the problems that have affected small-scale private tree growers in the past and elsewhere by making efforts to fulfil the following conditions:

- The landowners are fully involved in decision-making. The Tree Growers Association (TGA) of South Africa is an organisation that operates for and on behalf of the small growers in their collaboration with the forest companies.
- Tree growers are protected from the damaging effects of the dynamics of global markets, especially declining prices and decline in demand for products.
- Being organised in TGAs, the small growers are fully empowered by having access to information, which would have been more difficult for individual farmers acting independently.
- Provision of links between tree farmers and small-scale processing enterprises such as furniture and joinery as alternative markets and end uses.
- Assistance to small growers in the certification of their products to increase access to markets for their wood.

The Department of Water Affairs and Forestry (DWAF) expresses concerns over the possible impact of small-scale afforestation on the country's water resources. On their part, the forest industry is trying to promote rural development and economic empowerment through commercial woodlot development.



The conflict of interest becomes a constraint following the stringent requirements imposed by the National Water Act of 1998, and in particular the increasing difficulty in obtaining water use licences for afforestation.

5.2.2 Extent of commercial woodlot afforestation in South Africa

Two types of commercial woodlot afforestation take place in South Africa, namely:

- Coordinated and sponsored schemes run under the auspices of Sappi Forests (Project Grow), Mondi Forests (Khulanathi) and the Wattle Industry (SAWGU).
- *Ad hoc*, uncoordinated and individual plantings for which there are no records and no authorisation from DWAF or other relevant Government Departments.

Table 3 provides details of areas and number of growers that are involved in some Provinces. Zululand has the largest area planted and highest number of growers.

Table 3. Summary of existing small-grower schemes in South Africa.

Location	Area planted (ha)	No. of growers	Average size (ha)
Zululand	16 125	6 155	2.6
Natal Midlands	5 258	3 580	1.5
Southern Natal	2 555	2 504	1.0
Eastern Cape	267	45	5.9
Total	**24 205**	**12 284**	**2.0**

Source: Adapted from *Edwards (2000)*

5.2.3 Extent of involvement of land owners in tree growing

The out-grower schemes are based on individuals and communities bringing their own lands into tree production through technical and financial support of forest companies. Furthermore, the Forest Owners Association (FOA) survey revealed that these organised schemes represents only a portion of what actually takes place and that there is probably a considerable area planted by individual land owners/users for which there are no records available. These latter plantings have been carried out by the landowners without any form of support or encouragement by the organised forestry industry. They have been going on for a considerably longer period than the managed schemes (20 – 30 years) and have been particularly prevalent in the Zululand area and, to a lesser extent, in the Midlands and Southern Natal areas.

The industry supported out-grower schemes operate on the following premises:

- Individual or community land-right holders are approached and introduced to the concept of growing commercial plantation trees.
- The commercial forestry company supplies advice, assistance, finance, management and technical expertise.
- They also supply fast-growing, high-yielding superior plant stock to the growers.
- Under the guidance of qualified foresters, land is prepared, fertilised and planted.
- Weed control measures are carried out until the young trees close canopy.
- The company trains local contractors who provide the above mentioned maintenance services as a way of complementing their incomes.
- The growers are guaranteed a market for their wood by the companies, which will buy the timber at prevailing commercial market price when it is harvested six to eight years later.

5.2.4 Specific features of tree growing: scale of involvement, planting and contribution to wood production

A DWAF sponsored survey looked at the implications of the small grower schemes for employment, investment and income generation among rural communities. The results of the survey showed that:

a) In addition to the growers themselves, one job is created for every eight hectares planted. The promoting company also employs an additional person for every 1 000 hectares planted. This prediction model was applied to the current and planned future-planting situations to arrive at the following employment structure as shown in *Table 4*.

Table 4. Projected employment activity generated by small-grower scheme in South Africa.

Category of employment	Current employment (2000)	Projected employment (2005)
No. of growers	12 284	22 500
No. of employees	3 026	14 700
No. of company staff	24	120
TOTAL	**15 334**	**37 320**

Source: *Edwards (2000)*

b) The small growers sell their outputs through the Central Timber Cooperative (CTC), which comprises of the South African Timber Growers Association (SATGA) and the South African Wattle Growers Union (SAWGU). Members of CTC exported 700 000 tonnes of wood chips to Japan, Finland and Korea in 1994 (*SADC FSTCU, 1997*).

c) FSA reports excellent results from small growers development schemes in KwaZulu-Natal and the Eastern Cape Provinces. The organisation reports that there are more than 13 000 growers involved in the scheme on a total area of 18 000 ha. The progress that the scheme is making in contributing to the forestry industry output in the country reflects the support the industry is giving to the scheme. Current annual expansion of the schemes is put in the region of 1 000 to 1 500 new growers and an additional 10 000 ha into the afforestation programme of the industry. The FSA expresses the hope that the participation rate in the scheme will continue to grow over time especially in Eastern Cape.

5.2.5 Economic viability of small-scale private planting

The average investment in managed small grower schemes made by the sponsoring companies was calculated to be in the range of R 1 725/ha. Total current investments are R 41.8 million, expected to increase to R 202.3 in 2005.

At the individual household levels, the scheme is reported to yield a net benefit of around R 9 000 (c US$ 800) per household over a 6-year rotation period. For poor people, it is estimated that the out-grower schemes, under average management, can contribute from 12-45% of the income needed for a household to remain above the poverty line (*IIED, undated; CIFOR, 2000*).

The costs of administering the schemes per tonne of fibre produced appear to be higher than those incurred in commercial plantations. However, in the case of the Mondi Company, these costs are covered by an unspecified higher margin from the timber sourced from the schemes. In addition, there is considerable savings from land rentals, which are not paid in the scheme unlike in commercial plantations (*IIED, undated*).

According to *Edwards (2000)*, both the forest industry and the DWAF should recognise the national economic significance of the schemes, their critical importance in terms of jobs created, the investments made by sponsoring organisations and the income generated for poor farmers. Cognisance should also be given to the direct benefits that accrue from the programme such as:

- Development of support services in transportation, communication and research.
- Provision of retail outlets for the wood with small businesses such as furniture and joinery.
- General empowerment in terms of training and enlightenment.
- Poverty alleviation among members of the community.

Specifically, the benefits can be summarised as follows:

To the company: Assurance of adequate wood supply, access to free land, control over quality and quantity of wood, use of cheap household labour, use of subcontractors, and grassroots support.

To the out-growers: Assurance of markets, access to international markets, timely acquisition of inputs, access to credit, scheme provides informal collateral, and spin-off opportunities to form contracting enterprises.

With industrial wood demand expected to grow rapidly, the outlook for small grower and related entrepreneurial activities is very promising. The schemes offer substantial new opportunities for rural employment and empowerment, which together will assist with the national poverty alleviation programme.

The small grower schemes in South Africa represent an investment of more than R 50 million, which, at current market prices and based on the present holdings, should generate revenues of about R 175 million for growers when the plantations are harvested. Furthermore, the small timber growers supplement their livelihoods with growing of food crops on the periphery of their woodlots. They make good profit and many have extended their operations from a single woodlot to three or four. In addition, the local community benefits from increased participation in the monetary market and from job opportunities created by the contracting by the companies of support services for planting, maintenance, harvesting and transportation. Small growers and rural communities also benefit from training programmes offered by the forest companies (*DWAF, 2002; Edwards, 2000*).

In the context of the overall government development strategy of empowerment of people, community upliftment and building the nation from the ground, the small grower schemes have outstripped expectations. The schemes have the potential of becoming one of the most important resource bases for the future of the forestry industry. Finally, they are seen as one of South Africa's most exciting developments in the context of the original Reconstruction and Development Plan (RDP) strategy, which is providing significant economic stimulus for disadvantaged communities.

6.0 CASE STUDIES ON ENVIRONMENTAL REHABILITATION

6.1 The Capital Development Authority, Dodoma, Tanzania

6.1.1 Background to the case study

One goal of the Capital Development Authority (CDA) in Dodoma is to establish a 22 000 ha forest belt around the capital as per the master plan (*Kijoti and Chamshama, 1990*). This forest belt is for recreation, visual enhancement, control of water erosion and wind, and eventually for timber supply.

The Capital Development District (Lat. 6^0 30' – $6^0$0 36'S Long. 35^0 30' – 36^0 10'E) covers a total area of 262 000 ha. Altitude ranges between 1000 – 1300 m a s l. The topography is characterised by plains with scattered inselbergs and ridges of rows of hills. Soils are predominantly sandy with low phosphorus and organic carbon contents. Mean annual rainfall is about 560 mm. The rainy season is between December and April. Means of daily temperature maxima and minima vary from 26.2^0C to 31.1^0C and 13.3^0C and 18.1^0C respectively. Natural vegetation is *miombo* woodland seriously degraded due to overgrazing, shifting cultivation and fuelwood and poles collection. As a result, soils are eroded and there are strong winds - hence the need for rehabilitation to halt soil erosion and improve the micro-climate.

Afforestation of the Capital district started in 1976, with an annual target of 50 ha. The planting rate increased to 1 000 ha in 1985. However, targets were not always met and failures were so many that there were only 6500 ha in 2003. Other than planting, areas with less severe degradation are protected to enhance natural regeneration sometimes with occasional enrichment plantings.

6.1.2 Tree establishment, management and productivity

In the past, people in communities surrounding the district were employed for site preparation, planting, tending and protection. Starting three years ago, communities are no longer employed but participate as collaborators. They are allocated plots in the rehabilitation belt, provided with seedlings and technical advice and allowed to interplant the trees with food crops.

After manual clearance of shrubs (i.e. isolated trees are left) and burning, planting is done in pits of size 60 cm diameter by 60 cm depth in which cow manure has been added at a rate of about 4 litres per pit (*Kijoti and Chamshama, 1990*). The species planted include: *Eucalyptus camaldulensis, E. tereticornis, Azadirachta indica, Senna siamea, S. spectabilis, Syzygium cuminnii, Delonix regia, Peltophorum pterocarpum, Schinus molle, Casuarina equisetifolia, Acacia nilotica, A. tortilis, A. holocericea, Trichilia emetica, Leucaena leucocephala, Gmelina arborea* and *Parkinsonia acculeata*. The choice of species was mainly based on their performance in other semi-arid areas of the country.

Management includes watering of wilting plants during the dry season, initial tending by spot weeding, slashing of unwanted vegetation, and protection against livestock. There are no pruning and thinning prescriptions.

There has generally been low survival, slow growth, die-back and low stem qualities for some of the species planted. Survival and growth problems have not only been experienced in young trees but also in older ones. Some young stands, which initially exhibited promising performance, later on experienced dieback, reduced growth and increased mortality. *Kijoti and Chamshama (1990)* showed that tree performance differences were mainly due to site variations in soil characteristics. The presence of hardpans in some sites had more detrimental effects. In those sites, root strangulation was a common feature.

6.1.3 Investment in and benefits from the programme

The total investment in the project so far could not be obtained. The project has received funding from various sources, mainly the Government of Tanzania, Japan, UNEP, WFP and Denmark.

Although only about 30% of the Phase I target has been achieved, the project is generally considered a success. Rehabilitation around the Capital district has been achieved. Wind erosion has been controlled. Dodoma town, which used to be very dusty in the 1970's, is no longer dusty. Soil erosion due to surface runoff has also been controlled in most of the areas. People visit the planted forests for recreation.

6.1.4 Assessment of factors that have contributed to success/failure

The following factors are considered to have contributed to the *success*:

- Communities accepted the demarcated area for rehabilitation and stopped human activities to allow tree planting for rehabilitation of the degraded areas.
- There was awareness creation, which resulted in communities cooperating in the rehabilitation work.
- Communities are assisted with seedlings and technical advice to enable them do proper rehabilitation of the degraded areas.

Despite the indicated success, the project also has some *problems*, namely:

- Inadequate funds for rehabilitation. Currently, the project mainly depends on government funding, as donors pulled out at the end of their commitments.
- There were no species/provenance trials and thus species for planting were chosen based on performance in other dry areas within and outside the country. As a result some species did not perform well under Dodoma conditions.
- Most staff had no experience with rehabilitation work and this contributed at times to failures due to using wrong techniques.

7.0 LESSONS LEARNT ON THE PERFORMANCE OF PLANTED FORESTS

7.1 Introduction

This study has reviewed historical, technical, economic and institutional factors that underpin the development of plantation forests in Africa. The review took into consideration the political, social and economic considerations that guided and still guide plantation development programmes in Sub-Saharan Africa. The overall aim of the study is to examine the issues that have led to plantation establishment with a view to highlighting success and failure factors. The study further dwells on identifying good practices that have contributed to success as well as the bad practices that have caused failures. The goal is to document the lessons that could be learnt with a view to promoting good practices and success factors to achieve sustainable forest management. Due consideration was given to

the fact that lessons learnt from failures could also be the basis for understanding how to work towards achieving success in the future.

On the basis of this study, the following findings are noteworthy and are hereby summarised as lessons learnt which would inform policy makers on how best to achieve sustainable management of plantation forests in Africa.

7.2 Factors contributing to success and failure of planted forests

7.2.1 Success factors

Active private sector involvement in control and ownership of production resources

If the success of the Southern Africa forest plantation programme is anything to go by, then the success it has achieved can be very clearly traced to the active and significant involvement of the private sector, either as private corporate companies, out-growers, private individuals, or communities. With a large ownership share, which stands at 58 %, 70% and 100% in Zimbabwe, South Africa and Swaziland respectively, private sector involvement in plantation development brings in high efficiency and productivity standards into the forest industry. It is in the light of the success which the private sector has had in plantation development that the remaining 18% public sector plantation ownership, by the parastatal the South African Forestry Company Ltd (SAFCOL), is presently being considered for privatisation.

In West, Central and East Africa where there is limited private sector participation, plantation forestry has not been as successful in spite of often better site conditions and more and better land being available. This is mainly attributed to the monopoly of plantation programmes by the public sector.

Linkage with processing industry

The linkage of plantations to processing industries through forward integration arrangements is considered one of the most strategic arrangements that have kept the plantation development programme in Africa viable and vibrant. The linkage with processing plants provides major incentives for producers to establish plantations because there is a ready market and demand for the wood produced from the plantations, often at guaranteed prices. The commercial forest company buys the wood from the producer and adds value to it through processing and, in so doing, improves the income of the company directly and that of the tree farmer indirectly.

The industry-driven plantation development in South Africa has become so dynamic that in a little over hundred years, South Africa has made a transition from a net importer to a net exporter of wood-based products within an industrial setting of high international standards and competitiveness.

The use of industry supported out-grower schemes

The out-grower schemes have been used successfully by the forest industry to bring in private landowners, either individuals or communities, into wood production at cost-effective arrangements for both the growers and the companies. In the schemes, the forest companies provide financial (credit, seedlings, fertilisers and chemicals) and technical support (supervision, management and extension services) to the out-growers while the latter provide labour towards the plantation development. The companies in return are guaranteed a steady supply of wood raw materials without being involved in land acquisition.

The viability and attractiveness of this plantation development option is demonstrated by the potential rate of increase of growers in South Africa. *Edwards (2000)* forecast an increase in applicants from about 1 300 in 2000 to about 10 200 in 2005. Total area to be brought into production was also projected to increase from about 5 000 ha then to 93 100 ha by 2005.

Market orientation and economic incentives

The market and profit-oriented private sector has contributed very significantly to the success of the plantation development programmes in Southern Africa. Unlike the public sector plantation programmes, where profit maximisation is not the primary objective, the private plantation-based forestry sector has managed to show that forestry is potentially a profitable economic pursuit.

This success of the southern African plantation programmes is to a large extent due to the successful efforts by the private commercial forestry companies to find export markets for wood chips and pulp in Europe, Japan and Asia and in other countries in the SADC region. For example, when the demand for

mining timber dropped drastically in South Africa, the companies managed to find export markets for woodchips from Eucalyptus and wattle hardwoods

Diversification has also been a good strategy that has been adopted by the forest industries in which joint products are produced from the wood. For example, oil is extracted from Eucalyptus in addition to the use of the wood for timber and pulp chips. Similarly, wattle produces tannin and glue from the bark, chips, mining timber and fuelwood from the wood.

It was also clearly noted that where considerable success has been recorded, there were favourable environments and incentives created by governments. For example, the South African government has assisted the private sector by providing them with the necessary support such as land acquisition, water allocation and in financial support.

Fast growth of the exotic species

Much of the plantation development has been done with the help of exotic tree species, both hardwoods and softwoods. The fast growth and high yields of many of the exotics have been capitalised upon and used to the advantage and success of forest plantation developments. In southern Africa, pines and eucalypts have been planted extensively and in West Africa, it is mainly fast growing and high quality hardwood timber species such as *Gmelina arborea* and teak. In East Africa, it is a mixture of softwoods and hardwoods, mainly pines, cypress and various eucalypts. Exotic species are more productive than the indigenous species and are reported to be two or three times more productive in Sub-Saharan Africa especially South Africa than equivalent species in Europe or North America (*FSA, 2002*).

Liberalisation of the market for wood

The liberalisation of the wood trade in some regions, e.g. SADC, has significantly contribution to the success of the forest industry in southern Africa. The free flow of wood outputs, either as logs, semi-processed, or processed products, within the region has helped to maintain a balanced demand and supply situation and income earnings by the producers and the processing companies. More importantly, the free movement of investment capital within regions and within Africa is significant and has facilitated the ease with which plantations can be established in Swaziland or Mozambique to service processing companies in South Africa or Zimbabwe.

Research and technological improvement

The success of many plantation programmes can be traced to the intensity of research into the development of high yielding and disease resistant genetic materials. The success story of teak (*Tectona grandis*) in Côte d'Ivoire and *Eucalyptus urophylla* and *E. grandis* in Congo are linked to clonal improvement. In Côte d'Ivoire, the high performance clones developed for teak accelerated the rate of afforestation, increased yields and plantation productivity and shortened rotation age from 50-65 years down to 20-30 years.

In South Africa, improved breeding methods and practices, the use of improved seeds and germplasm and efficient management are key factors in the country's forest plantation success. For example, in the out-grower schemes the use of improved technology and support of farmers with such technology have been highlighted as contributing factors to the success of the schemes.

7.2.2 Failure factors

Public sector domination

The control and monopoly of the public sector in plantation development in many countries in West, Central and East Africa have had serious negative implications for successful forest management. In most situations where the government, or the public sector in general, continues to play a dominant role in plantation ownership and management the forestry sector has fallen short of effectively supplying wood to markets and to processing industries. The public sector in most SSA countries has financial problems, which lead to inefficiency in management, low productivity and, above all, corruption. The competence, capability and ability to achieve good forest management is often questionable.

There has often been a lack of clearly stated long-term objectives in the establishment and maintenance of government run plantation schemes. For example, there are several cases where such schemes have been located in areas far from markets and communication, and where the purpose of the plantation (and thereby choice of species and silvicultural management) has not been determined.

Likewise, there has often been a built-in lack of sustainability in the financing and management of plantation schemes as a result of strong initial dependence on donor funding, which has not been replaced by Government financial commitment when the donor funds have been terminated.

Limited local utilisation capacity and demand

The lack of effective domestic demand and the difficulty of gaining access to international markets bring serious burdens to bear on domestic industries and processing plants. Companies are forced to operate below capacity with negative cost implications and increased production costs. Limited capacity reduces employment and profit potentials and threatens the long-run the viability of the industry.

Failure to create effective domestic demand for plantation-grown wood has been largely responsible for the failure of many plantation programmes in Africa. The experience of the Pointe Noire Eucalyptus pulpwood plantation, which could not find attractive export markets (*AfDB, EC and FAO, 2003c*) and the over-mature pulpwood plantations in Zimbabwe, which looked for alternative markets in South Africa at reduced benefit (*SADC FSTCU, 1997*) are points in case. The teak plantation project in Côte d'Ivoire which was almost collapsing before export markets were found in Asia (*Maldonado and Louppe, 2000*) and the drop in domestic demand for hardwoods (Eucalyptus and wattle) used as mine timber in South Africa at the collapse of the mine industry (*SADC FSTCU, 1997*) are others. The wood later found overseas markets as pulpwood chips.

The World Bank and the African Development Bank sponsored *Gmelina arborea* pulpwood project in Nigeria suffered the same fate as the Zimbabwe and the Republic of Congo pulpwood. The plantation became over-mature for pulpwood and the government faced the difficulty of marketing the wood as sawlog instead of pulpwood.

High water demand and the scarcity of water

In some countries, the competition for water between user groups, e.g. plantation developers and agricultural producers, is high. This puts much strain on the limited available water supply. Thus, further plantation establishment in water deficit areas depends on how much water is made available to the plantation growers through the permit system that operates in some countries (e.g. in South Africa).

The land tenure system and property rights

Land tenure systems, which sometimes discriminate against potential investors on grounds of gender and nationality, are often a hindrance for sustainable development of plantation programmes in Africa. In most parts of eastern and southern Africa, foreign or non-resident investors can only be granted usufruct and not ownership rights to forest lands. The implication of this tenure arrangement is that the land is not properly managed and improvements are not made to develop the fullest potential of the land resource. Low productivity, predisposition to fire, disease and pest damage and logging related degradation are obvious consequences of the insecurity of tenure. An owner of a resource with well-defined property rights has a powerful incentive to use that resource efficiently as a decline in its value represents a personal loss in income and other benefits.

In most parts of the humid tropical Africa, there are poorly defined property rights over forest resources and their products and services. Lack of attention to these institutional anomalies is often the cause of unsustainable forestry management. Lack of clarity on property rights cause uncertainty about the supply of logs and this in turn makes investments in plantations a complicated and risky venture. The alternative, in which government owns all the rights to forest land, including plantations, and issue short concessions to loggers and sawmillers, often leads to unsustainable wood production and corruption.

It should be stressed that availability of suitable land is a prerequisite for sustainable development of plantation forestry. It is essential for every country to have an explicit land use policy to settle competing claims on land for alternative uses. This will require studies on a national land capability classification, ownership and land use pattern. Identification of areas suitable for different uses can be done based on such studies. Collective decisions, involving politicians and legislators, government departments and agencies, NGOs and civil society will be needed to zone lands for agriculture, forestry (including plantations), conservation and recreation at national, sub-national and local levels. A comprehensive national land use policy should then be formulated keeping in view the future demographic changes, development programmes, national need and priorities (*Pandey, 1996*).

Political and social unrest

The damaging influence of political instability and social unrest on the forestry sector as a whole and drain on investment capital resources has been widespread in Africa since the time of independence of many countries in the 1960s. The insecurity that political unrests precipitate; the force in political unrest or even armed combat all culminate in the neglect and in many cases destruction of existing forest plantations and processing factories. Due to the civil war in Congo Brazzaville, the 1997 timber production was halved to around 300 000 m^3 and one of the foundation companies Socobois had its factory destroyed *(Landrot and Speed, 2001)*. For the same reason of instability, plantations established in Zimbabwe in the 1960s, with the intent of linking them to processing industries, became over-mature before the end of the 20-year political struggle for independence when it was impossible to harvest the trees.

Instability also leads to other problems that are negatively affecting sustainable planning and management, e.g. reduced research and training, weakening inter-sectoral links, discontinuation of international contacts and market opportunities, and others.

7.3 Replicability of success stories

Successful practices, conditions and policies which are derived from human and societal efforts can, in principle, be replicated provided there is political and/or commercial will, policy support, financial means and institutional capacity and capability to back up necessary actions. Where conditions for success are related to natural conditions – good soils, a well placed harbour, sufficient rainfall, etc. – there is obviously less we can do. In general, the success stories reported in this study can be replicated in the following ways:

Privatisation of plantation development

This can easily be replicated elsewhere by allowing the private sector to establish plantations by bringing their land holdings into cultivation in the case of individuals and communities. In the case of out-growers, replicability will come through the identification and organisation of willing farmers and land-owners and providing them with necessary funds and technical support incentives. The establishment of plantations and their forward integration to processing industry is easily replicable if the investment capital is available locally or can be attracted into the country through attractive incentives including favourable tax rates, freedom to repatriate profits and dividends and tax waivers. This investment method has been adopted with great success in southern Africa especially in South Africa, Swaziland and Zimbabwe. Naturally, all this requires a stable and predictable political environment where the rule of law prevails.

Liberalisation of the market for wood

Liberalisation of the market will allow wood produced in a region or country to be traded in another country or region without stifling tariffs and barriers. In this way, the goods have bigger markets and stand a good chance of attracting better prices. This is the essence of the common markets and the regional economic blocs. These blocs should be used to an advantage in advancing the successes and gains made in a sector by a given country.

Use of improved germplasm and best practices

The study has shown that much research has been done and has produced genetically improved germplasm as well as appropriate silvicultural practices, which are used in plantation development with high yields. These technologies and best practices are often openly available, either free or at a cost, and should be replicated in appropriate ecological zones by plantation managers to avoid re-inventing the wheel.

7.4 Overcoming failures

Privatisation of public sector plantations

One major failure observed in this study is the domination of the public sector and its poor management in the forest plantation industry. There is need to privatise most public sector plantation programmes to allow the private sector, whose successes in the industry have been eloquently demonstrated in this study, to sustainably manage them. The public sector role should be limited to providing favourable environment and incentives for private sector investments.

Land tenure issues

The stringent policies that govern land tenure systems in Africa – often a mixture of government ownership and traditional community based situations - have remained a serious impediment and constraint to plantation, and other forms of land-based, developments in Africa. The restrictions on private land ownership and, in some cases, land use along gender, citizenship and residency lines limit the number of people who can invest and participate in wood production. It has become imperative in the light of the limited capability of the public sector to produce and manage plantation forestry effectively to devolve land tenure and rights to private companies, communities and individuals that have shown remarkable efficiency and ability to develop and manage plantations on a sustainable basis.

Green wood classification

Civil wars and other forms of armed conflicts cannot easily be predicted on the type of time horizons that forestry investments work in, but their damaging impacts on fresh and existing plantations and on sustainable management of forests in general can possibly be reduced. If wood is cut illegally by armed combatants in a conflict and sold on the market to support the war, such "blood wood" can be declared prohibited for sale on international markets. Only wood from officially recognised plantations will be marketed and should be sold under a "green wood" status to show that the conditions under which the wood is produced and harvested are peaceful and friendly.

Increase the demand for domestic-grown wood

Establishing processing plants and linking them to the plantations for steady supply of wood can best increase the domestic demand for wood. The processing plants and the plantations ought to be privately owned to increase the likelihood of efficient and sustainable management of the whole chain from the trees in the plantation to the consumer of processed wood.

Water demand and water allocation

Fast-growing trees that demand excessive water for their growth should not be selected for plantation development in sensitive areas where water scarcity for other essential sectors prevails. The increasing scarcity of water and the increase in the number of farmers that want to grow trees commercially should be given adequate attention. The allocation of water rights in some African countries where water is scarce and needed in plantation development should be eased so that emerging farmers who want to grow trees should not be constrained by lack of water. Water should be supplied at affordable cost, but still at a cost, to those who want to use it for tree growing and environmental quality improvement purposes. In other words, water cost should be subsidised for tree growers while those using water for non-essential purposes could be fully charged. It is not advisable to heed the proposal of the out-growers union in South Africa who advocates for free supply of water, because such a policy will make the opportunity cost of water equal to zero and users will certainly abuse the use of the resource if it is not properly priced.

8.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

8.1 Background and findings

Following successful species and provenance trials, mainly involving exotic trees, in the early 1900s, the first extensive plantings of industrial tree crops in Africa occurred during the period 1920-1945, mostly in countries with little utilisable natural forest and where there had been an early influx of European settlers (*Evans, 1992*). The major objective of establishing these plantations was to meet domestic and industrial demands for commercial and other products, both wood and non-wood. In 2000, the total plantation area in Africa was just over 8 million ha (3.4 industrial, 3.3 non-industrial and 1.4 million ha unspecified plantations) or about 4.3% of the global plantation area (*FAO, 2001a*). The annual rate of planting in Africa was estimated to be 194 000 ha in the same year, or 4.4% of the world total. The total plantation area and the annual planting area in Africa are the lowest among all the continents.

Despite the rapid expansion of plantation forestry, there are big variations in the performance, ranging from 30 $m^3ha^{-1}yr^{-1}$ to 1-2 $m^3ha^{-1}yr^{-1}$, and in some situations outright failures due mainly to budget cutbacks (*Zobel et al., 1987; Tiarks et al., 1998; FAO, 2001b; FAO, 2003a; FAO, 2003b*). The large variability found in productivity is due mainly to species/provenance selection, genetic improvement,

species-site matching and cultural practices (*Kanowski, 1997; Vichnevetskaia, 1997; FAO, 2001a; FAO, 2001b*).

Eucalyptus is the mostly widely planted genus covering 22.4% of all planted area, followed by Pinus (20.5%), Hevea (7.1%), Acacia (4.3%), teak (2.6%), other broadleaved (11.2%), other conifers (7.2%) and the remaining area is covered with unspecified species (*FAO, 2001a*). By far the largest planted area is based on exotic species chosen for their capability to grow rapidly and produce wood of desired quality (*Zobel et al., 1987; Tiarks et al., 1998*).

Generally, the plantations in many SSA countries are dominated by a species. For example, in Ghana, *Tectona grandis* covers 50% of the planted area (*FAO, 2002a*), while in Kenya, *Cupressus lusitanica* occupies 46% of the total area (*MENR, 1994*; *FAO, 2001d; FD, 2003*). Other examples include Congo with 75% of the area occupied by Eucalyptus, Nigeria (42% *Gmelina arborea*) and Swaziland with 76% *Pinus patula* (*FAO, 2002c*). Thus, there are risks of repercussions if serious pests or diseases strike the plantations (*FAO, 2001d*).

In Africa, industrial plantations are 52% publicly owned, 34% privately owned and 14% other or unspecified (*FAO, 2001a*). Out of the non-industrial plantations, 62% are publicly owned. Thus, with the exception of South Africa (where about 72% of the plantations are owned by companies and small growers), plantations are mainly owned by the governments in Africa (CIFOR 2000).

The case studies in this report show that the type of ownership has significant impact on the quality of management, productivity and links to the processing sector. Overall, government owned industrial or energy plantations suffer from replanting backlogs, low rates of new areas brought under plantations, low intensity site preparation techniques, poor quality trees due to use of un-improved seed, low survival due to poor species-site matching and delayed/low intensity weeding, neglected or irregular pruning and thinning, fire and insect problems, illegal felling and encroachments. Nearly all public sector plantations were initially established with donor support. After expiry of such support, funding of plantation management activities reverted to poor governments, resulting in neglected and poorly managed forests.

In contrast, forest plantations owned by private forest industry companies, common in South Africa, Swaziland and Zimbabwe, are very successful and have achieved high productivity due to careful site selection, intensive cultural practices, selection of best species/provenances and genetic improvement through research. In these countries, plantation programmes are strongly linked to industrial utilisation locally and regionally and to export markets. In the Republic of Congo, where research has also contributed to successful plantation establishment for pulpwood export, the programme has not been as successful as in southern Africa primarily due to limited capacity for local utilisation and price fluctuations in the export markets.

Industrial wood production by small farmers in the central highlands of Kenya has shown an increasing trend of tree cover and species diversification on privately owned farms. Farmers, who for a long time have used trees for coffee shade and for their own fuel and construction wood needs, have increasingly started to grow timber for sale on the market. A recent ban on logging in forest reserves, both plantations and natural forests, has given a sudden and dramatic boost to the farmers' commercial wood production enterprises. The main problem is the often deficient quality of the wood produced on farm

Plantation development for energy production and environmental improvements, such as combating desertification, controlling sand dunes movement and provision of windbreaks in the Sahel and drier areas of SSA, has not shown very significant progress. The difficulties faced by the programmes have been blamed on limited funds. This condition has led to continued reliance on natural forests for fuelwood to the extent that *AfDB, EC and FAO (2003a, b, d)* lamented that about 85-95% of the fuelwood supply in SSA still comes from natural forests rather than from plantations, in spite of the latter's potential to meet fuelwood and energy demand in the sub-continent in efficient and environmentally friendly ways.

Out-grower schemes are a relatively new development in the South African forestry sector and are considered as an important step in establishing the social sustainability of the industry. In the out-grower schemes, companies enter into long-term partnerships with small growers. The companies provide financing (loans), inputs like seedlings and extension support for the establishment and maintenance of the woodlots. For the companies, the out-grower schemes address the need to develop long-term timber supplies and they need not tie up large amounts of capital in land holdings when all

they require is wood. For the out-growers, the schemes contribute extensively to rural economies including employment, wealth creation and credit provision.

The forest environment rehabilitation belt planted around the Capital district of Dodoma in Tanzania has contributed to the control of both wind and water erosion. However, limited funds (mainly donor funds) have resulted in the achievement of only 30% of the scheme goal after 27 years since its inception. There was poor survival and growth of some species arising from the presence of hardpans or poor site-species matching. There is a new initiative to involve collaborating communities, which is both a cost effective and more sustainable approach.

8.2 Recommendations

8.2.1 Past public sector dominance and future private sector participation

Poor management of public industrial and energy plantations is mainly a result of forestry departments facing severe constraints of human, material and financial resources. This situation is unlikely to change, and the ongoing public sector restructuring in most countries is intended to redefine public sector functions, de-emphasising forest management responsibilities and enhancing the regulatory role. The private sector is thus expected to play a leading role in plantation forest management. However, the willingness of the private sector to acquire public sector plantations and expand areas under plantations depends on a number of factors like incentives, productivity of existing plantations and access to markets and availability of productive and accessible land.

The acquisition of public sector forest plantations and plantation expansion by the private sector is also expected to lead to technological improvements in harvesting practices with a potential to increase roundwood recovery and reduce logging residues. It will also facilitate better mill recovery rates resulting in reduced amounts of roundwood required in manufacturing, effective use of residues to meet demands of other wood processors and greater use of reconstituted panels and engineered wood products as a result of increasing scarcity of large diameter logs.

Where there are restrictions on large-scale industrial expansion by large companies due to shortage of land, out-grower schemes offer the opportunity for increasing land area under forestry, independently or in partnerships with large companies. Also small-scale farmers, by planting timber trees in their farms (trees outside forests-TOF), can substantially contribute to wood supply. Both out-growers and small-scale farmers require access to appropriate germplasm, technical advice and markets. For out-growers access to finance on appropriate terms is also an important requirement.

8.2.2 Appropriate institutional, legal and policy frameworks

SSA governments, after leasing plantations to private companies on a long-term basis, should play a regulatory role and ensure sustainable management of indigenous forests, as it is unlikely for the market-led private sector to invest in this. SFM of indigenous forests and an appropriate environment to attract private investment in plantation forestry require appropriate institutional, legal and policy frameworks. Governments of SSA countries should thus develop and implement such frameworks where they do not exist or where they are weak. In addition, building knowledge, skills and capacity necessary to successfully implement SFM are inadequate or not available, and contributing to building these will be a continued responsibility of the governments.

8.2.3 Integration of plantation development with processing

The linking of primary commercial wood production to processing plants has proved a good management strategy in the forest industry and is recommended. Forward integration of plantations to wood processing plants will add value to the products, diversify the product lines, improve the export potentials of the products and increase the viability, profitability and sustainability of the industry. This is the model, which has given rise to the success in forest industry in southern Africa and needs to be adopted by other countries.

8.2.4 Using best practices

The increasing domestic and international demand for wood and wood products will be met by opening new areas in some countries of SSA where constraints such as accessibility, water supplies, land availability and security of investment are less problematic. However, in most situations, future wood needs will have to be obtained from existing plantation sites, i.e. from second and subsequent rotations. There will also be continued and increased planting of trees on farms and on other sites outside forests and tree planting under out-grower scheme. In all these situations, productivity will be enhanced by using improved germplasm, site and species/provenance matching, appropriate silviculture, forest protection and harvesting practises. Site productivity must be maintained by adapting appropriate soil and site management and use of low impact logging techniques. In countries where best practices have not been developed, they should be adapted from others where ecological conditions are similar.

As a way of species diversification, suitable species/provenances from trials in similar situations in other countries should be incorporated into national plantation programmes, and studies are also needed to evaluate the biological and economic feasibility of mixed stands.

8.2.5 Criteria and indicators of SFM and certification

Efforts to develop, test and implement criteria and indicators (C&I) for evaluating the sustainability of forest management in SSA should continue alongside certification of planted forests. However, certification is expensive and special care must be taken to ensure that certification efforts do not prevent low- income families (e.g. out-growers) from accessing resources and markets.

8.2.6 Land-use planning

The contribution of planted forests to sustainable livelihoods should be optimised through participatory and coordinated land use planning processes at appropriate scales (bioregional, catchment, and individual enterprises) in all cases taking into account interests of local people/landowners, biodiversity conservation, ecotourism, water yield, slope of land, etc. An infrastructure that facilitates coordinated planning between agriculture, forestry urban and rural development departments is important.

8.2.7 Knowledge exchange and technology transfer

Some public and private research institutes have done excellent research on plantation forestry, including on various aspects of management (e.g. tree improvement, establishment and management techniques), which has contributed significantly to increased productivity and profitability of forest plantations. In most cases, however, outputs in plantation forestry research have generally been poor.

It is vital to strengthen knowledge and technology exchange in SSA, e.g. by developing Internet accessible databases of case studies of planted forests. There is also a need for strong partnerships, networking and collaboration among institutions and countries of SSA. Continental forest networks like the African Forest Research Network (AFORNET) and the Forestry Research Network for Sub Saharan Africa (FORNESSA), as well as sub-regional networks, should take a lead in this regard.

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