Forest Plantations Working Papers

HARDWOOD PLANTATIONS IN GHANA

Based on the work in 1998 of
F. Odoom
Consultant

Edited by M. Varmola

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Forestry Department
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The purpose of these papers is to provide information on on-going activities and programmes, and to stimulate discussion.

Comments and feedback are welcome.

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For quotation:

<table>
<thead>
<tr>
<th>ACRONYMS</th>
<th>FULL NAME</th>
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<tbody>
<tr>
<td>AGC</td>
<td>Ashanti Goldfields Corporation</td>
</tr>
<tr>
<td>AGI</td>
<td>Association of Ghana Industries</td>
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<td>BCR</td>
<td>Benefit Cost Ratio</td>
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<td>BOPP</td>
<td>Benso Oil Palm Plantation</td>
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<td>Bonsu Vonberg Farms Ltd.</td>
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<td>Current Annual Increment</td>
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<td>CFMU</td>
<td>Collaborative Forest Management Unit</td>
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<td>District Assembly</td>
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<td>Dalhoff Larsen and Horneman</td>
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<td>Dupaul Wood Treatment</td>
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<td>EC</td>
<td>European Community</td>
</tr>
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<td>Economic Community of West African States</td>
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<td>Electricity Corporation of Ghana</td>
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</tr>
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<td>Forest Plantations Development Centre</td>
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<td>FST</td>
<td>Forest Savannah Transition Zone</td>
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<td>GAP</td>
<td>Ghana Primewoods Products Ltd.</td>
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<tr>
<td>GCFD</td>
<td>Groupe Caisse Francaise de Development</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Development Product</td>
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<td>GERMP</td>
<td>Ghana Environmental Resources Management Project</td>
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<td>Geographic Information System</td>
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<td>GuS</td>
<td>Guinea Savannah</td>
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<td>HFZ</td>
<td>High Forest Zone</td>
</tr>
<tr>
<td>IDA</td>
<td>International Development Association</td>
</tr>
<tr>
<td>ITTO</td>
<td>The International Tropical Timber Organisation</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
</tr>
<tr>
<td>LI</td>
<td>Legal Instrument</td>
</tr>
<tr>
<td>MAI</td>
<td>Mean Annual Increment</td>
</tr>
<tr>
<td>ME</td>
<td>Moist Evergreen</td>
</tr>
<tr>
<td>MLF</td>
<td>Ministry of Lands and Forestry</td>
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<tr>
<td>MS</td>
<td>Moist Semi-Deciduous</td>
</tr>
<tr>
<td>MSS</td>
<td>Modified Selection System</td>
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<tr>
<td>NAC</td>
<td>National Agro-forestry Committee</td>
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<td>NGO</td>
<td>Non Governmental Organisation</td>
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<tr>
<td>NRCD</td>
<td>National Revolution Council Decree</td>
</tr>
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<td>NRMP</td>
<td>Natural Resources Management Project</td>
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<tr>
<td>NTFP</td>
<td>Non-Timber Forest Product</td>
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<tr>
<td>ODA</td>
<td>Overseas Development Agency</td>
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<td>OFR</td>
<td>Outside Forest Reserve</td>
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<tr>
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<td>Pioneer Tobacco Company Ltd.</td>
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<td>RFD</td>
<td>Rural Forestry Division (of the FD)</td>
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<tr>
<td>Samartex</td>
<td>Samreboi Timber and Plywood Ltd.</td>
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<td>SIPL</td>
<td>Subri Industrial Plantation Ltd.</td>
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<tr>
<td>SM</td>
<td>Southern Marginal</td>
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<tr>
<td>SMCD</td>
<td>Supreme Military Council Decree</td>
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<tr>
<td>SMS</td>
<td>Swiss Lumber Company Ltd.</td>
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<tr>
<td>SO</td>
<td>South-East Outlier</td>
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<tr>
<td>Spp.</td>
<td>Species</td>
</tr>
<tr>
<td>SuS</td>
<td>Sudan Savannah</td>
</tr>
<tr>
<td>SZ</td>
<td>Savannah Zone</td>
</tr>
<tr>
<td>TEDB</td>
<td>Timber Export Development Board</td>
</tr>
<tr>
<td>TSS</td>
<td>Tropical Shelterwood System</td>
</tr>
<tr>
<td>TUC</td>
<td>Timber Utilisation Contract</td>
</tr>
<tr>
<td>UE</td>
<td>Upland Evergreen</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environmental Programme</td>
</tr>
<tr>
<td>WE</td>
<td>Wet Evergreen</td>
</tr>
<tr>
<td>WVLC</td>
<td>Western Veneer and Lumber Company</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Historical background

The Forest resource base of Ghana has been described in addition to the various vegetation zones and the related climatic and soils conditions. A review of the general land use patterns has been undertaken.

The history and some of the experiences with respect to the management of the natural forests and hardwood plantations by the Government of Ghana and the private sector since about 1956 have also been analyzed. These include natural hardwood and forest plantation silvicultural systems such as the Tropical Shelterwood System (TSS), the Modified Selection System (MSS), Line Planting as well as block forest plantation formation and the Taungya systems. The status of the vegetation in the reserved forests as assessed by the Forestry department (FD) in 1995 is given.

It is proposed that any existing and relatively undisturbed past MSS areas and similar areas that were line planted should be reassessed using current improved analytical methods. The lessons learnt should be used to undertake further research on limited scales for possible application in the rehabilitation of the currently degraded natural forests on a larger scale. Although this study deals mainly with hardwood plantations, it is the opinion of the author that the proper management of the natural hardwood forests can also make a significant contribution towards the overall supply of hardwood timber on the market. It will also facilitate the amelioration of the environment as well as the improvement of the livelihood of the rural dwellers.

The Taungya system is also mentioned as being very important in the provision of revenue during the long gestation period before the first commercial thinning or the final harvest. Taungya is also very important in ensuring the people’s participation in forest management in accordance with the Ghana Forest and Wildlife Policy (1994) especially with respect to the rehabilitation of the degraded natural forest and open forest areas which are outside the reserved forests.

A description of plantation management models that are currently being practiced in Ghana with regards to rubber and oil palm which have the potential for application in forest plantations is given. These are the small holder, out-grower and the lease-back systems.

Institutional issues

1. Legal and policy issues

A review of the relevant legal and policy instruments that affect commercial plantation formation has been undertaken. The main findings on areas that can create disincentives for commercial plantation formation are discussed below:

- The Natural Resources Management Programme (NRMP) has been developed as a country-led initiative to implement the FDMP. Under the High Forest Resource management sub-component of the NRMP, the Government plans to establish a Forest
Plantations Development Centre (FPDC) to promote and encourage private forest plantation development. The sub-component is composed of three elements as follows:

- Project Management (funded by the IDA);
- Credit to Tree Growers (to be funded by the African Development Bank); and
- Technical Assistance (to be funded by the EU).

The project is meant to support all those who are planting or wish to plant timber trees commercially within the HFZ.

- Although the Forest Resources Management Act, 1998 (Act 547), accords the ownership of planted trees to the owner, it does not explicitly separate planted trees from the legal controls afforded to natural trees. These include:
  - The requirement of a TUC to harvest timber;
  - The requirement of Registered Property Mark to harvest timber for commercial purposes;
  - The export of specified types of processed or unprocessed timber which is subject to an export levy; and
  - Royalty rates, lease fees and any other applicable fees which apply equally to natural and planted timber.

Act 547 does not allow private holding of Timber utilization Contracts (TUCs). Permission is required from a plantation owner for the issue of a TUC which does not make it explicitly clear that a TUC can be issued to the plantation owner himself.

- The communities and landowners in particular have been against the inequitable distribution of the revenues that accrue from the forests on their land (see Table below) as prescribed by the 1992 Constitution (section 267(6)).

*Distribution of royalties with respect to exploitation from the natural forest*

<table>
<thead>
<tr>
<th>Recipient</th>
<th>On-Reserve (%)</th>
<th>Off-Reserve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State (i.e. Forestry Department)</td>
<td>70</td>
<td>-</td>
</tr>
<tr>
<td>Administrator of Stool Lands</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>District Assembly</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>Traditional Authority</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Landholding Stool</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

- The Trees and Timber Decree, 1974 (NRCD 273) requires the registration of a Property Mark for the exploitation of timber for commercial purposes.

- The Administration of Stool lands Act, 1962 (Act 123) states that the duration of timber rights may not exceed 30 years. The rotation of slow growing hardwood species would normally exceed the latter limit. Hence the application of Act 123 to plantations would require review.
• The Forest and Wildlife Policy, 1994, and the EPA guidelines require environmental impact assessments for forest plantations which extend over 40 hectares.

2. Land and tree tenure

Land tenure
A potential investor would have to deal with the following that may be considered as some of the disincentives with respect to the establishment of forest plantations:

- Multiplicity of interests and rights in land which may vary in different parts of the country leading to conflicting claims to ownership;
- Lack of reliable maps indicating stool/skin land boundaries which can give rise to disputes (the GERM Project under the auspices of the EPA is addressing this issue);
- Cumbersome land disposal and documentation procedures;
- Potential conflict concerning tenurial and management arrangements for plantations within forest reserves where parties other than the FD are involved;
- Inconsistencies in the extent of land over which timber rights can be granted. The Administration of Stool Lands Act and the Forest, 1962, and the Forest Resources Management Regulations, 1998 (LI 1649) give limits of 100 km² and 125 km² respectively.

Despite the above, the Ghanaian statutory and customary laws do not legally prevent one to secure long-term access to land. Provided suitable land can be identified without conflicting claims, there appear to be no inherent legal limitations to the negotiation of rights of sufficient duration for plantation purposes if the landowner agrees to the purported land use.

Tree tenure
Tenant/immigrant farmers may not plant trees on their land without re-negotiating for the change of the land use which was the basis for the grant/lease of the land in question. Under the traditional land-use system, the planting of trees by tenant farmers is generally considered as perpetuation of stay, which may in turn indirectly imply ownership of the land. The tenant farmer therefore does not own the natural or planted trees on the land issued to him except in the Upper West Region of Ghana. The tenant farmer may however harvest trees granted/leased land for won use but not for commercial purposes.

Technical issues

1. Species selection
Based on the past forest plantation experiences coupled with knowledge on the silvicultural characteristics of the indigenous species, potential species for planting in the various vegetation zones of Ghana has been proposed as shown in Table below.

All the recommended species have been tried by FORIG and/or the FD. The species on which little information is available locally is Piptadeniastrum africanum. The latter, however, has a successful history as a plantation species, particularly in Cote d’Ivoire although there is little information about potential yields.
Species recommendations for the ecological zones

<table>
<thead>
<tr>
<th>Ecological zone</th>
<th>Recommended species</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Evergreen (WE) &amp; Moist Evergreen (ME)</td>
<td><em>Triplochiton scleroxylon,</em> <em>Piptadeniastrum africanum,</em> <em>Heritiera utilis</em></td>
<td>Small-scale agro-forestry</td>
</tr>
<tr>
<td>Moist Evergreen (ME)</td>
<td><em>Triplochiton scleroxylon,</em> <em>Piptadeniastrum africanum,</em> <em>Heritiera utilis</em></td>
<td>OFR for sawlog</td>
</tr>
<tr>
<td>Moist semi-deciduous (MS)</td>
<td><em>Gmelina arborea,</em> <em>Triplochiton scleroxylon,</em> <em>Piptadeniastrum africanum,</em> <em>Terminalia superba</em></td>
<td>Areas capable of being restored to forest cover</td>
</tr>
<tr>
<td>Moist semi-deciduous (MS)</td>
<td><em>Triplochiton scleroxylon,</em> <em>Terminalia superba,</em> <em>Cedrela odorata,</em> <em>Tectona grandis,</em> <em>Gmelina arborea,</em> <em>Ceiba pentandra,</em> <em>Pinus spp.</em></td>
<td>Permanently degraded forest areas</td>
</tr>
<tr>
<td>Forest Savanna Transition (FST)</td>
<td><em>Cedrela odorata,</em> <em>Tectona grandis,</em> <em>Terminalia superba,</em> <em>Ceiba pentandra,</em> <em>Pinus spp.</em></td>
<td>Permanently degraded forest areas and non-forest land</td>
</tr>
<tr>
<td>Guinea &amp; Coastal Savanna (GuS &amp; CS)</td>
<td><em>Ceiba pentandra</em></td>
<td></td>
</tr>
</tbody>
</table>

2. Production of planting material

The capacities within the country for the production of improved seeds by the governmental agencies (e.g., the FORIG) and the private sector have been assessed. This has been found to be currently limiting with respect to either the availability of improved seeds or planting materials and the capability to produce the quantities of planting materials for large scale plantations (10,000 ha./yr. over next 20 years) as envisaged in the Forest Development Master Plan (1996-2020). This is an area that requires to be accorded the highest priority so as to ensure the success of the programme.

3. Summary of technical constraints

The main technical constraints to plantation formation in Ghana have been summarized as follows:

- Limited experience with successful commercial forest plantation formation. Hence no proven technical packages;
- Lack of institutionalized incentive packages to make investments in forest plantations competitive with alternative investment opportunities (such packages were however in their investigation stages at the MLF as at the time of writing this report);
- No information on available land and site typing even though there is no shortage of gross area;
- Lack of adequate and genetically improved planting material; and
- The lack of the capacity for fire management in the Forest Transition Zone.

In order to minimize the risks associated with tree plantations in Ghana as a result of the limited experience with commercial forest plantation formation, it has been proposed that proven silvicultural prescriptions and management systems should be adopted from both locally and similar areas in the tropical world. It has also been indicated that the identification of plantation locations must be based on climatic and soil/site factors of the species of interest when such data
Economic issues

The economic factors that may hinder commercial plantation formation include:

- Long and medium term loans for schemes such as forest plantations are not available in the country and the commercial lending rates are also very high;
- Illegal chainsaw lumbering and timber trade coupled with the marketing of plantation timber below the market price by the FD distorts the domestic timber prices;
- The vetting of contracts with respect to the marketing of tree products; and
- Timber industry not adapted to small diameter milling.

Economic calculations by the Ohene-Cofie (1997) and FAO (1998) have been reviewed. It has been deduced that the calculations by the FAO in 1998 may be the only comprehensive one that has so far been compiled. The results are shown in Table below.

### Summary of Benefit to Cost Ratio at 10% discount rate

<table>
<thead>
<tr>
<th>Species</th>
<th>Good site</th>
<th>Poor site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zone</td>
<td>Large</td>
</tr>
<tr>
<td>Niangon</td>
<td>WE</td>
<td>0.3</td>
</tr>
<tr>
<td>Wawa</td>
<td>ME</td>
<td>1.3</td>
</tr>
<tr>
<td>Ofram</td>
<td>MS</td>
<td>1.2</td>
</tr>
<tr>
<td>Gmelina</td>
<td>ME</td>
<td>1.3</td>
</tr>
<tr>
<td>Teak</td>
<td>MS</td>
<td>2.4</td>
</tr>
<tr>
<td>Cedrela</td>
<td>MS</td>
<td>1.7</td>
</tr>
<tr>
<td>Ceiba</td>
<td>MS</td>
<td>1.4</td>
</tr>
<tr>
<td>Pine spp.</td>
<td>MS</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Source: FAO (1998) Large (>100 ha), Medium (10 - 40 ha) and Small (<10 ha)

The conditions indicating acceptable economic outcome are shown as bold numbers. The above results indicate that the choice of site and possibly the use of improved genetic materials are very important. The most promising indigenous and exotic species are Ceiba/Wawa and Teak/Cedrela respectively. Teak comes out as the best due to the high value of sawlogs and the marketability of the intermediate produce.

All species perform well on “Good Sites” except for Niangon which is a long rotation species. A special support may be required for Niangon and similar species with niche markets so as to encourage their planting.

The financial rates of return obtained by FAO (1998) for selected species are as below.
**Estimated financial rates of returns**

<table>
<thead>
<tr>
<th>Species</th>
<th>Management model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Teak</td>
<td>15.0</td>
</tr>
<tr>
<td>Wawa</td>
<td>10.1</td>
</tr>
</tbody>
</table>

Source: FAO (1998)  Large (>100 ha), Medium (10 - 40 ha) and Small (<10 ha)

The FAO results as shown in the tables below may be taken as indicative. This is due to the paucity of objective and reliable data on costs on forest plantation formation and real growth rates achievable by potential species on various sites.

The FAO financial models relate only to direct costs and no overhead elements were considered. This may have effect on the figures for medium and large scale growers. No allowance is also made for the produce from Taungya used in the small scale model.

**Conclusions and recommendations**

The Government of Ghana is committed to the facilitation of the formation of commercial plantations in the country for economic, environmental and sociological reasons. It is also the intention of the government that most of the commercial forestry activities should be the province of the private sector. The forest policy indicates that a share of the benefits from forestry must be devoted to securing the resource.

The necessary political will exists to boost tree plantation formation. What is required are solutions to the pertinent technical issues in addition to the necessary incentives and policy reforms (as well as the refinement of the existing ones) to pave the way for an increased investments in commercial tree plantations by both local and foreign investors. Suggestions for the resolution of these elements have been given in Chapter 6 (Recommendations).
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1 BACKGROUND

1.1 The forest resource

The total area of Ghana is about 23.9 million ha. with a coastline of 567 km. It is divided into two main ecological zones: the High Forest Zone (HFZ) of southern Ghana covering 8.2 million ha (34%) and the northern Savannah Zone (SZ) covering 15.7 million ha (66%) (Table 1). The latter includes the Volta Lake, the largest artificial lake in Africa. These two zones merge into each other in the transition zone. There is also a very dry, Savannah zone in the South east corner.

The HFZ has a rich indigenous flora which satisfies the local population and contains species which are in great demand by the timber trade. In the SZ, most of the natural vegetation has been destroyed for agricultural purposes and there is a great shortage of wood for all purposes. Parts of the SZ are also heavily populated. The HFZ includes the wet and moist evergreen forest, moist and dry semi-deciduous forests (Hall and Swaine 1981, Hawthorne 1995, Swaine 1998).

Table 1. Vegetation zones and characteristics

<table>
<thead>
<tr>
<th>Vegetation zone</th>
<th>Area ('000 ha)</th>
<th>Total area %</th>
<th>Eco Zone</th>
<th>Rainfall Amount (mm)</th>
<th>Pattern</th>
<th>Growing season Major</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Evergreen (WE)</td>
<td>657</td>
<td>2.75</td>
<td></td>
<td>1,750-2,200</td>
<td>Bimodal</td>
<td>150-160</td>
<td>100</td>
</tr>
<tr>
<td>Moist Evergreen (ME)</td>
<td>1,777</td>
<td>7.45</td>
<td></td>
<td>1,500-1,750</td>
<td>Bimodal</td>
<td>150-160</td>
<td>100</td>
</tr>
<tr>
<td>Moist Semi-Deciduous (MS)</td>
<td>3,318</td>
<td>13.90</td>
<td>High Forest Zone</td>
<td>1,250-1700</td>
<td>Bimodal</td>
<td>150-160</td>
<td>90</td>
</tr>
<tr>
<td>Dry Semi-Deciduous (FST)</td>
<td>2,144</td>
<td>8.98</td>
<td></td>
<td>1,250-1,500</td>
<td>Bimodal</td>
<td>200-220</td>
<td>60</td>
</tr>
<tr>
<td>Southern Marginal (FST)</td>
<td>236</td>
<td>0.99</td>
<td></td>
<td>1,200-1,300</td>
<td>Unimodal</td>
<td>150-200</td>
<td>-</td>
</tr>
<tr>
<td>South-East Outlier (CS)</td>
<td>2</td>
<td>0.008</td>
<td></td>
<td>800-1,000</td>
<td>Bimodal</td>
<td>100-110</td>
<td>50</td>
</tr>
<tr>
<td>Guinea Savannah (GuS)</td>
<td>14,790</td>
<td>61.98</td>
<td></td>
<td>1,100</td>
<td>Unimodal</td>
<td>180-200</td>
<td>-</td>
</tr>
<tr>
<td>Sudan Savannah (SuS)</td>
<td>190</td>
<td>0.79</td>
<td>Savannah Zone</td>
<td>1,000</td>
<td>Unimodal</td>
<td>150-160</td>
<td>-</td>
</tr>
<tr>
<td>Others (thicket, swamp, grass etc)</td>
<td>750</td>
<td>3.14</td>
<td></td>
<td>1,000</td>
<td>Unimodal</td>
<td>150-160</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>23,864</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NB: Sums may not tally due to rounding off.

Within The HFZ, the Moist Evergreen forest contains about 27% of the commercial/economic species, whilst the Moist Semi-Deciduous forest has up to 17% of such species. The Wet Evergreen is relatively poor in economic species (9%). The South-East outlier and the Southern Marginal contain no commercial timber.
1.1.1 Forest reserves

The forest reserves established by the Forestry Department (FD) total 266 in number. They cover about 20% of the HFZ (i.e. 1.63 million ha) and about 6% of the SZ (i.e. 0.88 million ha). The forest reserves have been classified into the following working circles (Table 2).

### Table 2. Classification of forest reserves according to working circles

<table>
<thead>
<tr>
<th>Area category</th>
<th>Basal area (m²/ha.)</th>
<th>Area ('000 ha.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber production</td>
<td>&gt; 15</td>
<td>762.4</td>
</tr>
<tr>
<td>Permanent protection</td>
<td>-</td>
<td>352.5</td>
</tr>
<tr>
<td>Convalescence</td>
<td>&lt; 15 and &gt; 5</td>
<td>122.0</td>
</tr>
<tr>
<td>Conversion</td>
<td>&lt; 5</td>
<td>127.2</td>
</tr>
<tr>
<td>Not inventoried (conversion)</td>
<td>&lt; 5</td>
<td>270.0</td>
</tr>
<tr>
<td>Total reserve area</td>
<td>-</td>
<td>1,634.1</td>
</tr>
</tbody>
</table>

Source: MLF Master Plan (1996)

The permanent protection area consists of hill and swamp sanctuaries, areas of significant biodiversity, those for security of seed provenance and fire protection areas. The convalescence areas are those with reduced stocking but which are considered capable of rehabilitation within one felling cycle. Conversion areas are in various stages of degradation, including grassland, and require planting for rehabilitation where there is inadequate regeneration. The FD considers these areas (c. 397,000 ha) to have potential for tree planting. They are mainly located in the Forest Transition Zone (FST). The condition of the reserved forests as assessed in 1995 is shown in Table 3.

### Table 3. Area of forest reserves by condition and type

<table>
<thead>
<tr>
<th>Forest zone</th>
<th>1 - Excellent</th>
<th>2 - Good to OK</th>
<th>3 - Partly degraded</th>
<th>4 - Mostly degraded</th>
<th>5 - Very bad</th>
<th>6 - No forest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km²</td>
<td>%</td>
<td>km²</td>
<td>%</td>
<td>km²</td>
<td>%</td>
<td>km²</td>
</tr>
<tr>
<td>WE</td>
<td>346</td>
<td>15.1</td>
<td>1,239</td>
<td>56.3</td>
<td>617</td>
<td>28.0</td>
<td>0</td>
</tr>
<tr>
<td>ME</td>
<td>0</td>
<td>0</td>
<td>1,134</td>
<td>20.6</td>
<td>2,531</td>
<td>46.1</td>
<td>633</td>
</tr>
<tr>
<td>UE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>661</td>
<td>99.4</td>
<td>0</td>
</tr>
<tr>
<td>MS.se</td>
<td>0</td>
<td>0</td>
<td>34</td>
<td>1.9</td>
<td>1,144</td>
<td>63.5</td>
<td>358</td>
</tr>
<tr>
<td>MS.nw</td>
<td>0</td>
<td>0</td>
<td>75</td>
<td>1.8</td>
<td>1,224</td>
<td>30.1</td>
<td>1,584</td>
</tr>
<tr>
<td>DS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0.2</td>
<td>986</td>
</tr>
<tr>
<td>SM</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1.9</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>SO</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>12.9</td>
<td>54</td>
</tr>
</tbody>
</table>

NB: Due to rounding off, sums may not tally

MS se – Moist Semi Deciduous (South-west subtype)  
MS nw - Moist Semi Deciduous (North-West subtype)

The above table illustrates a number of features of the patterns of disturbance. Almost exactly half of the reserved forest is in reasonable condition (1 - 3). However, only about 15% of the total forest reserve area has the lightest or no disturbance in recent history (1 - 2). There is a general increase in forest disturbance from wet to dry areas. This is a consequence of both greater fire damage and greater logging damage.
There are large areas of forest (condition 6) in the semi deciduous zones which have suffered excessively from fire and logging. A number of forest reserves in this condition class was not forested at the time of reservation but is rather savannah or open woodland reserves. Other condition 6 areas have been managed as plantations with no natural forest in them at the time of reservation.

1.1.2 Outside reserved forests

The extent of forestland outside the reserves is not accurately known. It has been estimated that there are few remaining areas of intact closed canopy forest outside forest reserves. The estimates vary from 374,000 ha (Nsenkyire 1992) to 270,000 ha (World Bank 1987) to 100,000 ha (IUCN 1992), while others (e.g. Hawthorne 1990, Norton 1991) estimate that closed canopy forest outside reserves may comprise as little as a fifth of the latter amount, much of it in small, scattered patches in swamps and sacred groves.

1.2 Climate

The HFZ has a two peak rainfall during April to July and September to November. The rainfall varies between 1,200 - 2,200 mm. There is a comparatively short dry season during January and February. The relative humidity is always high and is seldom below 85%.

The SZ has a one peak rainfall during August to September which is followed by a long dry season of four or five months when the humidity is low. The uni-modal rainfall (800-1200 mm) is erratic and frequently undependable. This coupled with the long dry harmattan winds makes tree planting and survival difficult.

1.3 Soils

Due to the high rainfall in the HFZ, the soils are highly leached and acidic in reaction (pH 4.0 - 5.5). They are low in cation exchange capacity, available phosphorus, nitrogen and organic matter. The degree of acidity and hydration with a consequent yellow appearance of the soil increases with rainfall. In the wettest zones, the soils are very infertile, strongly acid and often have high aluminium content. Inundation is common on lower catena sites especially of the lower profiles. The relatively short dry seasons coupled with the high humidity of the WE, ME and MS forest zones reduces the risk of fire in forest plantations. In the FST zone, where the soils are derived from basement complex rocks, they tend to be deeper, with high concentration of organic matter and nutrients and heavier textured. These are the best areas for tree growth.

The principal physiographic feature of HFZ is the gentle undulations – a dissected peneplain – remnants of which are frequently capped by ferrous crust of drift material which give rise to poor soils. Over these gently rolling hills occur a characteristic sequence of earth comprising sedentary soils on the summits and middle slopes with colluvial soils on the lower slopes and alluvial soils in the valley bottoms.
The HFZ supports two thirds of the population of 17 million. Most of the country's economic activities are concentrated in this zone. They include tree cash crops (cocoa, oil palm, para rubber, coconut), mining (e.g. gold, bauxite, manganese) as well as forest industries.

**The Savannah Zone**

The soils here are often light textured and relatively poor in fertility, although usually less acid than in the wetter zones. Except for the alluvial soils and the clays of the valley bottoms soils throughout the area are shallow with thin topsoils and unsuited for deep rooted crops. The soils rarely exceed 150 cm or 180 cm in depth. Most of the soils in this zone are subject to laterisation at about 30 to 60 cm below the soil surface which leads to seasonal flooding of the soil profile as well as soil erosion. The topography is often flat or gently undulating and hence it is difficult to delineate zones which are sensitive to flooding. Careful site appraisals are therefore required. The areas of soils derived from metamorphic rocks are mainly in demand as agricultural soils. The main economic activities are annual crop (cereals, root crops and cotton) and livestock production.

**Soil fertility**

Numerous studies have shown that in Ghana the bulk of the soil organic matter and nutrients are bound within the few centimetres of the topsoil below which there is drastic decrease in these. It is also known that the soils lose their fertility very fast when cultivated. Hence the application of especially nitrogen and phosphorus is necessary for the maintenance of the fertility of the soil (Asiamah 1988).

**Soil conservation**

The upland soils are fragile and susceptible to soil erosion hazards when large tracts are cleared. It is therefore important to adopt practices that will conserve the soils at all times such as strip cropping, cover cropping, as well as ploughing, ridging along the contours and agro-forestry.

**Soil survey**

It is important that soil investigations are carried out in detail to determine the soil limitations before embarking on any forest plantation project. This will facilitate the implementation of the necessary curative measures necessary to offset any soil condition that may adversely affect the growth of the trees. The fitting of the appropriate tree species to site would also be made much easier.

1.4  **Land use**

The land use in Ghana can be grouped into seven major categories (Table 4).
Table 4 Broad land use categories in Ghana

<table>
<thead>
<tr>
<th>Land use</th>
<th>Land area ('000 ha)</th>
<th>% of Total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savannah woodland</td>
<td>7,100</td>
<td>30</td>
</tr>
<tr>
<td>Unimproved pasture</td>
<td>3,600</td>
<td>15</td>
</tr>
<tr>
<td>Bush fallow etc.</td>
<td>5,000*</td>
<td>21</td>
</tr>
<tr>
<td>Water bodies and wetlands</td>
<td>1,000</td>
<td>4</td>
</tr>
<tr>
<td>Forest reserves</td>
<td>2,600</td>
<td>11</td>
</tr>
<tr>
<td>Wildlife reserves</td>
<td>1,200</td>
<td>5</td>
</tr>
<tr>
<td>Tree crops</td>
<td>1,700</td>
<td>7</td>
</tr>
<tr>
<td>Annual crops</td>
<td>1,200</td>
<td>5</td>
</tr>
<tr>
<td>Unreserved forests</td>
<td>500</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23,900</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: MLF, Ghana.

*Includes human settlements, transportation infrastructure and utilities

2 HISTORY OF FOREST IMPROVEMENTS AND TREE PLANTING

The earliest records on plantation establishment that was gleaned by this study dates back to about 1956. A resolution at the Sixth Commonwealth Conference had called for the collection of information on the use of exotic tree species in the Commonwealth in a standardized form for presentation to the next commonwealth Forestry Conference. Questionnaires were consequently sent out. The information given in reply to it that was based on work carried out up to January, 1956, was published by D.A. Lane, the then Silviculturist of the Forestry Department, Ghana (Lane 1956).

The above report indicated that the general policy at the time was to concentrate on indigenous species in the HFZ. The few exotic species that were planted in the latter zone had been introduced mainly for fuelwood plantations near large population centres or for mining use. Those exotic species that were tried in the HFZ include *Eucalyptus torelliana* and *E. tereticornis*. Both species were reported to have been attacked by white ants when young and apparently healthy. Those that survived – especially in the latter case – grew particularly well.

In the SZ, however, the report indicated that most of the natural vegetation had been cleared for agricultural purposes and that there was great shortage of wood for all purposes. The policy at that time was therefore to find suitable species to grow as plantation crops to supply timber, poles and fuelwood. Hence, a large number of exotic species were tried from 1951. The few species that showed promise were planted on a general scale. They include *Azadirachta indica*, *Cassia siamea*, *Cedrela mexicana*, *Dalbergia sissoo*, *Gmelina arborea*, and *Tectona grandis*. The country of origin for all of them was India (provenances not indicated) except for *Cedrela mexicana* which was obtained from the Caribbean area as well as some of the teak from Burma.

It is on record that *Cedrela odorata* was introduced in Ghana in 1898 (Truope 1932). *Tectona grandis* trials in the country dates back to 1905 under the German administration in the Volta Region of the country (Kadambi 1972).
It is interesting to note that forest plantation trials to meet the future requirements of wood products were contemplated as far back as the pre-independence days. It is however unfortunate that no follow up was carried out on these earlier attempts. The knowledge and experience from the earlier trials would have been invaluable in the planning of the Forestry Department’s major plantation programme from 1963 to 1987. Perhaps this underscores the fact that over the years research has in most cases been abandoned before completion. This has resulted in the limited amount of guidance for field staff. It would be useful for the FD (or the new Forest Service to come) to try to search for any useful information on such past efforts from their archives.

2.1 Natural forest silviculture

2.1.1 Tropical Shelterwood System

Attempts at the development of a silvicultural system for the indigenous forests of Ghana dates back to 1946 when the “Tropical Shelterwood System” (TSS) was introduced. The TSS was modeled on the classical shelterwood systems and the Malayan Uniform System. According to Owusu (1996), the implementation of the TSS was an attempt “to convert the forest from its complex multi-species, all-aged structure to a simpler forest made up preponderantly of a few preferred or ‘economic’ species and with trees of more or less the same age in any block or compartment”.

The treatments were applied to the forest reserves in the richer moist semi-deciduous forests to promote the growth of the redwoods especially the Milicia and Meliaceae species. The system was abolished in mid-1990 after about 5,000 ha had been treated. The results at that time indicated that the desired “economic” species constituted about 6 - 10% of the regeneration in two of the richest forest reserves that were included in the experiment.

Alder (1993) concludes from analysis of the TSS data from the Bobiri Forest Reserve that, despite the heavy disturbance and the poisoning of 85% of the basal area, the forest has, within a period of 20 - 30 years re-established a structure not greatly dissimilar to that of the undisturbed forest. The species composition is however not the same (Owusu 1996). Alder also indicates that the reduction in stocking has led to higher growth rates while low intensity logging may lead to little or no net growth.

FORIG’s (then FPRI) annual report in 1968 indicated that Entandrophragma utile was the most successful under the TSS with average results for E. angolense and Khaya ivorensis. Success was also achieved with Guarea cedrata, Mansonia altissima, Nesogordonia papaverifera and Piptadeniastrum africanaum. Failures were E. cylindricum, Milicia excelsa, Terminalia ivorensis and Tieghmella heckelii.

2.1.2 Modified Selection System

Between 1956 and 1970, the “Modified Selection System” (MSS) was also tried in Ghana. Improvement thinnings were undertaken through climber cutting and the use of arboricides in an attempt to create a forest that is similar in structure to that in its natural state. Less preferred
“economic” species that were competing with young more preferred species were killed by poisoning to promote faster growth of the latter and to create room for regeneration. Better formed undesirable species were often sacrificed in favour of crooked “economic’ species (Owusu 1996).

A 25-year felling cycle was adopted for the system. But the system was abandoned in 1971 when over 259,000 ha (about 30,000 ha/year from 1958 to 1970) of high forest reserves had been treated. It proved to be expensive and lead to predominance of over-mature trees (c. 110 cm diameter and above). A decision was subsequently taken to remove these over-mature trees over a ten year period. This appeared to be a wrong decision as a lot of gaps were created in the canopies of the affected forests which in turn introduced weeds on the forest floor followed by fires (pers. comm., Owusu 1996).

The MSS was also wasteful as some of those species that were listed as “undesirables” for removal are currently marketable. However, as in Nigeria, there was no evidence that the treatments accelerated the growth of the selected trees (Osafo 1970). The removal of the “poisoned trees” could have probably made a difference to growth and regeneration on the forest floor.

2.1.3 Line planting

About the same period as the TSS, enrichment plantings were carried out to improve the stocking of the poorly stocked Wet Evergreen forest reserves as well as to sustain the supply of the then desirable species. Striplings (about 1 m to 1.5 m high) were planted at 5 m within lines that were cut 20 m apart. Khaya, Entandrophragma, Lovoa and Heritiera species were used. After planting an area of about 2,500 ha, the method was discontinued due to the fact that many plants were choked by weeds (Nolan and Gharney 1992). Climbers can be a severe problem following canopy opening and if the species used is not tolerant of these then very heavy investment in weeding is required.

Lamb (1967) inspected line-planting in Ghana and Nigeria. He reported that whilst the mahoganies grew too slowly to escape competition before the lines closed over, Cedrela odorata, Terminalia ivorensis and Triplochiton scleroxylon grew sufficiently fast to become established successfully. He noted also the benefit of the side shade provided by line planting for the early growth of both Cedrela odorata, and Triplochiton scleroxylon.

Overall, there is no doubt that line planting can succeed providing appropriate species and appropriate silviculture are employed. Foury (1956) prepared a list of the requirements for the success of line planting that was adopted by Dawkins (1958) as follows:

- Align the lines East - West to maximize illumination;
- Use close spacing between the plants along the lines;
- Use only strongly light demanding species capable of extremely fast height growth in their juvenile stage;
- Complete all harvesting operations prior to establishment and thereafter close the area to any further felling;
• Apply tending to the whole forest, not just the lines, although obviously there must be
  concentration on the lines;
• Liberate the planted trees from overhead and lateral shade and from root competition;
• Protect the whole area from wildlife. (Enrichment planting is generally unsuited to forests
  with a heavy stocking of game, particularly when the planted trees are palatable).

The main problem is that line planting, and indeed any forest enrichment is normally a post-
exploitation treatment and access to the forest is via former haulage roads and extraction tracks.
These deteriorate rapidly if not maintained and may close over after about five years, becoming
impassable to wheeled transport (Hardcastle et al. 1998).

Brasnett (1949) indicated that enrichment planting needs a great deal of labour and the tending
period is always under-estimated. The result is that foresters are liable to plunge into operations
on too large a scale and find themselves later on facing commitments of maintenance beyond the
staff and funds available.

2.1.4 Conclusions

Techniques for natural forest silviculture have not been successful for ecological and managerial
reasons. None of those that were successful on a research scale has been successfully translated
into a large scale field practice.

Some of the tried silvicultural systems (i.e. line-planting, TSS and the MSS) may require to be
re-assessed especially with respect to those treated forests that have not been disturbed much, if
there are any (as has been done by Alder 1993). The experience that can be gained from the
effect of gap size and shade (both top and side) would be invaluable. This can be done in the
light of the current improved analytical tools. In the author’s opinion, the retention of the
“poisoned trees” may have affected the emergence of the juvenile trees either through their effect
on light conditions below the canopy level or that they may have constituted physical
obstructions to the proper growth of some of the emerging trees. The current marketability of
more species may facilitate the removal and utilization of most of such species instead of
poisoning them if the MSS were to be implemented in these days. The use of such trees would
contribute towards the economy of the silviculture operations.

The factors that were considered to have contributed to the failure of the attempted natural forest
silviculture techniques include:

• Concentration on the promotion of the growth of the few so-called “desirable” species
  (the range of marketable species has increased significantly since then);
• Inadequate knowledge about the shade requirements of the different species at the various
  stages of their growth to maturity; and
• Inadequate control of weed growth due to the lack of access to remote areas in addition to
  the underestimation of the extent of funding required (there may be a better opportunity
  for success with improved road network coupled with the current positive environment
  for investment in tree planting).
Further research can be undertaken based on the up-to-date knowledge on the growth requirements of some of the indigenous tree species, available skills and available resources including improved communication and remote sensing monitoring systems.

It may be possible that some of the silvicultural prescriptions that had been tested will be suitable (may be with modifications) for application on some of the currently degraded natural forests in Ghana. This includes those forests categorized as “convalescence” and degraded by the Forestry Department (i.e. with basal area <15 m$^2$/ha and < 5 m$^2$/ha respectively, see Table 2) to improve their stocking. It may be better to manipulate the forest to influence the composition of the new crop based on proven techniques than leave such conditions to nature. Potential techniques can be put to research on limited scale beforehand.

2.2 Natural forest replacement by artificial regeneration

2.2.1 Methods of land acquisition for forest plantations

All lands for large scale plantations by the FD had been concentrated in the forest reserves. The forest reserves were chosen for convenience as the FD had much control on those lands. “In the past, forest has been dismissed as suitable for planting schemes if there were no economic trees or had been slightly damaged” (Hawthorn and Abu-Juam 1995).

Other recent private forest plantation had depended on lands leased from Stools. These include the efforts by the BVFL and DWT in the Brong Ahafo and the Greater Accra Regions. There are also several woodlots on private and Stool lands.

Lands for large scale tree crops such as rubber and oil palm were acquired by executive instruments (e.g. GREL and BOPP). The same applies to land for the SIPL *Gmelina* plantations. But the SIPL has also leased land outside the forest reserves for forest plantation formation.

2.2.2 Overview of the silvicultural systems used

The experience in Ghana with respect to forest plantation formation in the “degraded” natural forest has been mainly in the form of cut and burn technique with respect to site preparation, conventional nursery formations to raise seedlings in polypots and to produce stumps. This experience extends to lining out and planting in the field.

Choice of species

The main species planted were *Tectona grandis*, *Cedrela odorata*, *Terminalia ivorensis*, *Mansonia altissima*, the *Miliaceae* spp. and *Gmelina arborea*. Other species include *Eucalyptus tereticornis* and *Triplochiton scleroxylon*. Teak formed over 50% of the area planted (1). The indigenous hardwood species were planted particularly in the Eastern and Western Regions but with very low success rates (Appendix 2).

There was a greater reliance on exotic species than the indigenous ones. Foli and Ofosu-Asiedu (1997) attributed this to the following convictions at the time of the plantation establishments:
• They are faster growing than indigenous species and therefore have shorter rotations, making it economically worthwhile for investment;
• There is information (from experience elsewhere) on their growth requirements; and
• They have fewer management problems than the indigenous species.

The species that were planted can generally be considered as having been done on trial basis as there was no prior experience with them with regards to large scale plantations. There was no objective and consistent appraisal of the performance of the species after planting. Field observations however showed some of the species to have performed better or to have the potential (see Appendix 3).

Species-site matching
There was virtually no attempt at species-site matching during the establishment of the plantations by both the FD and other private efforts. Even though poor genetic material was used, field observations indicate that much better results could have been achieved if the proper post-cultural activities had been implemented.

The only recorded attempts to carry out pre-clearing reconnaissance surveys to map out land suitable for the planting of a particular species for maximum growth and also to reserve sensitive land from clearing of the natural vegetation is at the SIPL, Daboase. However, pressure to attain the annual planting targets of about 1,000 ha on dispersed areas, shortage of trained staff to do such work and inadequate road network due to funding problems sometimes did not make this possible.

Forest plantation management

Weeding. Weeding mainly took place based on the available resources including funds.

Thinnings. The first attempt at thinning the teak plantations was also not properly done. Contractors took advantage of the weak supervision by the FD to impoverish the stands that were treated. Most of those stems that were marked for retention were rather the ones that were removed.

Forest protection. There have been and continues to be repeated fire outbreaks in especially the plantations in the semi-deciduous forest zone without any conscientious fire prevention or control effort. Budgetary constraints coupled with the lack of the relevant expertise in this field may have contributed to this situation.

2.2.3 Taungya

The techniques for plantation formation were block plantations either with (i.e. the Taungya system) or without the inter-cropping of food crops. Most of the forest plantations by the FD in the forest reserves were undertaken through the Taungya system.

The system was often attempted where the necessary conditions of farmer organization, FD supervision and provision of inputs were non-existent. The management of the system was also
prone to corruption and people asked for more land than they could manage. In some instances commercial farming by absentee farmers took over.

In 1987, the Taungya system was stopped nationally, as was further large scale planting, to give way to re-planting of failed areas, especially those established with the Taungya system. The problem was not in the silvicultural aspects but in the management and application of the system. Essentially, the farmers want maximum return on their investment and have an interest in delaying the time of abandonment of planted land in the forest reserves involved which were and still are under the control of the FD. The latter in turn wants trees established as quickly as possible, without damage or severe competition to the tree crop. The debate therefore hinges on equity.

One of the main reasons for the utilization of the Taungya system in some of the forest reserves where plantations were established was land hunger. Whilst Taungya may have been attractive under such conditions, the results did not justify its use for those areas. Land hunger had ironically contributed a great deal to most of the failures in the application of the system.

A typical example is the Kabakaba Hills Forest Reserves (North, East and West Blocks) which surround a group of towns and villages in the Volta Region of Ghana. Co-operation from these villages in plantation formation via Taungya within the forest reserves in question was reported to have been better when the system started far from the villages. The villagers’ attitudes however changed adversely as the Taungya got closer to their villages. This was when the possibility of eventually becoming landless became very apparent to them. Sabotage to the Taungya system ranged from the loosening of the rooting system or turning of the seedlings upside down to the pouring of hot water on them. Hence the most successful Taungya stands in the above area are those that were established earlier on from the late 1960s to the early 1970s (Arbor Nova Ltd. et al. 1994).

All Taungya systems require social criteria to be in place with respect to security of land tenure and an effective land allocation system. There is also a difference between the use of Taungya to establish plantations which have a rotation of 70 to 100 years and its use as a tree fallow with a rotation of 25 to 30 years. In the latter case, the farmers are likely to remain in the locality and thus develop settled social structures. What is generally agreed is that Taungya is an appropriate system for farmers who practice shifting agriculture on soils that cannot support continuous cropping (Hardcastle et al. 1998).

Examples of Taungya schemes are given below.

Karigbonto Ceiba Plantation
This is a plantation of *Ceiba pentandra* on the outskirts of Tamale in the Northern Region of Ghana on the Tamale-Kintampo road. The objective of the plantation is primarily for the production of Kapok and the seeds which are edible. The *Ceiba* found in this area is without the usual thorns on the stem as can be found on the variety in the high forest zone. This could be an environmental variety of the type in the south.

The plantation is young and located on a 0.8 ha plot. It was planted in 1993 with a spacing of 8 x 8 m. The area is covered mainly with grass. Hence the site preparation is mainly by ploughing.
The system of inter-cropping and the outputs are summarized below. The yields of produce were based on interviews with the farmer concerned (one Osmanu Haruna):

**Year 1**  Planting of maize before the *Ceiba* seedlings. Fertilizer applied*. Harvest of 10 Cocoa sacks maize (i.e. 12.5 bags/ha.)

**Year 2**  Inter-planting with Yam. Harvest of 1000 tubers of yam (2,500 tubers/ha.)

**Year 3**  Inter-planting with maize. Fertilizer applied*. Harvest of 15 Cocoa sacks of maize (37.5 bags/ha.)

**Year 4**  Last inter-planting with maize (1997). Fertilizer applied*. No harvest yet. The tree canopy about to close. Growth of the maize close to the tree stems adversely affected.

**Year 5**  Extension of farm and cycle re-starts.

*Compound fertilizer (15:15) is applied to the maize crop at about 2 - 4 weeks after planting. Thereafter Sulphate of Amonia is also applied when the maize is tussling.

Harvesting of the Kapok is expected to start in earnest in year 5. There were fruits already on the tree at year 4 and a small harvest was expected. Kapok is harvested during the Harmattan season (February to April). The highest price for Kapok is obtainable during the lean season in between harvest times. The Kapok seeds (“Konton”) is ground and used for seasoning soups.

The young tender leaves are also edible and are said to taste like okro when used for soups. The leaves are mainly for home consumption and generally not sold. The harvesting is via long sticks or sickle. The Kapok may not be exported but is an important local market commodity for mattresses and pillows. It is also known to be used for the stuffing of life jackets as insects do not attack the “cottonwool”.

*Bogunayili Ceiba Plantation*

The Chief of Bogunayili has inherited about 5 ha of *Ceiba pentandra* plantation. The objective of this plantation is also for kapok and the seeds. It is located on a sandy soil that is lying fallow. The spacing is about 10 x 10 m and planting is said to have been done at about 1960. The measured average diameter of the trees was about 70 cm in 1997. Growth rates could not be determined as the exact date of planting is not reliable.

Harvesting of Kapok and seeds however continues annually and the Chief estimates that the rotation age should be about 30 years when the trees can be harvested and replanted. But this needs to be objectively verified.

Taungya was an important tool in the formation of plantations by the Forestry Department. Its failure may be attributed mainly to the lack of understanding of the socio-economic implications of the system as well as inefficient management and application of the system. Taungya can provide some revenue during the gestation period when the tree crop is not due for harvesting. It can also be applied in an out-grower scheme in areas where intensive agriculture is practiced.

The Forest and Wildlife Policy of Ghana encourages increased public (including farmers and communities) awareness and involvement in the establishment, management and utilization of the forest resources. The Taungya system would therefore become one of the important techniques to get the rural folks involved in tree planting.
This time around, the farmer may have to be encouraged to plant on his own farm. Extension packages which will not affect farm productivity and which may even increase the yield on the farm would be more desirable. Advice on the arrangement of trees on the farm so as to optimize the use of the farmers land in addition to the utilization of farmer-preferred species would become more important.

3 EXPERIENCES WITH HARDWOOD PLANTATIONS

3.1 Forest plantation initiatives by the Government

3.1.1 Forestry Department

The technical and economic difficulties found in all enrichment operations have caused foresters to prefer total replacement (Dupuy and Mille 1991). In the same vein attention was re-directed from rainforest silviculture towards plantation formation in especially the forest reserves in Ghana.

In 1960, the FAO proposed a national forest plantation estate of 590,000 ha (FAO/UNEP 1981). In the late 1960s, a National Land Use Planning Committee revised the objectives downward and targeted an estate of 110,000 ha to be established over a 10 year period from 1970/71 (Nsenkyire 1992). The main objectives in plantation formation in the late 1960s by the FD had been to improve the stocking of commercial species in poorly stocked forest reserves to meet the expanding timber industry and also to provide employment for the rural dwellers (Apomasuh 1992).

It has been estimated that approximately 50,000 ha of plantations was established by the state in the HFZ in 88 forest reserves between 1963 and 1987 (Figure 1). The FD plantations were established in the forest reserves due to easy access to land in these areas. Of the 50,000 ha planted in the HFZ, 15,000 ha (33%) was assessed to have been successful by the FD in 1991 (Figure 2). More than 80% of the stands have stocking of less that 300 stems/ha and only a third have basal areas in excess of 18 m²/ha (FD 1994).

About 2,500 ha of teak plantations were established in the productive forest reserves in the Volta Region. The successful area was assessed to be about 1,300 ha (52%) with a mean stocking of about 330 stems/ha (Arbor Nova Ltd. et al. 1994). FD records also indicate that there are about 1,600 ha of teak plantations in the Northern regions of Ghana both within and outside forest reserves. Some of the plantations in the north are above 40 years old. Most of the teak trees there are however below pole sizes (i.e. dbh < 20 cm).

The current status of most of the FD plantations is generally a mixture of natural forest re-growth/bushes and the plantation species. Most of the fully stocked teak stands have very little undergrowth and erosion has occurred under those on moderate to steep slopes. The plantations were neither pruned nor thinned until recently when market was established for teak poles and Cedrela logs.
Figure 1. Forestry Department annual planting rates achieved

FD National Annual Planting Rates Achieved (1963-87)
(Source: Forestry Department)

Figure 2. Forestry Department hardwood forest plantation establishment by species

FD Plantation Establishment by Species (1963-87)
(Source: Forestry Department)
3.1.2 Community forestry

Government institutions are very recent converts to the community forestry scene. The FD’s Rural Forestry Division (RFD) was created under the FRMP in 1990. This was after several years of involvement of the Forestry Department in community forestry programmes, coordinated by inter-agency committees, in the northern savannah zone.

The six-year programme designed by the RFD under the FRMP was based on a pilot approach covering the six savannah zone regions. The programme centred on tree nurseries at central, subsidiary and village levels. By 1995 - 1996 it was planned that 112 nurseries would be producing 1.9 million seedlings annually. Evaluation of progress up to the third year of the programme recorded that there were 52 nurseries established producing 1.4 million seedlings in 1993. However, it was also concluded that 50% of the nurseries were ‘very substandard’ and only 11% were ‘good’ in terms of condition, appropriateness of species and demonstration value. The major concern however was that seedlings were being produced with little subsequent community or individual planting (Markanday 1993).

Of the planting that did take place, woodlots accounted for about 90% of the seedlings while the remaining 10% were aimed at agro-forestry, boundary planting, wind breaks and home gardens. The RFD’s stated aim was to support private sector planting to the tune of 10 - 15 million seedlings/year by the year 2000 (Abu 1993). The RFD anticipates expansion into activities in the HFZ in the future, possibly starting with the Eastern Region which falls in the SZ. A role for the RFD is seen particularly in training other FD staff, facilitating the development of village organizations for forestry and working with NGOs (Abu 1993). The FD’s Collaborative Forest Management Programme, with a focus on the HFZ, became fully operational in 1993.

The National Agro-forestry Committee (NAC) was established in 1993. This Programme represents the FD’s major co-operation with the Ministry of Agriculture’s Agro-forestry Unit, under the Crop Services Division. Under the NAC, a unified extension services was established. This was considered to have been ineffective due to competing land uses between forestry and agriculture coupled with the use of the amount of food produced as the measure of success.

The Agro-forestry Unit had support from the FAO and FRMP. About 120 trial plots were established around the country, mostly demonstrating alley cropping with Leucaena and Gliricidia spp.

3.2 Private sector efforts

3.2.1 Individuals

Deliberate organized tree planting has never been part of the Ghanaian culture except for isolated cases of shade and fruit trees. Most community forest efforts have therefore been the result of bilateral donor projects with little initiative coming from the rural communities themselves. Hence, developments have not survived without external support. Rural communities can be reluctant tree planters for a number of reasons: shortage of land or ambiguous tenure over trees
planted, limited availability of labour and capital, and previous bad experience of the Taungya system where the FD failed to provide seedlings or appropriate advice (Abu 1993).

The RFD and several NGOs have generated interest in tree planting in many parts of the country but their activities have been concentrated largely on woodlots. Lately the perceived market for utility poles – which were mainly produced from the thinnings of the FD’s teak plantations – has generated an unprecedented interest in the planting of teak.

The RFD and most NGOs have given out free seedlings. The provision of free seedlings has made some farmers make wrong decisions. Examples are that farmers have grown large tracts of plantations for which they did not have the requisite financial capacity to maintain.

National Association of Tree Growers has about 500 registered members. It is estimated that the members of this association have planted a total of about 2,000 ha. The majority of the plantings are teak. But there are small stands of indigenous species like *Triplochiton scleroxylon* and *Terminalia ivorensis*.

### 3.2.2 Companies and firms

*Bonsu Vonberg Farms Ltd. (BVFL)*

This is a typical example of an investment company. The project was initiated in 1993 and planting commenced in 1994. The Bonsu Vonberg Farms is located at Somanya some 40 km north east of Accra. It is owned jointly by Dutch and Ghanaian investors. The investors have been assured of reasonable returns on their investments by a guarantee of the revenues from the sale of the wood by an independent international accounting firm.

The main objective of the BVFL is sawlog production. The total area of the Somanya plantation is about 700 ha. Of this about 500 ha has been planted with teak. The remaining area is composed of wetlands and natural vegetation. A further 3,000 ha of plantable land has been identified in the Brong Ahafo Region. The overall objective is to plant a total of 10,000 ha in Ghana.

The vegetation at the BVFL plantations is mainly grass with scattered bushes. The area has been divided into 10 ha blocks or management units. A sample plot has been established in each unit for the assessment of growth rates. Site preparation is mechanized. The teak has been planted on vertisols. The stands are of indifferent form and flowering on the terminal shoot at age 4 years which will have adverse effect on the future growth of the stands.

Mechanical weeding is carried out during the first two years before the dry season using slashers. This type of weeding does not usually affect the weed growth at the base of the trees. These weeds are the crucial ones with respect to competition. It was learnt that such weeds are generally removed by manual weeding. The performance of the seedling planted during April - June seems to perform better than those that are planted in September - October (BVFL management).
BVFL has established an out-grower scheme that is supposed to be used to educate the inhabitants of the area on how to assist with the amelioration of the environment through tree planting. The extent of the individual areas involved is about 0.4 ha to 1 ha each. The total number of out-growers was not available at the time that the writer visited BVFL. An Extension Officer visits each out-grower about 2 to 3 times in a month. Free seedlings and technical advice is given. Advice has been given to the farmers involved to plant mainly marginal land, farm boundaries or a proportion of the farmland. The condition attached to the offer of support by BVFL to the farmers is that the mature crop would be sold to the company at the prevailing market rates.

Subri Industrial Plantation Ltd. (SIPL)
The SIPL is a parastatal organization and is a successor to the erstwhile “Subri Project” that was under the FD. To date, the SIPL is the only company that has established the most extensive forest plantations of the same species. It was incorporated to commence business in 1985 with the Government of Ghana, five local financial institutions (National Investment Bank, Ghana Commercial Bank, Agricultural Development Bank, Social Security Bank and Social Security and National Insurance Trust) as shareholders. An African Development Bank loan was obtained to cover the entire foreign exchange and some of the local costs.

The SIPL was formed to establish 4,000 ha of *Gmelina arborea* for the production of fibre for a proposed paper mill which was intended to be established at Daboase on the eastern banks of River Pra in the Western Region of Ghana. The delay in the establishment of the pulpmill has resulted in the addition of the production of sawlogs to the objective in 1990. The total area which has currently been established stands at about 5,000 ha. The project’s land of about 17,800 ha was acquired by Executive Instrument by the government in 1990 which was later assigned to the SIPL.

The local counterpart funding which is meant mainly for plantation formation and maintenance has generally been untimely and inadequate. The tending of the plantation has consequently been adversely affected. Salaries are also in arrears and this has affected the morale of the staff.

Due to the lack of market for smallwood, thinnings have been delayed. The growth of most of the stands has consequently been adversely affected. As a result of the above, the SIPL has embarked on a campaign for private investors and technical partners. Weeding was carried out after 4, 7, 21 and 28 months. Normal practice would be every 3 to 4 weeks until canopy closure. This would be expected after 6 to 8 months on correctly sited plantations with the rainfall of at the SIPL (Hardcastle 1998).

The conversion of natural forest, whatever its condition, is not environmentally acceptable. The SIPL management has realized this and commenced the search for agricultural fallow lands within a 25 km radius of Daboase. In 1995, about 1,000 ha of such lands (cassava fallow) was acquired at Manso and about 925 ha planted with *Gmelina arborea*. The silvicultural operations were given out on contract to the locals. Inter-cropping with black pepper was permitted and part of the land is set aside for food crops (SIPL management). The limited financial resources of the company have affected the tending of the plantation.
Swiss Lumber Co. Ltd. (SMS)
The SMS has embarked on a kind of out-grower scheme for planting timber species. The project is said to have started in 1989 by trial and error. Contract or agreement has been established concurrently with tenant farmers and the respective landowners for the growing of timber trees on mainly fallow farm areas. Such lands are usually those that are unsuitable for growing cocoa. The total area under contract as at mid-1997 was 101 ha with about 66 ha having been planted at that time.

The species used are *Triplochiton scleroxylon*, *Terminalia superba*, *Khaya ivorensis*, *Milicia excelsa*, *Entandophragma anglonse*, *Entandophragma cylindricum*, *Lovoa trichiloides*, *Nauclea diderrichii*, *Lophira elata*, *Tieghemella heckelii*, *Guarea cedrata* and *Mansonia altisima*. *Tectona grandis* and *Piptadeniastrum africanum* have been added recently. The *Tieghemella heckelii* trees that were grown in the open were not doing well. They could have been established under shade initially. The most promising growth is *Triplochiton*, which at the age of 5 years has a mean dbh of about 18 cm and is putting on MAI of about 3.66 cm/yr. In some places the crowns of the *Triplochiton* trees were touching at that age and may require thinning soon.

The management and supervision of the SMS plantation project is under the supervision of one Manager and a retired Senior Forest Guard of the FD. 5 x 5 m planting espacement is used in open areas and along cleared lines. Where the vegetation is dense lines are cleared 5 m apart and plants put in at the same distances. Inter-planting with food crops by the farmer is allowed up to crown closure in the open areas.

Other Timber Firms
Apart from the SMS, some other timber companies have also established plantations on limited scales. They include Sunstex Ltd., Western Hardwoods, WLVC, Ghana Prime Woods Products Ltd., Specialised Timber Products, John Bitar & Co., Asuo Bomosadu Timbers and Samartex Ltd.

Pioneer Tobacco Company Ltd. (PTC)
Since the early 1970s, the PTC has been establishing plantations of mainly in the Brong Ahafo Region where the company’s tobacco is grown. The species that has been planted include teak, *Gmelina*, *Cassia* and *Eucalyptus* spp. About 90% of the plantations are teak. The main objective has principally been the production of fuelwood for the curing of tobacco as well as for environmental reasons.

The area coverage of the company’s teak stands is about 4,900 ha. About 25% of the area has been established through assistance to farmers, schools, churches and other private communities and organisations. The assistance is in the form of provision of seedlings and pegging. The sizes of the plantations are 50 ha or less. Seeds are collected from plus trees in the FD plantations

Ashanti Goldfields Company Ltd. (AGC)
The AGC has teak stands of about 1,400 ha on their concession for mine props and fuelwood. There are also about 150 ha and 42 ha of *Gmelina* and *Eucalyptus* species, respectively.
Samartex Afforestation Projects
The Samreboi Timber and Plywood Company Ltd. (Samartex) has initiated a forest plantation programme at Oda Kotoamso near Asankrangwa in the Western Region. The area is an abandoned cocoa farm outside the reserved forests. The project is under the supervision of three graduate foresters. The major objective is to raise the standard of living of the farmers. The total area involved is 500 ha. About 40 ha had been planted with indigenous species and Teak as at the time of the study. Snail/fish farming and honey production has been introduced in the area. There is also inter-cropping with black pepper and cola. Cedrela, teak and indigenous species are being planted. The management philosophy is to undertake line planting in secondary forest. There is no land clearing where farms are located. Spacing of 10 x 10 m is used for inter-cropping on farms.

Joint Forest Management Project, Gwira Banso
Ghana Primewoods Products Ltd., Takoradi (GAP) has initiated a “Joint Forest Management Project” outside the reserved forests in late 1995 at Gwira Banso in the Western Region. In this project, the landowners, Tenant Farmers, GAP, and a timber marketing company – Dalhoff Larsen and Horneman (DLH) of Denmark – are co-operating in the design and implementation of a sustainable forest management system. It includes tree planting on farm as well as line enrichment planting of the natural forest. The results of this project would be invaluable in other similar areas in the country. The project is still in its design stages.

Care International has shown interest in the project and plans to co-operate with the project with respect to capacity building of the individual farmers and local institutions to implement sustainable land-use practices. This is meant to improve their livelihood security within the forest ecosystem.

Conclusions
The assessment of only 11% of the RFD nurseries as being of the optimum standard point to the fact that upgrading of skills in this area of plantation formation as in the case of the other relevant disciplines is very important.

The issues of free seedlings to farmers also require review in the future. The lack of incorporation of post-planting support to the farmers in the RFD programmes must have contributed a great deal to the large surplus of seedlings that were raised but not planted. There were therefore no incentives for those who had not planted before to do so and those who did plant would not increase the size of their plantations.

There are also a lot of small scale planters who have been girded on by the recent good market for teak thinnings. Future programmes would have to take such planters into consideration to maintain the interest that has already been generated as well as encourage others to follow suite. Incentives to such tree planters must include training, provision of genetically improved planting material of farmer-preferred and marketable species, establishment grants and the provision of extension services by funded consultants. Assistance would also be required to assist such planters to organize themselves into co-operatives to facilitate efficient delivery of the proposed incentive schemes.
3.2.3 Private tree crops

_Ghana Rubber Estates Ltd. (GREL)_
In addition to the forest plantations cited above estimates, Ghana has about 11,200 ha of rubber plantations. Ghana Rubber Estates Limited (GREL) owns about 8,500 ha of this and plans to fell and re-plant with improved planting material at the rate of about 500 ha/year from 1999 onwards.

3.3 Some silvicultural experiences

Site preparation
The decision by the BVFL management to stump and plough during site preparations was due to the difference in growth that had been observed on areas that received such treatments as compared to those which did not receive similar treatment at the beginning of the project. The growth of the former is about one and half times as much as the latter.

Measurements during field visit by the Author to the Somanya site gave the average diameter and growth rates of the ploughed and the unploughed stands as:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age (years)</th>
<th>dbh (cm)</th>
<th>Growth (cm/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plough + Stumping</td>
<td>3</td>
<td>7.21</td>
<td>2.62</td>
</tr>
<tr>
<td>Plough + Stumping</td>
<td>2</td>
<td>6.96</td>
<td>3.21</td>
</tr>
<tr>
<td>No plough or stumping</td>
<td>3</td>
<td>5.17</td>
<td>1.59</td>
</tr>
</tbody>
</table>

The difference between the above data is evident. Observations in the field indicated less grass growth under the ploughed and stumped stands whose canopy also tended to close earlier. But it may be early yet to make any substantive conclusions from the data.

Planting material
Vegetative reproduction of _Gmelina_ has been tried by the SIPL. The cuttings were observed to produce mainly lateral roots and the trees grown from them become susceptible to wind-throw. They are however reported to be more vigorous and branchier than those plants raised from seeds (SIPL management).

The experience at BVFL is that teak stumps (2” root, 1” stem) do better when planted between late April and mid-May (usually with 90% success). The success rate with respect to the use of stumps reduces to about 70% after mid-May hence the use of polypots after the latter period.

Planting distances
Teak
Since the 1970s, the changes in the espacements used by the PTC for the establishment of teak plantations are shown below. The related observed periods for the canopy closure are also given:
Year | Spacing (m) | Canopy closure time
--- | --- | ---
1972 | 4 x 4 | more than 5 years
1988 | 3 x 3 | by the 5th year
1990 onwards | 2 x 2 | by the 3rd year

No pruning or thinning is done. Pole sizes (20 - 25 cm) are said to be attained in about 20 years at the planting distance of 2 x 2m (pers. comm., Oyirifi). Firewood is cut at tree sizes of between 10 cm and 15 cm.

**Gmelina**
A spacing of 4 x 2 m (1250 trees/ha.) has been observed to be the best for *Gmelina arborea* at the SIPL plantations for the production of pulpwood and sawlogs (SIPL management). It is also recommended that due to frequent problems with the shape of *Gmelina* (straight bole, forking, and multiple stems) and pruning, a planting density of the order of 1,100 stems/ha which ensures natural pruning and a sufficiently large stock for a good selection at the time of thinning should used (Cabaret 1988).

**Weed suppression (Cover crops)**
The high cost of post-planting maintenance of forest plantations makes any affordable and environmentally friendly measure that can be used to suppress weed growth more than welcomed. The oil palm and para rubber industries both in Ghana and elsewhere have used and continues to make use of the creeper plant *Peuraria phaseoloides* for weed control and soil improvement. But forestry in Ghana has never applied this technique.

*Pueraria* is leguminous creeper that colonizes very rapidly. It is nitrogen fixing and drops a lot of leaves which improves soil texture. It is also evergreen and is good for weed suppression and erosion and evapo-transpiration control. The attributes of *Peuraria* would make it very useful as a cover crop especially for teak, which requires an undergrowth to prevent soil erosion and also to fix nitrogen in the soil.

Other similar cover crop species include *Centrosena pubescence* and *Mucuna utilis*. The latter is easier to establish than *Peuraria*. It is an annual plant that dries up in the dry season and re-seeds in the wet season and hence creates fire hazards in fire-prone areas. *Centrosena* on the other hand does not climb tree trunks when used in tree plantations. It would be worth the trial for the adoption of the use of cover crops for weed control in forest plantations.

### 3.4 Summary of established hardwood plantations

Table 5 gives a summary of the major hardwood plantations in Ghana the government and the private sector. This is based on the available data obtained from the various organizations indicated and those estimated. The time for the study did not allow verification of the data in the field. There are other medium to small scale hardwood plantations whose data are being compiled by the FD. These were not available at the time of the study. The details can be found in Appendix 1.
The extent of the FD plantations may currently be less than indicated in the above table due to lack of maintenance and frequent fires especially in the Transition Zone (FST). Recent thinnings of the teak plantations were also not properly supervised and has resulted in creaming of the better stands.

Table 5. Summary of the estimates of areas of major hardwood plantation in Ghana

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated area (ha)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teak</td>
<td>22,900</td>
<td>No info. on DWT areas</td>
</tr>
<tr>
<td>Cedrela</td>
<td>3,800</td>
<td></td>
</tr>
<tr>
<td>Gmelina</td>
<td>6,350</td>
<td></td>
</tr>
<tr>
<td>Terminalia</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>42</td>
<td>No info. on FD areas</td>
</tr>
<tr>
<td>Mixed Hardwoods</td>
<td>6,070</td>
<td>No. info. on AGC areas</td>
</tr>
<tr>
<td>Rubberwood</td>
<td>11,200</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50,762</strong></td>
<td></td>
</tr>
</tbody>
</table>

3.5 Potential management models

There are various relationships that have been used for the establishment of tree crops – especially rubber and oil palm – in the country for several years. These are normally between companies and individual farmers. They include:

1. The small holder scheme;
2. The out-grower scheme; and
3. The lease-back system.

In the case of (1) and (2), the companies are multi-nationals which benefit from their international expertise and experience in the establishment of the tree crop in question.

3.5.1 The small holder scheme

Under such a system the individual planter or small farmer does not own the land. A nucleus company arranges for credit and provides extension services and planting material for the establishment and maintenance of the tree crop. The nucleus company also serves as the market for the produce.

An example of this type of relationship is what is being practiced by the Benso Oil Palm Plantations (BOPP) in the Western Region. The company has 6,000 ha of land acquired by Government instrument. About 4,200 ha of the land has been developed by BOPP and the remaining 1,800 ha is placed under a small holder scheme. BOPP provides the management and extension services while the loans for the smallholders come from the Groupe Caisse Francais de Development, Ghana (GCFP) and managed through BOPP. Interested poorest farmers in the vicinity are screened to join the scheme. They are given a 4 ha plot of land each to tend.
The land is prepared by BOPP and the planting, weeding, fertilization and harvesting is done by the small holder. Extension workers from BOPP ensure that the farmers use approved methods and harvest the palm fruits at the appropriate times. Supervision of planting and other cultural operations is undertaken up to the second year after planting when the first harvest is expected. It has been planned that the farmers work on their plots for 4 hours a day. That leaves them the rest of the day to tend to their own food crop farms.

The company assists the selected farmers with the relevant inputs such as fertilizer, tools and bicycles for commuting to work in the form of loans. The farmer is assured of ready market for the produce and the loans are deducted from the sale of the oil palm fruits to the company after harvest. The loan is about US$2,700 for each 4 ha plot. The payment is expected over 12 years with a 5 year grace period and a fixed interest rate of about 16.5%.

3.5.2 The out-grower scheme

This is similar to the small holder scheme. The main difference is that the farmer owns his own land. This can be in the form of lease, freehold or share-cropping. In the case of share-cropping, agreement is required between the tenant farmer and the landowner for the purposes of joining the scheme. The relationship in the latter case is further strengthened through a tripartite agreement between the landlord, tenant farmer and the nucleus company. To prevent the splitting of land into uneconomic units after the death of an out-grower, a next-of-kin agreement is established with the chiefs/landowners and the family of the farmer as witnesses.

All inputs except land and labour are provided by the company and seedlings may be sold at cost to the farmer as is the case with the small holder scheme. The services include extension and farmer loan account services. Usually this type of service company will define a radius within which a farm must fall to qualify to join the scheme.

Companies which are applying the system include the Ghana Rubber Estates Ltd. (GREL) in the Western region and the Ghana Oil Palm Company (GOPC) in the Eastern Region. The main sources of finances are the companies’ own funds, the World Bank and the GCFD.

3.5.3 The lease-back system

In this case, the farmer who owns the land does not want or is unable to make any investment towards the establishment of the crop. The nucleus company is granted use of the land. The farmer may or may not provide paid labour to the company but usually takes a share of the final value of the harvest. This is the model which is being implemented by the SMS.

Under the agreement, SMS undertakes the planting of the tree crop and its maintenance to maturity. Annual rent is paid by SMS to the landowner 3 - 5 years in advance at the rate of about US$12/ha/yr. The future proceeds from the sale of the trees are planned to be shared between the tenant farmer and the landowner on a 50/50 basis. The SMS has the first option to buy the timber. But the farmer can also sell his or her share elsewhere.
The individual areas concerned are mapped and endorsed by the respective Paramount Chief in addition to the Chiefs of the Stool lands concerned to confirm that the tenant farmer has their blessing for using the land as such. The condition for the acceptance of a farm into the scheme is that it should share boundary with an existing plantation so as to ensure their efficient management.

Weeding is carried out four times a year during the first two years and three times a year during the third and fourth years. Maintenance is carried out by SMS labour or the out-grower who is then paid for such services on contract by SMS. The cost benefit analysis of the SMS lease back scheme is yet to be assessed.

3.6  Environmental effects

3.6.1  Erosion

Pure teak stands have been associated with the deterioration of soil and erosion. This is usually the case when teak is either planted on steep slopes where undergrowth has been systematically cleared or where excessive burning has taken place. Evidences of such environmental degradation under teak in Ghana include parts of the plantations at the Ho Hills Forest Reserve in the Volta Region and the Yendi Town Plantation to the north of the country. Some of the plantations are also devoid of undergrowth due to the frequent fires that run through the stands. No cover crop is planted under teak plantations in Ghana.

The maintenance of a protective under-storey after canopy closure tends to prevent the deterioration of the soil, especially when the undergrowth is a nitrogen fixer. For example, in Indonesia the inter-planting of teak with *Leucaena glauca* is practiced. This is done soon after the teak is planted to form an under-storey and is regularly pruned to prevent competition with the teak. The advantages claimed for *Leucaena* are the improvement of soils aeration, nitrogen fixation and the prevention of surface run-off.

3.6.2  Fire

There is a fire problem in the area of the BVFL’s plantation at Somanya as is the case with similar savannah areas. The 5 m wide roads constructed round the 10 ha blocks serve as firebreaks in addition to facilitating the transportation of seedlings to the planting site. Weeding of the plantation is also carried out before the dry season. The company has had about 20 workers trained by the National Fire Service in fire fighting. The trained fire fighters have been supplied with bicycles and radio communication equipment to call for help when the need arises. The company plans to install fire towers in the future to assist in early fire outbreak detection. After fires, burnt young teak trees are cut to the ground level. It has been observed that this intervention leads to vigorous sprouting from the stool.
3.7 Seed availability and production

3.7.1 Seed orchards

*Tectona grandis*
There are seed orchards at the FORIG, Kumasi, and the Dupaul Wood Treatment (DWT) plantation at Offinso, in the Ashanti Region. The latter was expected to start producing seeds in 1998. Teak seeds have recently been imported from Tanzania for the production of high quality seeds. The FORIG cannot meet the current demand for teak seeds from its seed orchards. Hence supplementary supplies are obtained from plus trees in the Forest Department plantations.

*Triplochiton scleroxylon*
Wawa seed orchard has been established at the FORIG and the testing for the production of high quality seedlings via mist vegetative propagation techniques is in progress. The potential availability of adequate quantities of improved seeds is limited. The selection and mapping of plus trees in the natural forest requires urgent attention.

*Cedrela odorata*
There is a neglected seed orchard of *Cedrela* that is being rehabilitated by FORIG. It can provide about 20 kilos of seeds annually (pers. comm., A. Gyimah). Requirements in excess of this quantity are met from plus trees in the established plantations. New seed stands are required for effective large scale plantation formation.

*Gmelina arborea*
The FORIG and the SIPL have seed orchards of *Gmelina*.

The clonal seed orchard at the SIPL was established with local superior phenotypes. The company has also imported some *Gmelina* seeds from Nigeria.

3.7.2 Seed production by the FORIG

The collections of seeds and the provision of extension services by the FORIG are generally based on requests (pers. comm., A. Gyimah).

The FORIG Tree Improvement and Seed Technology Laboratory are currently ill-equipped and there are no control environments for the proper testing of seeds. The estimated average annual production of seeds from FORIG is teak: 1000 kg, Cedrela: 20 kg and indigenous species: 20-30 kg (pers. comm., A. Gyimah). The existing refrigeration facilities can store about 20 kg. of seeds annually.

3.8 Pests and diseases

The *Miliaceae*
The shoot borer - *Hypsipyla robusta* – was the main constraint to the planting of the mahoganies. Although it is reported that *Lovoa trichilioides* tends to be less susceptible to the borer than the
other *Miliaceae* species it is not resistant. It has been observed that mixed planting of about 10 to 15% with resistant nurse species that has the appropriate crown to give a side shade (not top shade) and which grows at similar rate (e.g. *Nauclea diderrichii* and *Gmelina arborea*) is very essential to minimize the risk of the borer. The shoot borer attack was also found to be less where the mahoganies were in complete mixture than where the mahoganies and the nurse trees were put in separate lines (Hardcastle *et al.* 1998). FORIG is undertaking research into this problem. A combination of resistant clones, species and age mixtures, nutritional studies and shade manipulation is being tested.

*Terminalia ivorensis*

The species has no serious pests and diseases. But there was a widespread die-back throughout Ghana. In Nigeria, the cause of this phenomenon is attributed to inhibition of nitrogen mineralization in the litter layer and to the accumulation of calcium which lead to the tree “poisoning itself in monocultures”. It is however recommended that large scale monocultures of the species should be avoided pending the resolution of the problem through research (Hardcastle 1998).

*Milicia excelsa*

*Milicia* is a very high value timber that has a potential for rapid growth. But the main constraint on its survival is the gall *Phytolama lata* which attacks the leaves of seedlings. In this case also, the FORIG is leading a research into the identification of resistant clones under an ITTO project (PD 3/95).

*Triplochiton scleroxylon*

Leading shoots are likely to be killed by aphids. Almost annually (in August - September), much defoliation by the caterpillar of *Anaphe venata* occurs. Loss in increment due to this is however not apparent. Stumps of *Triplochiton* are liable to severe or fatal termite attack if soil is not moist at the time of planting (Taylor 1962).

*Cedrela odorata*

In its original range, the main problem is the attack of the shoot borer moth - *Hypsilla grandella*. Even though there is *Hypsilla robosta* in Ghana that attacks the *Khaya* species it has not been observed to attack *Cedrela* yet.

*Gmelina arborea*

At the SIPL it has been observed that the *Gmelina* develops heart-rot at the age of 20 years and above resulting also in reduced coppicing ability. A rotation age of less than 20 years is therefore necessary. In a recent inventory of the SIPL plantations, 300 trees were bored with increment borers to assess the extent of the butt-rot. Eighteen (i.e. 6%) of the number bored had rot that extended to 0.5 m from the base of the tree. Of these, 6 were located on ridge tops, 5 on mid-slopes and 7 in valley bottoms. The rot had extended to about 1 meter from the base in only 2 (i.e. 0.6% of the 18 trees found with rot). About 95% of the 18 trees with rot were in the 30 cm to 50 cm diameter class. Their ages were also 20 years or more. They were found mostly on sandy soils in valley bottoms.

It was therefore concluded that the age of the stand (which is related to the size of the tree) in combination with the soil type are the possible causes of heart-rot in the *Gmelina* trees in the
area (Odoom 1998). In order to prevent heart rot in *Gmelina*, it appears that sandy soils must be avoided.

An attack by grasshoppers on *Gmelina* leaves at the SIPL in 1990 was sprayed with Dioxenon chemical and there has been no occurrence since then (SIPL management).

### 3.9 Research

#### 3.9.1 Species trials

The Forestry Research Institute of Ghana (FORIG) has tried over 150 tree species in experimental plots with various experimental designs between 1957 and 1990. Out of these about 30 species (20%) are indigenous. The research plot sizes ranged from about 0.04 ha to about 15 ha in extent (Foli and Ofosu-Asiedu 1997). The plots were located within the various ecological zones in the country. The objectives of the experimental set-ups included:

- Species provenance trials;
- Species growth trials;
- Espacement trials;
- Planting with poly-pot and ball of earth;
- Plantings with striplings and stumps;
- Effect of full, row ploughing and ring weeding during establishment;
- Thinning experiments; and
- Agro-forestry species trials.

Due to budgetary and personnel constraints, the maintenance of the research plots could not be sustained and the data on the experiments are yet to be processed.

#### 3.9.2 Seeds and seedling production

Investigations that have been carried out by the FORIG include seedling production with respect to pot sizes, depth of sowing, watering regimes as well as the use of bare rooted seedlings as opposed to those whose roots are covered with ball of soil.

Research into the vegetative propagation of *Triplochiton scleroxylon*, *Milicia excelsa*, *Khaya* spp., *Ceiba pentandra*, *Terminalia superba*, *Baphia* spp. and *Ficus* spp. is underway. FORIG expects to produce *M. excelsa* seedlings by vegetative propagation techniques for sale by the end of 1998 (pers. comm., Nketia and Ofori).

*T. scleroxylon* has irregular seed years with uncertain quantities of seed. Hence seeds cannot be relied upon for supplying plantation requirements. For example, Wawa has fruited once in the last 6 years (Foli and Ofosu-Asiedu 1977). Rot in *T. scleroxylon* cuttings have been observed at FORIG. This is said to have resulted in a germination rate of about 60%. The problem is being investigated (pers. comm., Nketia and Ofori).
3.9.3 Pests and diseases

There is ongoing research to try and gather genetic material from throughout the range and to identify resistant clones. This is funded under an ITTO project (PD 3/95) co-ordinated by Forest Research Institute of Ghana to which Cameroon contributes.

The SMS is co-operating with the FORIG/ITTO project in the field with regards to the control of the attack of *Phytolyma lata* on *Milicia excelsa*. The monocultures in Phase I had a lot of problems. During Phase II that was initiated in 1997, *Milicia excelsa* from the Ashanti Region, which is susceptible to gall attack, has been mixed with *Piptadeniastrum africanum*, *Khaya ivorensis* and *Antiaris toxicaria* to assess the performance of the species in a different environment. The trials are being undertaken on one of the SMSs lease-back lands.

3.10 Quality and consistency of forest plantation management

Prior to the Fourth Republic, the forestry sector lacked an updated and clearly defined forest policy spelling out goals, objectives and strategies for development of forest resources and the future direction of the timber industry. As a result, administration by the relevant sector institutions was weak and this lead to widespread trade malpractice including failure to pay forest fees, speculative felling, illegal trading in forest products and unauthorized subletting of concessions to illicit timber operators. In force at the time were ridiculously low fines and outdated legal sanctions that served as stimuli, rather than as deterrents, to the rampant commission of forest offences. These deficiencies led to excessive depletion of the most marketable timber species causing severe forest degradation and an escalated rate of deforestation by agricultural encroachment. Also, a lack of local community involvement in forest resource protection and an absence of comprehensive and co-ordinated medium to long-term plans further aggravated the situation.

The key issues that militated against good forest management were therefore inconsistent financing of the forest sector operations, ill-motivated civil service personnel, and weak legislation coupled with lack of co-operation from the law enforcement agencies. There is also lack of unity in the private sector trade associations. Their co-operation with the forest sector agencies in the implementation of sound forest management practices was not as expected.

*The Forest Service Bill* (1998) requires the removal of the FD from the civil service and its transformation into a semi-autonomous Forest Service with a managerial and financial independence. This is meant to overcome the past short-comings of the establishment as well as ensure an effective management of the nations natural forest resources.
4 PROMOTION OF TREE PLANTATIONS

4.1 Technical aspects

4.1.1 Species and growing conditions

Due to the limited experience in the country with respect to commercial plantations establishment, progress can only be made by combining any relevant local lessons learnt with proven technologies in similar areas of the tropical world especially in West and Central Africa. Experiences with such tree crops as rubber in the country (e.g. GREL) give pointers to the feasibility of undertaking such a venture if the proper silviculture and high quality forest management are applied through effective supervision and training. The introduction of the appropriate incentives to motivate potential investors is also required.

The risks associated with any uncertainty can be minimized through species diversification and the use of mixed stands. This will provide options to switch product types in the event of market failure or glut and the susceptibility of the plantations to diseases.

FAO (1998) has undertaken an extensive study of the prospective species for plantation formation in Ghana. This was based on the assessment of the performance of the species in plantations in the country and other tropical regions in conjunction with information on their natural growing conditions. The selected species are as shown in the table below.

**Table 6. Species recommendations for the ecological zones**

<table>
<thead>
<tr>
<th>Ecological zone</th>
<th>Recommended species</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Evergreen (WE) &amp; Moist Evergreen (ME)</td>
<td><em>Triplochiton scleroxylon</em>, <em>Piptadeniastrum africanum</em>, <em>Heritiera utilis</em></td>
<td>Small-scale agro-forestry</td>
</tr>
<tr>
<td>Moist Evergreen (ME)</td>
<td><em>Gmelina arborea</em>, <em>Triplochiton scleroxylon</em>, <em>Piptadeniastrum africanum</em>, <em>Terminalia superba</em></td>
<td>OFR for sawlog</td>
</tr>
<tr>
<td>Moist semi-deciduous (MS)</td>
<td><em>Triplochiton scleroxylon</em>, <em>Terminalia superba</em>, <em>Cedrela odorata</em>, <em>Tectona grandis</em>, <em>Gmelina arborea</em>, <em>Ceiba pentandra</em>, <em>Pinus spp.</em></td>
<td>Areas capable of being restored to forest cover</td>
</tr>
<tr>
<td>Moist semi-deciduous (MS)</td>
<td></td>
<td>Permanently degraded forest areas</td>
</tr>
<tr>
<td>Forest Savanna Transition (FST)</td>
<td><em>Cedrela odorata</em>, <em>Tectona grandis</em>, <em>Terminalia superba</em>, <em>Ceiba pentandra</em>, <em>Pinus spp.</em></td>
<td>Permanently degraded forest areas and non-forest land</td>
</tr>
<tr>
<td>Guinea &amp; Coastal Savanna (GuS &amp; CS)</td>
<td><em>Ceiba pentandra</em></td>
<td></td>
</tr>
</tbody>
</table>

All the recommended species have been tried by FORIG and/or the FD. The species on which little information is available locally is *Piptadeniastrum africanum*. It has, however, a successful history as a plantation species, particularly in Cote d’Ivoire although there is little information about potential yields. The characteristics of the species including their growth requirements are given in Appendix 2 and 3.
Comments on some of the isolated indigenous species by the FORIG based on provisional calculations of growth rates (see Appendix 3) are:

- *Triplochiton scleroxylon* (fast growing, problem is irregular fruiting patterns, supplementation with vegetative propagation of seedlings required);
- *Ceiba pentandra* (fast growing, high survival rates, low incidence of pests);
- *Terminalia superba* (not affected by die-back as *T. ivorensis*, even though Ambrosia beetles pose a threat to its survival); and
- *Heritiera utilis* (fast growing, high survival rates).

The species and their proposed mixtures as recommended by the FD are given in Appendix 4.

### 4.1.2 Growth rates

Of the species that have been planted by the FD, yield tables have been compiled for only teak. This was derived from data from temporary sample plots of stands of ages 10 to 25 years and extrapolated to 50 years. The other yield table that was also derived from temporary sample plots is that for the *Gmelina arborea* on the SIPL plantations in the western region of Ghana. The plots used covered stands with ages up to 27 years.

Both these site index curves are provisional and require to be field tested and upgraded. They are depicted in Figures 3 and 4. Due to the poor management of the plantations, the indicated yields can be considered as conservative estimates. Higher yields are possible with high quality planting stock and proper management.

A recent inventory of the SIPL *Gmelina arborea* plantations (stands up to 27 years) gave the following results (Table 7).

#### Table 7. Summary by stand yield class (m³/ha/year) - SIPL Gmelina arborea plantations

<table>
<thead>
<tr>
<th>Yield class range</th>
<th>Mean yield class</th>
<th>No. of plots</th>
<th>% Cum.</th>
<th>Mean square diam.(cm)</th>
<th>Stocking (stems/ha)</th>
<th>Basal area (m²/ha)</th>
<th>Volume (m³/ha)</th>
<th>MAI (m³/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7</td>
<td>4</td>
<td>36</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>706</td>
<td>3.16</td>
<td>14.9</td>
</tr>
<tr>
<td>8–11</td>
<td>10</td>
<td>60</td>
<td>9</td>
<td>14</td>
<td>14</td>
<td>901</td>
<td>12.93</td>
<td>63.6</td>
</tr>
<tr>
<td>12-15</td>
<td>13</td>
<td>66</td>
<td>10</td>
<td>24</td>
<td>16</td>
<td>851</td>
<td>16.85</td>
<td>84.5</td>
</tr>
<tr>
<td>16-19</td>
<td>18</td>
<td>60</td>
<td>9</td>
<td>33</td>
<td>19</td>
<td>712</td>
<td>18.04</td>
<td>100.5</td>
</tr>
<tr>
<td>20-23</td>
<td>22</td>
<td>128</td>
<td>19</td>
<td>52</td>
<td>22</td>
<td>603</td>
<td>22.14</td>
<td>124.9</td>
</tr>
<tr>
<td>24-27</td>
<td>25</td>
<td>149</td>
<td>22</td>
<td>74</td>
<td>24</td>
<td>546</td>
<td>22.75</td>
<td>126.3</td>
</tr>
<tr>
<td>28-31</td>
<td>29</td>
<td>93</td>
<td>14</td>
<td>88</td>
<td>27</td>
<td>479</td>
<td>25.02</td>
<td>141.8</td>
</tr>
<tr>
<td>&gt;32</td>
<td>34</td>
<td>78</td>
<td>12</td>
<td>100</td>
<td>28</td>
<td>548</td>
<td>33.30</td>
<td>190.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-</strong></td>
<td><strong>670</strong></td>
<td><strong>100</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

Source: Odoom (1998)

No thinnings have been carried out in the SIPL plantations due to lack of market for the smallwood. Maintenance of the stands has also been adversely affected by budgetary constraints.
Figure 3. Site Index curves for teak (*Tectona grandis*)

![Provisional Site Index Curves - Ghana Teak](image)

*Index Age = 20 years*

Figure 4. Site Index curves for Gmelina arborea

![Provisional Yield Class Curves - SIPL Gmelina arborea Plantation](image)

*Index Age = 10 years*
Previous two studies (IFSC 1991, FAO 1982) gave indications that a maximum current annual increment of 20 m³/ha/year for *Gmelina* is achieved between 5 to 8 years whilst the figure for Odoom (1998) was about 22 m³/ha/year which is comparable (see Figure 5). That given by FAO (1998) with regards to “good” site is similar (see Table 8). But the growth trend in the IFSC study had been constrained by a “generalized curve” to give a maximum MAI of 10 m³/ha/year between the ages of 15 to 20 years the maturity of which is unusual for a short-lived species like *Gmelina*.

Virtually all the *Gmelina* stands with yield classes of about 26 m³/ha/year and more are below 10 years old. The older stands are below yield class 26 with a majority below yield class 22. The younger stands had been established with seeds from the company’s seed orchards. This finding point to the fact that even with moderate seed and silvicultural improvements a significant increase in productivity of the stands is achievable.

Provisional calculation of growth rates from selected plantations in the country is shown in Appendix 3. FAO (1998) gives the MAI for the recommended species as in Table 8.

The MAI for teak in Table 8 was based on regression for calculating potential growth using only meteorological data (Pandey 1996). The results were adjusted using experiences from its application in Nigeria and Cote d’Ivoire.

According to Hardcastle (1998), moisture availability is a major determinant of tree growth in the tropics provided that the soil structure and fertility are reasonable. He expects a closer
correlation between soil moisture and predicted yield than indicated by FAO (1998). Using the same climatic data, Hardcastle determines site suitability for teak based on the calculation of soil moisture stress. The results are as in Table 9. It shows the unsuitability of the Axim area for teak.

Table 8. Estimated Mean Annual Increment (MAI) for selected species

<table>
<thead>
<tr>
<th>Species</th>
<th>Good site</th>
<th>Poor site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zone</td>
<td>MAI (m³/ha/yr)</td>
</tr>
<tr>
<td><em>Heritiera utilis</em></td>
<td>WE</td>
<td>10</td>
</tr>
<tr>
<td><em>Triplochiton scleroxylon</em></td>
<td>ME</td>
<td>20</td>
</tr>
<tr>
<td><em>Terminalis superba</em></td>
<td>MS</td>
<td>18</td>
</tr>
<tr>
<td><em>Gmelina arborea</em></td>
<td>ME</td>
<td>20</td>
</tr>
<tr>
<td><em>Tectona grandis</em></td>
<td>MS</td>
<td>12</td>
</tr>
<tr>
<td><em>Cedrela odorata</em></td>
<td>MS</td>
<td>18</td>
</tr>
<tr>
<td><em>Ceiba pentandra</em></td>
<td>MS</td>
<td>18</td>
</tr>
<tr>
<td><em>Pinus spp.</em></td>
<td>MS</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 9. Estimation of growth potential using soil moisture stress

<table>
<thead>
<tr>
<th>Station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Altitude (m)</th>
<th>MAT °C</th>
<th>Rainfall (mm)</th>
<th>Stress 100mm</th>
<th>Stress 200mm</th>
<th>Potential yield¹</th>
<th>Vegetation zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axim</td>
<td>4° 52'</td>
<td>2° 14' W</td>
<td>38</td>
<td>26.3</td>
<td>2246</td>
<td>40</td>
<td>0</td>
<td>9.5 ²</td>
<td>WE</td>
</tr>
<tr>
<td>Sefwi Bekwai</td>
<td>6° 12'</td>
<td>1° 20' W</td>
<td>172</td>
<td>26.6</td>
<td>1717</td>
<td>139</td>
<td>39</td>
<td>9.3 ³</td>
<td>ME</td>
</tr>
<tr>
<td>Kumasi</td>
<td>6° 43'</td>
<td>1° 36' W</td>
<td>287</td>
<td>25.5</td>
<td>1556</td>
<td>137</td>
<td>37</td>
<td>8.4</td>
<td>MS</td>
</tr>
<tr>
<td>Ho</td>
<td>6° 36'</td>
<td>0° 28' E</td>
<td>158</td>
<td>26.6</td>
<td>1418</td>
<td>165</td>
<td>65</td>
<td>8.7</td>
<td>FST (E)</td>
</tr>
<tr>
<td>Wenchci</td>
<td>7° 45'</td>
<td>2° 06' W</td>
<td>339</td>
<td>27.2</td>
<td>1181</td>
<td>720</td>
<td>620</td>
<td>8.9</td>
<td>FST (NW)</td>
</tr>
<tr>
<td>Bole</td>
<td>9° 02'</td>
<td>2° 29' W</td>
<td>301</td>
<td>26.1</td>
<td>1087</td>
<td>541</td>
<td>441</td>
<td>8.1</td>
<td>S (SW)</td>
</tr>
<tr>
<td>Navrongo</td>
<td>10° 54'</td>
<td>1° 06' W</td>
<td>201</td>
<td>28.2</td>
<td>1057</td>
<td>903</td>
<td>803</td>
<td>4.8</td>
<td>S (N)</td>
</tr>
</tbody>
</table>

Source: Hardcastle (1998)

MAT – Mean Annual Temperature
1 – Yield as calculated using the FAO (1998) method
2 – soil definitely unsuitable for teak
3 – soil probably unsuitable for teak

4.2 Economic aspects

4.2.1 Markets and prices

Although the management of the forest has hitherto been undertaken by the Government, logging and timber processing is dominated by the private sector. Lumber and veneer are the main products. Kumasi is the centre of the logging and wood processing industry. Wood product exports are carried out mainly through the Takoradi Harbour.
The contribution of the wood industry to the economy of Ghana is very important. FAO (1997) records that forestry accounts for 9% of the nation’s trade and 11% of its GDP. Internal records show the wood processing industry as contributing 8.4% to the GDP and being responsible for 18% of total export income in 1994. In 1996 it contributed 7.5% to GDP.

Whereas teak is a timber which is well recognized for its desirable properties, the marketability of Cedrela has a relatively narrow range of uses. However, prices close to that of mahogany have been achieved locally for Cedrela recently. There is no market basis in Ghana for imputing a value to Gmelina logs. Gmelina from Ghana has been test marketed in shortwood lengths, to Zimbabwe. Gmelina is used successfully as a lightweight furniture timber in Malawi and Sierra Leone. The wood properties of Gmelina are considered more superior over those of Triplochiton scleroxylon. Despite its importance in log production terms, very little Ceiba has been exported.

There is a perception that domestic prices will rise, partly as a consequence of increased demand and also as a result of further processing of mill fall downs by the mills. The illegal logging trade coupled with illegal chainsaw operations are however helping to keep prices artificially low.

The demand and marketing aspects of the main wood products are discussed below.

**Logs**

The local log prices are artificially depressed. This is due to the recent suspension of log exports in 1995 and the inability of the loggers and the millers to agree on equitable local prices for logs. Illegal trade in timber also contributes towards the distortion of the domestic wood market.

Most of the mills do not own forest concessions. It is estimated that millers hold about 35% of the land area under concession. Those millers that do hold concessions generally exploit them based on requests for particular species from the market (mainly the export market). The latter group prefers to buy logs delivered to the mill. In such cases, the loggers are usually assisted with logging equipment.

**Lumber**

It is estimated that the total lumber requirement for domestic consumption is about 456,000 m$^3$/year (TEDB 1995). On the basis of a conversion rate of 40%, this amounts to 1.14 million m$^3$ of round logs. There is no doubt that continued economic growth in Ghana will stimulate increased demand for wood products. There is also a thriving local timber market.

The volume of lumber retailed locally was about 385,000 m$^3$ in 1995. “Chainsaw lumber” constituted 73% (i.e. 282,000 m$^3$) of this volume while the remaining 27% was supplied by the sawmills and bushmills. There is thus a lumber supply gap of about 70,000 m$^3$ or more. 85% of the lumber retailed in 1995 in the Ashanti Region was from “chainsaw lumber” even though the region has the highest number of sawmills and bushmills in the country (TEDB 1995).

The extensive reliance on the “chainsaw lumber” is due to the fact that they are more readily available and much cheaper than can be obtained from the local sawmills. The chainsaw operators have a lower production cost and usually evade the payment of taxes and forest fees. The foregoing has led to suggestions for the control of illegal chainsaw operations and
government intervention to induce sawmills to supply the domestic market. The alternative would be to put illegal trade into effective check to cause an increase in the real domestic price so as to induce consumption of alternative materials and also increase the millers’ interest in the domestic market.

According to a TEDB market survey in 1995, there are differences in prices between sawmill lumber (usually the non-export quality ones) and chainsaw lumber in all the local retail outlets. Chainsaw lumber was on the average 30% cheaper than those from the sawmills. However in Accra, the sawmill price for Obeche was more than double (132%) the price of chainsaw lumber.

**Poles**

Thinnings from the FD teak plantations have been the main source raw material for the wood pole treatment industry in Ghana. The current demand, however, exceeds the supply and some of the pole treatment plants in the country have been importing softwood poles to supplement the local supplies. It is estimated that about 100,000 wood poles per year would be required for the national electrification programme for the next 30 years (pers. comm. at the ECG/VRA/Ministry of Mines and Energy). Assuming an average pole volume of 0.3 m\(^3\), this amounts to some 30,000 m\(^3\) per year.

The export of poles was, in principle, banned from November 1995. Owing to the current practice by the Forestry Department of selling poles from their plantations at subsidized prices, there is no reliable market price information for poles. Discussions with growers indicate that the current price of transmission poles (8 -10 m) is around 100,000 Cedis. The Dupaul Wood Treatment (DWT), Takoradi, was allowed to re-export poles originating from Benin and Cote d’Ivoire during 1996. These were the poles whose sizes were below that required for the national electrification programme. The re-export of poles whose sizes are in demand locally is not permitted (DWT management).

**Fuelwood**

In Ghana, it is estimated that about 80% of the population – mainly in the rural areas – depend on fuelwood for cooking. Its source is mainly from natural forests. A significant quantity is in the form of slabs from the sawmills. The fuelwood consumption is about 1.1 m\(^3\)/year (roundwood equivalent) per capita and the estimate for 1997 is put at about 16.4 million m\(^3\) (AGI 1997). There is also a significant internal trade in forest products including substantial amounts of fuelwood and charcoal.

As the “slash and burn” agriculture recedes, the availability of fuelwood from the off-reserve areas will decrease. Hence it would be necessary to consider fuelwood plantations as part of the general national plantation programme.

### 4.2.2 Industrial capacity

Ghana's forest industries are categorized into three parts based on the type of operation. These are the primary (logging), secondary (sawmilling/plymilling/veneering) and tertiary (furniture, furniture parts, mouldings, floorings, toys, etc.). The state and structure of the industry is as follows:
<table>
<thead>
<tr>
<th>Activity area</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logging</td>
<td>250</td>
</tr>
<tr>
<td>Sawmilling</td>
<td>110</td>
</tr>
<tr>
<td>Plymilling</td>
<td>9</td>
</tr>
<tr>
<td>Veneer milling</td>
<td>15</td>
</tr>
<tr>
<td>Chipboard</td>
<td>2</td>
</tr>
<tr>
<td>Furniture (medium/large)</td>
<td>40</td>
</tr>
<tr>
<td>Flooring</td>
<td>4</td>
</tr>
<tr>
<td>Doors</td>
<td>6</td>
</tr>
<tr>
<td>Profile Boards</td>
<td>5</td>
</tr>
<tr>
<td>Toys</td>
<td>2</td>
</tr>
</tbody>
</table>

Companies may be involved in one or more areas of activity. There are other several small wood industries serving mostly the local market.

The industry capacity estimates of the wood processing sectors in 1995 (TEDB) was:

<table>
<thead>
<tr>
<th>Industry</th>
<th>Capacity (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawmills and bushmills</td>
<td>1,300,000</td>
</tr>
<tr>
<td>Veneer and plywood</td>
<td>390,000</td>
</tr>
<tr>
<td>Chainsaw Operators</td>
<td>740,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,430,000</strong></td>
</tr>
</tbody>
</table>

Since 1995 the milling industry has continued to expand its capacity. The potential saw milling capacity was estimated to be in the order of 3.7 million m³/year (Smith 1997). This figure includes neither the requirement of the veneer and plywood industry nor the unquantified informal sector. Assuming that the consumption of the veneer and plymills remain the same as in 1995, the industry consumption can be put at about 4 million m³/year. The wood industry requirement therefore far exceeds the prescribed annual allowable cut of 1 million m³.

Most of the sawmills in Ghana are not equipped to process small diameter plantation logs. Even the large diameter logs are not being processed efficiently in most of the cases. There are some mobile sawmills in the system. Sawmills like Prima Woods, Kumasi, have also modified saws for the breakdown of teak sawlogs. The industry in general, however, will require re-tooling and skill upgrading to be able to process the plantation logs.

### 4.2.3 Plantation area required

The gap in the supply and demand of can be bridged by a combination of the following measures:

- Efficient control of exploitation, utilization and protection of the remnant forest resources;
- Importation of logs from some of the neighbouring countries such as Gabon and Cameroon, and
- The establishment of plantations.
The estimated total local demand for wood products can be summarized below (Table 10). It has been assumed that all wood requirements would be met from future plantations whose average mean annual increment is about 10 m³/ha/year.

**Table 10. Theoretical plantation area calculations**

<table>
<thead>
<tr>
<th>End-Use</th>
<th>Estimated annual requirement (m³ round)</th>
<th>Supply from existing forests (m³ round)</th>
<th>Balance (m³ round)</th>
<th>Plantation area required (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry¹</td>
<td>4,000,000</td>
<td>750,000⁵</td>
<td>3,250,000</td>
<td>325,000</td>
</tr>
<tr>
<td>Fuelwood³</td>
<td>16,400,000</td>
<td>8,000,000</td>
<td>8,400,000</td>
<td>840,000</td>
</tr>
<tr>
<td>Poles³</td>
<td>30,000</td>
<td>15,000</td>
<td>15,000</td>
<td>1,500</td>
</tr>
<tr>
<td>Local lumber²</td>
<td>1,140,000</td>
<td>250,000⁴</td>
<td>890,000</td>
<td>89,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21,570,000</td>
<td>9,015,000</td>
<td>12,555,000</td>
<td>1,255,500</td>
</tr>
</tbody>
</table>

¹ Sawmill, bushmill, veneer and plymill. Exclude chainsaw  
³ 50% assumed from the forests  
² Include chainsaw  
⁴ 25% of AAC of 1,000,000 m³/yr.  
⁵ 75% of AAC of 1,000,000

Assuming that the existing natural forest resources and plantations can be effectively managed to supply the volume as in Table 10, about 415,500 ha of additional plantation area would be required to meet the estimated raw material requirement for the industry, local lumber as well as for poles.

It appears from the above table that the future fuelwood requirement is very important and needs to be tackled through all the necessary means. The exploitation of the natural forest for charcoal in particular is very intensive in the Transition and the Savanna vegetation zones. Hence the involvement of the producers in the regeneration of the forests involved is essential.

### 4.2.4 Economic and financial analysis

Both FAO (1998) and the NRMP preparation activities (World Bank 1998) have undertaken substantial economic and financial analysis on plantation formation in Ghana. FAO has undertaken extensive calculations on financial returns for a range of models.

The input requirements of machine time, wage labour and materials, and charge rates were derived from:

- Direct interviews with local tree farmers;
- Publications by the Forestry Department Planning Branch (FD 1993);
- Previous plantation project proposals (ODA/EC 1993);
- Data provided by the FORIG; and
- Estimates compiled under FAO project No. TCP/GHA/6714.

The result from the above was used to derive a harmonized cost structure for the silvicultural treatments. It was adjusted based on experiences elsewhere and applied to all species in all sites. Models were constructed for four indigenous and four exotic species. Each species model was applied to two sites. They are “Good” and “Poor” sites corresponding to the species optimum
and minimum acceptable performances. Different cost models were applied to each species model for Large (>100 ha), Medium(10-40 ha) and Small (<10 ha) growers (Table 11). No overhead and land rental costs were included in the model.

### Table 11. Estimated plantation establishment costs

<table>
<thead>
<tr>
<th>Silvicultural treatment</th>
<th>Annual costs (US$/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Site clearance</td>
<td>239</td>
</tr>
<tr>
<td>Site preparation</td>
<td>133</td>
</tr>
<tr>
<td>Planting &amp; replanting</td>
<td>274</td>
</tr>
<tr>
<td>Weeding</td>
<td>120</td>
</tr>
<tr>
<td>Pruning</td>
<td>51</td>
</tr>
<tr>
<td>Intensive Protection</td>
<td>70</td>
</tr>
<tr>
<td>Protective Maintenance</td>
<td>22</td>
</tr>
</tbody>
</table>

The assumptions used in all the models include:

- Production objective: small diameter sawlogs, minimum small end diameter under bark of 30 cm;
- Site preparation involves degraded forest and secondary bush re-growth;
- 3 x 3 m spacing (1,111 trees/ha) with fertilization of 20 kg/ha for large and medium scale growers;
- Weeding: 3 times a year for a number of years; Taungya used by small scale growers;
- One pruning after thinning;
- 3 thinnings: timing and intensity based on the expected final d.b.h. and rotation age;
- Rotation age: Good Site (20 - 50 years), Poor Site (35 - 50 years);
- Target final crop diameter: Good Site (40 - 70 cm), Poor Site (35 – 50 cm); and
- Sawlog production assumed to be the principal product: Good Site (210 - 295 m³/ha), Poor Site (100 - 230 m³/ha). In the case of Teak supplementary products were considered in the order of increasing size and age of the crop (i.e. building poles, telephone poles and transmission poles).

### Prices

The calculation of ex-forest prices for sawlogs was based on the average price for air-dried lumber. Data from the FPIB Export Permit Report (1997) was used. This was adjusted to obtain an average imputed log price. The latter was subsequently modified with the species price differentials. There is a clear distinction in prices between low density timbers (*P. africanum, C. pentandra, T. Scleroxylon and T. Superba*, in particular), which are priced 20-40% below the market average, and the medium density timbers (*K. ivorensis, H. utilis* and *M. exelca*), which are 10 - 40% above. A conservative estimate for *Gmelina* log price will be on par with the known low density timbers at 60% of market average. *Cedrela*, an exotic, fits well into the second category; and Teak ranks far higher (80% above average) in a category of its own (FAO 1998). The assumptions were:

- Mill recovery 35%
- Transport and processing 30%
- “Fire insurance”: fire tender species 10%
The sawlog and teak pole prices used in the model are shown in Table 12.

**Table 12. Estimated end product prices**

<table>
<thead>
<tr>
<th>Species</th>
<th>Sawlogs Price (US$/m³)</th>
<th>Type</th>
<th>Teak poles Price (US$/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tectona grandis</em></td>
<td>170</td>
<td>Building Poles</td>
<td>10</td>
</tr>
<tr>
<td><em>Terminalia ivorensis</em></td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Gmelina arborea</em></td>
<td>60</td>
<td>Telephone Poles</td>
<td>25</td>
</tr>
<tr>
<td><em>Ceiba pentandra</em></td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Heritiera utilis</em></td>
<td>110</td>
<td>Transmission Poles</td>
<td>40</td>
</tr>
<tr>
<td><em>Cedrela odorata</em></td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus spp.</em></td>
<td>70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The comparative Benefit Cost Ratios (BCR) of the models using a test discount rate of 10% are shown in Table 13. Those conditions indicating acceptable economic outcome are shown as bold numbers.

**Table 13. Summary of Benefit to Cost Ratio at 10% discount rate**

<table>
<thead>
<tr>
<th>Species</th>
<th>Good site</th>
<th>Poor site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Zone</td>
<td>Large</td>
</tr>
<tr>
<td>Niangon</td>
<td>WE</td>
<td>0.3</td>
</tr>
<tr>
<td>Wawa</td>
<td>ME</td>
<td>1.3</td>
</tr>
<tr>
<td>Ofram</td>
<td>MS</td>
<td>1.2</td>
</tr>
<tr>
<td>Gmelina</td>
<td>ME</td>
<td>1.3</td>
</tr>
<tr>
<td>Teak</td>
<td>MS</td>
<td>2.4</td>
</tr>
<tr>
<td>Cedrela</td>
<td>MS</td>
<td>1.7</td>
</tr>
<tr>
<td>Ceiba</td>
<td>MS</td>
<td>1.4</td>
</tr>
<tr>
<td>Pine spp.</td>
<td>MS</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Source: FAO (1998)

The above results indicate that the choice of site and possibly the use of improved genetic materials are very important. The most promising indigenous and exotic species are Ceiba/Wawa and Teak/Cedrela respectively. Teak comes out as the best due to the high value of sawlogs and the marketability of the intermediate produce.

As a comparison, Hardcastle (1998) states that there are extensive and successful plantation projects elsewhere in Africa and Latin America that produce satisfactory returns on investment with *Pinus caribaea* for instance with an MAI of 22 m³/ha/year and a net sawlog price of about US$44/m³. This is an indication that the rate of returns for pines could be better than the FAO calculations.

All species perform well on “Good Site” except Niangon which is a long rotation species. There is a niche market for Niangon. A special support may be required for Niangon and other similar niche species to encourage their planting. Only small scale Teak, Cedrela and Ceiba appear to yield satisfactory returns on “Poor Sites”. Generally, economic performances as shown in Table 6.8 tend to be the highest in all cases for the small-scale planters whose establishment costs are
lower due to inter-cropping with annual crops to provide favourable cash-flows during the early years of the plantation.

Based on the cost estimates above, financial rates of return for Teak and Wawa for management models are as in Table 14.

**Table 14. Estimated financial rates of returns**

<table>
<thead>
<tr>
<th>Species</th>
<th>Management model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
</tr>
<tr>
<td>Teak</td>
<td>15.0</td>
</tr>
<tr>
<td>Wawa</td>
<td>10.1</td>
</tr>
</tbody>
</table>

Source: FAO (1998)

FORIG has undertaken simple calculations for the establishment of a one hectare teak plantation. The calculation is based on data from a plantation which was established via Taungya in 1913 in the Pra Anum Forest Reserve as part of the institution’s research trials (Ohene-Coffie 1997). The extent of the plantation was not given. It is possible that it was less than 15 ha which was the maximum of the FORIG research plots (Foli and Ofosu-Asiedu 1997). The plantation could qualify for a small-scale or medium scale grower in accordance with the categorization by FAO above. The following silvicultural system was employed with no application of fertilizer:

- Manual site preparation;
- Planting distances: 3 x 3 m (1,100 stems/ha);
- Weeding at various intensities up to year 5;
- Pruning to 2 m height after canopy closure;
- One thinning at 10 years (intensity not indicated, but could be 100 stems/ha); and
- Final crop of 1,000 stems/ha at year 25.

The final stem size was not indicated. But at the stated stumpage of US$11 for the standing tree at year 25, it appears that transmission poles were produced. The MAI used or achieved was not given. The direct cost of establishment was US$478/ha. The latter compares with the FAO figure for small scale of US$450/ha. But the seedling cost (US$0.04/unit) and the price of the produce at rotation were not practical. The price may have been influenced by the effect of low pricing of poles on the local market by the Forestry Department. Although Taungya was used, there was no account for the intermediate yields except thinnings (this is also the case with the FAO calculations for the small scale grower). The conclusion was that teak plantation was only viable at discount rates of 20% or less. The BCR at the latter rate was calculated as 1.93. Due to the limitations in the calculations as indicated, the results may be considered as indicative.

Due to the paucity of objective and reliable cost data on forest plantation formation in Ghana, it may be deduced that the above FAO (1998) financial calculations may be the only comprehensive one that so far has been compiled. The main weaknesses of the data may be the prices for the end products (i.e. sawlogs and poles) as well as the growth rates used. These were based on deductions from average prices and untested global regression for growth rates respectively for want of realistic data pertaining to the local conditions.
The main determinants of return are yield and price assumptions. It is therefore important that information deficiencies in these areas are improved to facilitate the calculations of real returns to encourage private participation in tree growing. The required data include real growth rates achievable by potential species on the various sites, the costs involved in plantation formation, and the calculation expected returns on investment.

### 4.3 Institutional aspects

#### 4.3.1 Legal and policy issues

The chronology of Ghana’s forest laws is given in Appendix 5. The relevant ones pertaining to forest plantation formation is discussed below.

In 1994, a new **Forest and Wildlife Policy** was adopted with the aim of “conservation and sustainable development of forest and wildlife resources for maintenance of environmental quality and the perpetual flow of optimum benefits to all segments of the society”. The main objective of the policy is the involvement of all stakeholders for efficient management of the forest resources.

The response of the Forestry Department is the creation of the Collaborative Forest Management Unit (CFMU) within their Planning Branch to “explore and develop the potential for local people’s involvement in each and every aspect of integrated high forest management including timber production, environmental protection and bio-diversity conservation”. The strategies being developed include involvement of the locals in the planning and management of the forests as well as the provision of a fair share of the revenue from sustainable forest management to landowners and access to NTFP’s for domestic use on a sustainable basis.

The section 5.3.8 of the policy indicates the “promotion of resource development programmes aimed at reforesting suitable harvested sites, rehabilitating degraded mining areas, afforesting denuded lands, regenerating desired wildlife species and habitats and sustainably developing wildlife potential”. The “introduction of environmental impact assessment as a pre-requisite for resource development and utilization projects, in compliance with approved standards” is also stated in section 5.3.12.

Hitherto, landowners did not consider that forest reservation was a paying concern and hence did not invest resources in forest protection and management. The royalties from the exploitation of the forests were also poorly collected and even more poorly distributed. The communities and landowners in particular have been against the inequitable distribution of the revenues that accrue from the forests on their land (Table 15) as prescribed by the Constitution (section 267(6)). The result has been the mining of the forest resource as the responsible government agency (i.e. the FD) has not been adequately equipped and motivated to execute its mandate.
Table 15. Distribution of royalties with respect to exploitation from the natural forest

<table>
<thead>
<tr>
<th>Recipient</th>
<th>On-Reserve (%)</th>
<th>Off-Reserve (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State (i.e. Forestry Department)</td>
<td>70</td>
<td>-</td>
</tr>
<tr>
<td>Administrator of Stool Lands</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>District Assembly</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>Traditional Authority</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Landholding Stool</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The royalty policy in Ghana has over the years been shaped by the timber lobby, which has managed to keep royalty levels particularly low, by skilful and expedient politicking. Forest policy change has ever hardly been the result of “rational” analysis. It is almost always the result of compromises and trade-offs among and between various and diverse interests and players (Nii Ashie Kotey et al. 1998).

The Forest Development Master Plan (FDMP 1996 - 2020) has been prepared by the Ministry of Lands and Forestry as a master plan for ensuring sustainable harvesting of timber and also to increase the awareness and encourage the involvement of individuals and communities in the protection and management of forest resources. The objectives of the plan include the mobilization of a wide range of Ghanaians, mainly from the private sector, to undertake tree growing ventures within each district of the country. Accordingly, a series of incentive packages will be designed to ensure widespread appeal and positive response across the nation.

The FDMP forms the basis for the implementation of the Forest and Wildlife Policy (1994). It is composed of three phases. The scope of Phase I (1996 - 2000) includes:

- Consolidation of forest management systems to ensure that timber can be certified as “sourced from sustainably managed forests” by the year 2000 (Ghana is committed to ITTO Year 2000 Objective);
- Development and launching of flexible schemes for investment in commercial forest plantations, tree farming and propagation of non-timber products and wildlife; and
- Creation of an enabling climate for rationalization of the timber industry and consolidation of fiscal measures for efficient utilization and increased value added processing.

Under the plan, the expected outputs include the increase of the forest and tree cover of Ghana by 10%. A nation-wide planting target of 200,000 ha has consequently been proposed for establishment by annual plantings of 7,000 to 10,000 ha over the next 20 years on unproductive forest lands. The focus will be the enrichment and restocking of degraded forest areas and concessions, establishment of plantations on suitable conversion areas and support to community forestry and agro-forestry needs. In this respect, the forest industry would also be encouraged to modernize and also to re-tool to be able to process small logs and plantation products in the future.

The Timber Resources Management Act, 1998 (Act 547) also prescribes the identification and management of forest concessions – both within and outside the forest reserves – by the Chief Conservator of Forests (CCF) with the involvement of the stakeholders (i.e. landowners, local communities, District Assemblies and farmers).
Act 547 does not allow private holding of Timber Utilization Contracts (TUCs) even though in principle there is an option for the owner or owners of forest(s) to manage them under the direction of the Forestry Department in accordance with section 18(2) of the Forest Ordinance. For example, the section 4(2) of Act 547 states that “No timber rights shall be granted in respect of land with forest plantations…… without the authorisation in writing of the individual, group or owner concerned”. In other words, one may permit some other person to operate ones plantation as a TUC. But it is not clear whether a plantation owner can manage his/her stand unilaterally without control.

The Act does not also explicitly exempt planted timber from the requirement of a TUC for timber harvesting. Act 547 prescribes the establishment of forest plantations by concessionaires on a basis of 10 ha/km² of the TUC area in question (MLF). The modalities for the implementation of the latter are yet to be clearly defined in the related Timber Regulation – LI 1649 which is expected to receive cabinet approval in the near future. Under the LI 1649, forest exploitation both on-reserve and off-reserve is being brought under control. New stumpage rates have also been introduced.

The Natural Resources Management Programme (NRMP) has been developed as a country-led initiative to implement the FDMP. Under the High Forest Resource management sub-component of the NRMP, the Government plans to establish a Forest Plantations Development Centre (FPDC) to promote and encourage private forest plantation development. The project is meant to support all those who are planting or wish to plant timber trees commercially within the HFZ.

Institutions and facilities necessary to encourage private investment in plantation forestry would be developed. A Forest Plantations Development Fund (FPDF), for instance, would be set up using as its core asset the proceeds of the export levy on air-dried lumber of some nine endangered timber species. A practical and feasible incentive scheme for investors in plantation forestry is yet to be worked out.

The sub-component is composed of three elements as follows:
- Project Management (funded by the IDA);
- Credit to Tree Growers (to be funded by the African Development Bank), and
- Technical Assistance (to be funded by the EU).

Under the erstwhile Trees and Timber Decree, 1974 (NRCD 273), anyone who fells a growing tree either on or off the reserved forests for export in log form or for conversion in a mill to obtain the permission of the Chief Conservator of Forests. The implication is that one could in principle fell trees on his farm and say set fire to it legally as no trading is involved.

The Administration of Stool lands Act, 1962 (Act 123) states that timber rights may not exceed 30 years in duration and about 100 km² in size (Sect. 12). The Schedule 1 of the Timber Resources Management Regulations, 1998 (LI 1649) stipulates that TUC areas are not to exceed 125 km² for both reserve and off reserve areas. It would be a disincentive if the lease periods for land for forest plantations are made to conform to the prescriptions of Act 123.
Large-scale forestry plantations can have considerable environment impacts and an Environmental Impact Assessment (EIA) is mandatory for these projects according to Ghana’s environmental regulations (e.g. section 5.3.12 of the Forest and Wildlife policy, 1994). The Ghana Environmental Protection Agency (EPA) guidelines request an EIA for all plantations exceeding 40 hectares. Transformation of primary or secondary forest into forestry plantations would put a project in Environmental Assessment Category I and would require a full EIA.

The Income Tax Decree, 1975 (SMCD) as amended establishes a 35% corporate tax on limited liability companies. This is reduced to 8% for companies that process and export timber. Section 3 of the Decree envisages a tax exemption for income derived from tree crops such as coffee, oil palm, shea butter, rubber, coconut during the 10 years following the date of the “first harvest”. This could be made applicable to forest plantations if a proper definition can be given to the “first harvest” in the context of forestry. This first harvest could possibly be the first commercial thinning.

The Ghana Investment Promotion Centre (GIPC) Act, 1994 (Act 478), establishes the centre as a body corporate with a number of functions relating to the promotion of investments. Registration with the GIPC is required for 100% foreign owned and Joint Venture Partnerships with Ghanaians. It does not apply to wholly Ghanaian businesses. A 100% foreign owned company requires a minimum equity of US$50,000 either in cash through the banks or as capital goods. In the case of a joint venture partnership, US$10,000 minimum equity in cash or capital goods is required. If capital goods are used, they must be registered on Form 6 at the Register General’s office in Accra as equity.

After the necessary formalities relating to the registration or incorporation under the applicable Ghanaian laws have been completed, a GIPC certificate of registration is issued within 5 days and the foreign partner(s) issued with Resident Permit(s).

4.3.2 Restructuring of the Forestry Department and the District Assemblies

The FD will also be transformed into an affective, responsive, decentralised and semi-autonomous Forest Service. This is to facilitate a much more effective management, utilisation and felling controls for the forest reserve and off-forest reserve areas in conformity with sustainable forest development principles. The involvement of the proposed Forest Service in plantation development would be limited to the management of the existing ones and the provision of extension and training services on contract to prospective clients (MLF 1998).

As part of the Government’s Decentralisation Programme, District Assemblies (DAs) have been established in 110 Districts in the country in accordance with the Local Government Act, 1993 (Act 462). Section 10 (5) of the Act makes the DAs responsible for the co-ordination, integration and the harmonization of the execution of the Government, public and NGO programmes in the respective districts. Section 38 of the Act further establishes a Natural Resources Conservation Department (NRCD) with a Forestry and Game and Wildlife Division. The Forestry Department does not have the capacity to support all 110 DAs. Hence support will be required for capacity building in some of the districts with respect to the management of forests and Wildlife.
Conclusions
The ownership of planted trees is not clearly defined. No particular exemption is made for planted timber from legal requirements applicable to natural timber.

TUC holders are expected to plant. The location of the areas to be planted is currently uncertain and the modalities for the implementation of the concept have not been spelt out explicitly. It would be more appropriate for qualified plantation experts to be contracted out to do the planting on behalf of the TUC holders to ensure the success of the programme. Lessons from other areas where such a scheme has been tried (e.g. Nigeria) indicate that the concessionaires cannot be relied upon to execute such an assignment and the control of the operations involved also tends to be cumbersome (Hardcastle et al. 1998).

For the immediate future, the process through which stakeholder participation is fostered will require more policy attention. The relevant laws that have been promulgated are relatively new but are in the right direction. They would, however, require intensive investment of resources in education and awareness creation so as to change attitudes positively towards tree planting.

It would also be essential that it is made explicit that any plantation in one block does not exceed the above area limitation. It is possible that an owner of plantations could acquire scattered pieces of land whose cumulative area may exceed the limit given in LI 1649 and this may become a potential disincentive for potential investors in large scale plantations.

The requirement for individual EIAs for each and every plantation development will be a disincentive. In this respect, it would be necessary for the EPA and the MLF to formulate environmental guidelines – instead of the EIA – for application to forest plantations.

The investment and the tax laws could have been used to control the expansion in the wood industry which has resulted in the over-capacity in the sector to favour the efficient ones. The incentives offered to the other tree crops could also be applied together with other necessary incentives to encourage investment in forest plantations.

4.4  Land and tree tenure

In discussing the above, the main objective is to evaluate the conditions that may encourage the rural farmers or communities to contribute towards increased supply of hardwood to the industry in the future. This can be achieved through the tending and protection of natural regeneration as well as the planting of trees on or near farms in conformity with the Forestry and Wildlife policy (1994) and the Forest Development master Plan (1996).

4.4.1 Land tenure

In general, there are five main categories of land in Ghana.
**State land**

This is land that has been compulsorily acquired by the Government in the public interest or for public purpose under section 1 of the State Lands Act, 1962, (Act 125) as amended by **State Lands (Amendment) Decree, 1968** (NLCD 234). Revenue accruing from these lands is paid into the Consolidated Fund.

**Vested land**

This is stool land that has been vested in the state as trustee for the appropriate stool under section 7 of the **Administration of Lands Act, 1962** (Act 123). Revenues from these lands are paid into the Stool Lands Account for the appropriate stool.

**Stool land**

This is land that is vested in the appropriate stool on behalf of the community or “oman” represented by a Chief. The land, however, is vested in the relevant Communal Chief, District Chiefs, Sub-Chiefs, or the head of the clan/tribe or family concerned in a fiduciary capacity for his people. A prospective investor may therefore be confronted with a multiplicity of interests or rights.

Members of a landholding group have usufruct rights which is equivalent to freehold. They may permanently appropriate a portion of the land by “permanent” developments like cocoa, palm or coffee farms or a house. Such land for most practical purposes belongs to the member and his interests are secure, inheritable and generally alienable.

Any disposition of such land by the stool or head or family requires the consent of the holder of this interest. Article 267(3) of the Constitution however requires certification by the Regional Lands Commission that any disposition or development of stool lands is consistent the development plan drawn up or approved by the planning authority for the area concerned. The same authorities must also consult with the traditional authorities in all matters relating to the administration and development of stool land (Article 267 (7)). Even though the land is vested in the stool, collection of revenue and its disbursement are the responsibility of the Administrator of stool lands.

**Family land**

This is land that is vested in a family represented by a Head of family. The Administrator of stool lands has no mandate to manage revenues accruing from these lands.

**Privately owned land**

This is land, the freehold interest of which has been purchased outright by an individual or a group of persons. In a majority of cases, this type of land ultimately turns out to be family land upon the death intestate of the individual owner.

**4.4.2 Tree tenure**

Traditionally land is deemed to include things on and under the soil. It does not necessarily include things attached to it such as houses and trees. Examples are the right to hunt, collect snails, harvest and collect fruit and herbs. The right to economic trees is vested in the owner of
the paramount interest to the land on which they grow even when the land has been given out or sold. But individual farmers with freehold rights may be allowed to maintain and harvest trees (both natural and planted). Individuals cannot harvest economic trees on unallocated communal land even if they have been planted by them.

In general, the situation with respect to a tenant farmer is different as compared to the subjects of the area. The tenant farmer who has acquired land for agricultural purposes however will be expected by his landlord to re-negotiate if he wants to change his land use.

In most cases, trees are viewed as permanent features of the land-use system. Some landowners therefore tend to view the growing of trees by tenant farmers as being tantamount to perpetuating their stay on the land which in turn may also indirectly imply ownership of the land. Tenant farmers therefore do not own the trees found or even planted on their land except in the Upper West Region where planted economic trees may belong to the planter whether landlord or tenant. Tenant farmers may however be allowed to harvest trees for their own use, but not for commercial purposes.

### 4.4.3 Land and tree tenure in forest reserves

The *Concessions Act*, 1962 (Act 124) provides that all timber resources, together with all land declared to be forest reserves or subject to timber concessions (both within and outside the reserved forests) are vested in the state in trust for the communities concerned (Section 16). These resources are administered by the central government through its various agencies principally the MLF and the FD. In theory therefore, the landholding stools own the forest land and the timber trees thereon. In practice, however, the land and trees are managed by the central government with little or no input by stools, village communities and local authorities. The Government of Ghana therefore has all rights that relate to determining what, where and when access is given to the forest resources in forest reserves and areas outside forest reserves which fall within timber concessions.

The *Forest Ordinance* (Cap. 157) Section 18(1) indicates that the ownership of land is not altered by its declaration as a forest reserve. Forest reserves may be managed by the owner or owners under the direction of the Forestry Department, or by the Government at the option of the President (Section 18(2)).

**Plantations in forest reserves**

Prospective investors who wish to use degraded lands in forest reserves would have to deal with the FD and the landowners concerned. In forest reserves, the land and forest resources are vested in the Government to be managed in trust for the land-owning stools. The landowners however retain significant rights through vestiture. They are:

- The right to consultation;
- The right to access to reserves to meet specific basic needs known as customary rights; and
- The right to a share of the benefits from exploitation and development of the forest resource (i.e. royalties etc.).
These rights would have to be taken into consideration in developing industrial plantations in the degraded forest reserves. They may be retained where practicable or re-negotiated with the landowners. In traditional land agreements, when the tenant changes the land use, which was agreed upon during the land acquisition, the landowner’s consent must be sought.

Conclusions
The key issue in land acquisition is the consent of the landowner regarding the proposed or change of land use for the area of interest.

The FD is the manager of the forest resources within forest concessions without owning the land. The various new natural resource laws all encourage landowners and other stakeholders to be involved in decision making with respect to natural resources management. Any change of the contractual agreement with regards to the management of the forests in the reserved forests by the introduction of third parties without the consent of the landowners in question can therefore lead to tenurial and management conflicts. In the same vein, should the location of the plantings, which are legally required to be undertaken by the TUC holders, fall within the forest reserves similar conflicts could apply.

FD can either be as partners or facilitators of negotiations between investors and landowners. The latter is better, more equitable and secure for all parties involved. Consultations with the Administrator of Stool lands would also be essential.

4.4.4 Effect of natural forest exploitation on farmers

There is generally high incidence of farming in the OFR concession areas. This will undoubtedly increase with the growth of the population. In these areas, farmers repeatedly complain about the destruction of their crops during logging operations on their farms.

Discussions with some Chiefs and some of their subjects during this and other studies conducted by the Consultant indicated that the technique of skidding trees felled on farmlands is deemed as the most destructive. They consider the effect of a felled tree, if properly, directed as tolerable. In this regard, their suggestion is that the processing of the felled tree in situ would be preferred. They consider a share of about 30% of the lumber produced (interestingly, not money) as an adequate incentive to maintain trees on the farm. This issue requires to be investigated further to determine how farmers could be encouraged to keep and tend trees on or near their farms.

The farmers are generally not adequately compensated for the damages caused by timber exploitation. In these circumstances, they would prefer to either destroy the trees or connive with the chainsaw operators to process them on the farm if they are assured of a much more equitable share of the proceeds that will ensue from the operation. The Forestry Department Interim Procedures (1995) as well as the Timber Resources Management Act, 1998 (Act 547), however require that a farmer agree to the felling of any tree on his farm.
4.5 Land titling

A potential investor would have to deal with the following that may be considered as some of the disincentives with respect to the establishment of forest plantations:

- Multiplicity of interests and rights in land which may vary in different parts of the country leading to conflicting claims to ownership;
- Lack of reliable maps indicating stool/skin land boundaries which can give rise to disputes;
- Cumbersome land disposal and documentation procedures;
- Potential conflict concerning tenurial and management arrangements for plantations within forest reserves; and
- Inconsistencies in the extent of land over which timber rights can be granted.

Despite the above, the Ghanaian statutory and customary laws do not legally prevent one to secure long-term access to land. Provided suitable land can be identified without conflicting claims, there appear to be no inherent legal limitations to the negotiation of rights of sufficient duration for plantation purposes if the landowner agrees to the purported land use.

A “Land Bank” has been recommended under the proposed plantation project which is to be implemented under the NRMP. This bank is meant to assist the confirmation of the legal status of a particular land by potential investors. It will also help to bring together interested investors and genuine land owners. The Lands Commission is also undertaking national mapping of stool/skin boundaries using a GIS. The mapping is being carried out under the Ghana Environmental Resources Management Project (GERMP) and is expected to be completed by the end of 1998. It will greatly facilitate the isolation of dispute areas to be avoided.

5 GENERAL CONCLUSIONS

The role of forest plantations in filling the serious wood supply gap is obvious, and it would not be difficult to calculate the area and timing of the plantations needed to meet this gap. The main difficulty is to ensure that these targets can be, and are, met and that the plantations raised are of acceptable standards and yield.

An essential requirement in this regard is to have a medium to long-term (master) plan of plantation development which should identify plantation locations (based on soil and site characteristics and other relevant factors), species, market, etc., and provide detailed analysis of costs and benefits.

Whilst encouraging the development of new forest plantations, existing plantations must be supported to sustain interest in private forest plantation formation. The main constraints to plantation formation in Ghana can be summarized as follows:

- Limited experience with successful commercial forest plantations formation. Hence no proven technical packages;
- No information on available land and site typing even though there is no shortage of gross area;
• Lack of adequate and genetically improved planting material;
• Security of land and tree tenure;
• Fire in the Transition Zone;
• Illegal timber markets and the sale of plantation timber below the market price by the Forestry Department, and
• Timber industry not adapted to small diameter milling.

There is, however, considerable scope for successful commercial plantations in Ghana when the following are compared with those in other tropical countries:

• Favourable conditions for tree growth and quality wood development;
  • Climate
  • Topography, and
  • Soils
• Political stability;
• Reasonable local infrastructure and access to ports;
• Strong domestic markets for wood products and good access to major ECOWAS and European markets;
• Favourable labour market in terms of skills, price and availability;
• Existing processing capacity; and
• Extensive areas of degraded forests within forest reserves suitable for tree planting, and by statute dedicated to permanent forest status.

The Government of Ghana is committed to the facilitation of the formation of commercial plantations in the country for economic, environmental and sociological reasons. It is also the intention of the government that most of the commercial forestry activities should be the province of the private sector. The forest policy (section 3.2.8) indicates that a share of the benefits from forestry must be devoted to securing the resource. The necessary political will exists to boost tree plantation formation. What is required is the necessary incentives and policy reforms to pave the way for an increased investments in commercial tree plantations by both the local and foreign investors.

6 RECOMMENDATIONS

The high investment required to properly establish and manage forest plantations calls for their management on business principles. The active and direct participation of the private sector – as indicated in the Forest Development Master Plan (1996 - 2020) – is the best indicator of the application of business principles to forest plantation establishment.

In order to achieve this “business principles” objective, incentives are required to encourage the necessary private investment. These incentives should be related to providing long-term land tenure, and reducing the cost of land and funds needed to establish and maintain the plantation over a period of time during the gestation period.

There is a rich world of experience on systems of incentives for forest plantations: fiscal incentives, capital incentives, interest and capital subsidies, loan guarantees, soft loans, special
loans, duty exemptions for tools and equipment, etc. The incentives and business framework must be aimed at providing the investor with at least the same, if not even better, returns than provided by other applications of his fund. In the short term, this may require subsidy (direct or indirect). In the longer term, as the plantation mature, there should be greater overall benefits.

The recommended activities, which are required to promote tree commercial tree plantation formation, are discussed below.

### 6.1 Access to funds

Favourable investment policy environment requires to be created to promote private commercial plantation formation. Currently, long and medium term investments for schemes such as forest plantations are not available. The commercial lending rates are also very high.

The MLF has initiated support to plantation formation and plans to create a Forest Plantations Development Fund (FPDF) from the export levy on air-dried lumber to stimulate input of grant funds from the donor community. The decision on the utilization of these funds by the MLF would, however, require Cabinet approval and possible legislation. The Ministry of Finance has, however, already approved the deposit of donor funds in commercial banks (MLF 1998).

The fund is meant to provide subsidies to improve financial returns to investors who may be interested in tree plantation formation. These include investment companies, organised groups/communities and individuals.

The modalities for the administration of the FPDF are under preparation. Its success would depend on security over the assets being created and some authority over the quality of the adopted technical packages as well as the effectiveness with which they are implemented. Systems that could be employed to ensure this include those being practiced by GREL and BOPP (see Chapter 5.2.3) under the smallholder and out-grower schemes.

Other measures to be considered with respect to funding of forest plantations are:

- To secure the interest of a large scale investors with good track records who meet the requirements for probity and technical competence expected of applicants for TUCs. The timber plantation sector would benefit from examples of large scale investor displaying good practices;
- Investigations of the possibilities of investment from local pension funds and insurance companies;
- The possible use of planted trees as collateral;
- The use of carbon sequestration funds from western power utilities. This has the potential to provide capital for investments in forest plantations;
- The recognition of the special investment conditions for forestry with long gestation period by the financial institutions; and
- The provision of support for the undertaking of feasibility studies for plantations as well as for the utilization of the services of forestry consultants and contractors for extension services and field activities.
6.2 **Silviculture**

*Improved genetic planting material*

The importance of using reliable and proven seed sources for any plantation development programme cannot be over-emphasized. The cost of raising seedlings, planting and maintaining plantations are basically “fixed”, while the volume and value of the final crop can vary by more than 100%, depending on the source of seed and the planting materials used. This is particularly important for industrial timber production.

The establishment of seed bank and the development of a private decentralized seeds distribution system is therefore very crucial. It is therefore recommended that:

- Genetically superior seeds than currently available should be procured and used;
- A seed bank be established at FORIG with the latter undertaking the certification of seeds and its distribution so as to ensure that only quality materials are used;
- In the long term, the seed bank should to be involved in the selection, mating and genetic testing to ensure sustained supply of the desirable species; and
- The products from seed orchards should be used to establish demonstration plots to generate interest in the use of improved seeds.

*Tree nurseries*

Due to the lack of adequate capacity for the production of improved seedlings for commercial plantation formation, appropriate assistance and support (e.g. credit facilities at favourable terms) should be given to private commercial nurseries to produce seedlings. Private plantation owners such as SMS, BVFL in addition to experienced FD staff who may be retrenched through the restructuring exercise could be candidates in this regard after an appropriate training in the field.

For the recommended species, the services of an experienced specialist would required to undertake practical nursery trials in sowing systems, fertilization requirements, growing media, containers and protection measures to select a commercial scale nursery system for the species to suit prevailing conditions.

The work of the specialist should also include the practical training of prospective private nursery operators in the developed systems as well as assistance to the FORIG to perfect its technique on the vegetative propagation of especially *Triplochiton scleroxylon*. The FORIG should be contracted to continue the training of the selected private nursery operators including vegetative propagation of other species.

*Silvicultural prescriptions*

In order to minimize the risks associated with tree plantations in Ghana, it would be necessary that proven silvicultural prescriptions and management systems are adopted from similar areas in the tropical world as has been done in the case of rubber and oil palm plantations in the country. It is also essential that identification of plantation locations are based on climatic and soil/site factors of the species of interest when such data is available.
6.3 Suggested policy reforms

Considerations for the Investment Code
Incentives for tree plantations should be incorporated within the framework of the National Investment Code as accorded to rubber/oil palm/coconut (see section 6.3: Income tax Decree 1975).

Security of land tenure
The security of tenure of land on which trees are planted is of prime importance if investments in tree plantations are to be encouraged. The establishment of the proposed “Land Bank” is therefore welcomed. It is, however, recommended that:

- The appropriate information – especially the results of the mapping of land ownership boundaries which is being undertaken by the Lands Commission – should be readily accessible to potential investors in forest plantations;
- Grants should be made available to cover land acquisition to potential investors especially the requirement for the payment “drinks” up-front which can be excessive in some areas as a result of competition for land.
- Equitable contractual agreements for the lease of land for plantations should be developed and possibly standardized in consultation with the Administrator of Stool Lands. The standard lease format for the Ashanti Region can serve as a model. Options for consideration may include the following. In each case the consent of the Chief and his elders is a must for the success of the project;
  - Payment of agreed amount for the lease;
  - Share of the title to the final produce with the owner of the land;
  - Fair compensations for property on acquired land;
  - Access for collection of specified forest products (e.g. firewood, herbs etc) where it may not be detrimental to the project; and
  - Observance of pertinent local customary laws which may not impinge on the efficiency of the management of the forest plantation.
- Impartial and transparent mechanisms for prompt resolution of land tenure, plantation practice and management conflicts, which have the confidence of all stakeholders, should be instituted by the MLF.

Security of tree tenure
The uncertainty surrounding tree tenure should be removed. Issues that must be resolved include:

- The need to separate planted trees from the legal controls afforded to natural trees. Policy reforms are necessary to obviate or minimize the effects of;
  - The requirement of a TUC to harvest timber;
  - The requirement of Registered Property Mark to harvest timber for commercial purposes;
  - The export of specified types of processed or unprocessed timber which is subject to an export levy; and
  - Royalty rates, lease fees and any other applicable fees which apply equally to natural and planted timber.
- The mode of plantation establishment by TUC holders requires clarification in addition to guidelines for effective implementation and monitoring;
• The tree planters should be required to work within an approved plan but no other controls should be necessary. The tree planter should have full rights to the final produce; and
• There should be equitable distribution of royalties from the exploitation of the TUCs in the indigenous forests as well as plantations by the Forestry Department within the reserved forests to encourage the Landowners to support their management and protection. In the same vein, all unpaid royalties and other forest fees due must be collected and distributed.

Environmental considerations
A system of environmental and land use guidelines should be developed by the EPA and the MLF for application to forestall the necessity for EIAs for individual plantations. The draft guidelines produced by the EPA in June, 1998, could form the basis.

Control of marketing
The following measures are recommended to make the marketing of plantation timber attractive:
• The marketing of tree products should be improved with no vetting of contracts, etc. as is the case with natural timber;
• Illegal chainsaw lumbering and timber trade must be controlled to prevent the distortion of the domestic timber price;
• The Forestry Department should cease the marketing of plantation timber below the market price. Hopefully this will naturally follow from the restructuring of the FD into a self-financing one; and
• Royalty rates should be increased to economic levels to make marketing of small diameter logs competitive with the larger ones.

6.4 Forest industry re-orientation
Retooling of industry would be required to efficiently convert saw small diameter plantation wood. In the case of sawlogs this can be done in two ways:
• The allocation of funds at reasonable interest rates for the implementation of adapted small diameter processing lines; and
• The promotion of the use of small diameter portable sawmills in plantations to minimize the cost of handling small diameter logs.

6.5 Training of stakeholders and extension services
The provision of selective technical assistance and training for all stakeholders is essential for the success of any plantation programme due to existing limited experience with respect to large scale plantation formation in the country.

Local capacity building should include managerial and technical support to existing organised tree growers to sustain the interest in tree growing and the profitability of such ventures. The support should include:
• Assistance with the acquisition of the appropriate planting material;
• Advice on matching of species to site;
• Appropriate forest plantation/agro-forestry models;
• Organization development and management support for identifiable progressive groups;
• Extension services;
• Monitoring and reporting; in addition to
• Marketing support with respect to merchantable tree crops.

It is also necessary to assess how the skill requirements in forest plantation formation, management, harvesting and utilization of commercially valuable forest plantation timber is met by the existing forestry training institutions so as to recommend the necessary remedial actions to support the current and future forest plantations.

The School of Forestry, Sunyani – which is in a good position to train field technical staff – will require strengthening of its teaching staff and teaching aids to facilitate training in the relevant disciplines at the school.

6.6 Perceived incentives for plantation development

A summary of most popular incentives according to a recent FAO 1998 study is as indicated below:

• For saw millers: Low interest credit availability, availability technical expertise, income and capital tax reduction, training for staff, concessions in Forestry Department plantations and land available at low rent and long lease conditions.
• For loggers: low interest credit availability, availability of improved seeds, technical expertise availability of technical advice, training for staff and concessions in Forestry Department plantations.
• For farmers: low interest credit availability, availability of improved seeds, technical expertise availability, inter-cropping of shorter rotation trees with annual crops, training, grants-in-kind and guaranteed access to markets.

These are generally covered by the earlier analysis of the situation and the recommendations which ensued.

6.7 Future plantation research requirements

In order to support the proposed forest plantation effort, the promotion of adaptive research would be necessary. These include:

• Rehabilitation of existing teak trials;
• Establishment of non-teak species trials for industrial and commercial purposes;
• Survey to identify farmer-preferred species and focused research programme on such species;
• Improved husbandry practices for nursery and plantations (optimum spacing, fertilizing, enrichment planting, and other methods of restoring natural forest cover, fire control techniques, etc.) and the preparation of technical manuals;
• Improved agro-forestry/land use planning;
• Wood technology practices to promote rational utilization of plantation products;
• Demonstration plots using improved seeds from either imported seeds or the existing seed orchards.

REFERENCES

Nii Ashie Kotey et al. 1998. Falling into Place. Policy that works for forests and people series No. 4. Study undertaken under the IIED, United Kingdom, and the MLF, Ghana.


### Appendix 1. Area estimates of the major hardwood plantations in Ghana

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated Area (ha)</th>
<th>Location</th>
<th>Organisation/Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teak</td>
<td></td>
<td><strong>Total: 22,900</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11,700</td>
<td>FR's (HFZ)</td>
<td>FD</td>
</tr>
<tr>
<td></td>
<td>1,300</td>
<td>FR's, Volta Region (FTZ/ SZ)</td>
<td>FD</td>
</tr>
<tr>
<td></td>
<td>1,600</td>
<td>FR's &amp; OFR's, North (SZ)</td>
<td>FD, Towns and Waterworks</td>
</tr>
<tr>
<td></td>
<td>3,600</td>
<td>OFR's, Brong Ahafo (FTZ)</td>
<td>Pioneer Tobacco Company (PTC)</td>
</tr>
<tr>
<td></td>
<td>1,300</td>
<td>OFR's, Brong Ahafo (FTZ)</td>
<td>Farmers assisted by PTC.</td>
</tr>
<tr>
<td></td>
<td>1,400</td>
<td>OFR, Ashanti (HFZ)</td>
<td>Ashanti Goldfields Company Ltd. (AGC)</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>OFR, Eastern (FTZ)</td>
<td>Bonsu Vonberg Farms Ltd. (BVFL)</td>
</tr>
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<td></td>
<td>1,500</td>
<td>OFR</td>
<td>Private Planters*</td>
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<tr>
<td></td>
<td>***</td>
<td>OFR, Brong Ahafo (FTZ)</td>
<td>DWT</td>
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<tr>
<td>Cedrela</td>
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<td>FR's (HFZ)</td>
<td>FD</td>
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<td></td>
<td>40</td>
<td>OFR Western (HFZ)</td>
<td>Gwira Banso Project</td>
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<tr>
<td></td>
<td><strong>Total: 3,840</strong></td>
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<td></td>
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<tr>
<td>Gmelina</td>
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<td>FR &amp; OFR, Western (HFZ)</td>
<td>Subri Industrial Plantations Ltd. (SIPL)</td>
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<tr>
<td></td>
<td>1,000</td>
<td>FR's (HFZ)</td>
<td>FD</td>
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<td>150</td>
<td>OFR (HFZ)</td>
<td>AGC.</td>
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<tr>
<td>Terminalia</td>
<td>400</td>
<td>FR's (HFZ)</td>
<td>FD</td>
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<tr>
<td><strong>Total: 400</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>42</td>
<td>OFR, Ashanti (HFZ)</td>
<td>AGC.</td>
</tr>
<tr>
<td></td>
<td>***</td>
<td>FR's (HFZ)</td>
<td>FD</td>
</tr>
<tr>
<td><strong>Total: 42</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubberwood</td>
<td>9,000</td>
<td>OFR, Western (HFZ)</td>
<td>Ghana Rubber Estates Ltd. (GREL)</td>
</tr>
<tr>
<td></td>
<td>2,200</td>
<td>OFR (HFZ)</td>
<td>Others</td>
</tr>
<tr>
<td><strong>Total: 11,200</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>FR's (HFZ)</td>
<td>FD</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>OFR, Western (HFZ)</td>
<td>Swiss Lumber Company (SMS)</td>
</tr>
<tr>
<td>Miliaceae/Mixed</td>
<td>3,600</td>
<td>OFR</td>
<td>Private Planters (mainly pole and firewood crops)*</td>
</tr>
<tr>
<td>Hardwoods</td>
<td>2,400</td>
<td>OFR (HFZ)</td>
<td>Gwira Banso Project (Farm plantings: 20 x 20m)</td>
</tr>
<tr>
<td></td>
<td>***</td>
<td>FR (HFZ)</td>
<td>AGC</td>
</tr>
<tr>
<td><strong>Total: 6,070</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HFZ – High Forest Zone  FTZ – Transition Zone  SZ – Savannah Zone  *** No Data available
### Appendix 2. Sample tree growth data - Selected FORIG research plots and others areas

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Ecological zone</th>
<th>dbh (cm)</th>
<th>Age of stand (yrs.)</th>
<th>Growth rate (cm yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORIG Research stations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. scleroxylon</em></td>
<td>Mpraeso</td>
<td>DS&lt;sub&gt;IZ&lt;/sub&gt;</td>
<td>37.03</td>
<td>23</td>
<td>1.61</td>
</tr>
<tr>
<td><em>T. ivorensis</em></td>
<td>Amantia</td>
<td>MS&lt;sub&gt;SE&lt;/sub&gt;</td>
<td>50.17</td>
<td>29</td>
<td>1.73</td>
</tr>
<tr>
<td><em>K. ivorensis</em></td>
<td>Amantia</td>
<td>MS&lt;sub&gt;SE&lt;/sub&gt;</td>
<td>63.24</td>
<td>23</td>
<td>2.75</td>
</tr>
<tr>
<td><em>T. superba</em></td>
<td>Amantia</td>
<td>MS&lt;sub&gt;SE&lt;/sub&gt;</td>
<td>46.16</td>
<td>33</td>
<td>1.39</td>
</tr>
<tr>
<td><em>Haritiera utilis</em></td>
<td>Mpraeso</td>
<td>DS&lt;sub&gt;IZ&lt;/sub&gt;</td>
<td>-</td>
<td></td>
<td>2.56</td>
</tr>
<tr>
<td><em>Nauclea diderichii</em></td>
<td>Benso</td>
<td>ME</td>
<td>30.01</td>
<td>26</td>
<td>1.15</td>
</tr>
<tr>
<td><em>Cedrela odorata</em></td>
<td>Amentia</td>
<td>MS&lt;sub&gt;SE&lt;/sub&gt;</td>
<td>68.97</td>
<td>33</td>
<td>2.09</td>
</tr>
<tr>
<td><em>Tectona grandis</em></td>
<td>Amentia</td>
<td>MS&lt;sub&gt;SE&lt;/sub&gt;</td>
<td>36.00</td>
<td>23</td>
<td>1.57</td>
</tr>
<tr>
<td><em>P. hondurensis</em></td>
<td>Mpraeso</td>
<td>DS&lt;sub&gt;IZ&lt;/sub&gt;</td>
<td>30.82</td>
<td>23</td>
<td>1.34</td>
</tr>
<tr>
<td><em>P. oocarpa</em></td>
<td>Mpraeso</td>
<td>DS&lt;sub&gt;IZ&lt;/sub&gt;</td>
<td>33.79</td>
<td>22</td>
<td>1.54</td>
</tr>
<tr>
<td><em>P. caribaea v. car.</em></td>
<td>Mpraeso</td>
<td>DS&lt;sub&gt;IZ&lt;/sub&gt;</td>
<td>34.16</td>
<td>23</td>
<td>1.49</td>
</tr>
<tr>
<td><em>P. caribaea v. bah.</em></td>
<td>Benso</td>
<td>ME</td>
<td>29.10</td>
<td>23</td>
<td>1.27</td>
</tr>
<tr>
<td><em>P. caribaea v. hond.</em></td>
<td>Benso</td>
<td>ME</td>
<td>21.63</td>
<td>22</td>
<td>0.98</td>
</tr>
<tr>
<td><em>P. caribaea</em></td>
<td>Benso</td>
<td>ME</td>
<td>20.74</td>
<td>20</td>
<td>1.04</td>
</tr>
<tr>
<td><em>P. oocarpa</em></td>
<td>Benso</td>
<td>ME</td>
<td>26.77</td>
<td>18</td>
<td>1.49</td>
</tr>
<tr>
<td><em>P. caribaea v. hond.</em></td>
<td>Benso</td>
<td>ME</td>
<td>22.34</td>
<td>18</td>
<td>1.24</td>
</tr>
<tr>
<td><em>P. oocarpa</em></td>
<td>Benso</td>
<td>ME</td>
<td>24.29</td>
<td>14</td>
<td>1.74</td>
</tr>
<tr>
<td><strong>FD/SIPL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>E. tereticornis</em></td>
<td>Yenku F.R.</td>
<td>SZ</td>
<td>19.30</td>
<td>24</td>
<td>0.80*</td>
</tr>
<tr>
<td><em>G. arborea</em>(coppice)</td>
<td>Subri F.R.</td>
<td>ME</td>
<td>13.88</td>
<td>3</td>
<td>4.63*</td>
</tr>
<tr>
<td><em>T. scleroxylon</em></td>
<td>Subri F.R.</td>
<td>ME</td>
<td>23.00</td>
<td>3</td>
<td>7.67*</td>
</tr>
<tr>
<td><strong>Swiss Lumber Co.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. scleroxylon</em></td>
<td>OFR</td>
<td>ME</td>
<td>18.28</td>
<td>5</td>
<td>3.66*</td>
</tr>
<tr>
<td><em>Nauclea diderrichii</em></td>
<td>OFR</td>
<td>ME</td>
<td>9.93</td>
<td></td>
<td>1.99*</td>
</tr>
<tr>
<td><strong>Karigbonto-Tamale</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Ceiba pentandra</em></td>
<td>OFR</td>
<td>SZ</td>
<td>22.55</td>
<td>4</td>
<td>5.64*</td>
</tr>
</tbody>
</table>

Source: E.G. Foli, Unpublished memo
*Sample field measurement by Author (non FORIG stands)  
MS<sub>SE</sub> - Moist Semi Deciduous(south-east subtype)  
DS<sub>IZ</sub> - Dry Semi Deciduous(Inner Zone)
### Appendix 3. Some characteristics of selected indigenous and exotic species in West and Central Africa

<table>
<thead>
<tr>
<th>Species</th>
<th>Density (kg/m³)</th>
<th>Natural durability</th>
<th>End-Uses</th>
<th>Soils</th>
<th>Vegetation Zones</th>
<th>Suitability for Taungya</th>
<th>Potential growth rates (m³/ha/year)</th>
<th>Rotation (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Tectona grandis</em></td>
<td>580-820</td>
<td>Durable</td>
<td>Top quality cabinet, sliced veneer, flooring</td>
<td>-wide range of soils; -no waterlogging or shallow compacted soils or heavy clays; - avoid steep slopes; - pH requirement: 6.0 to 7.5</td>
<td>Degraded areas of semi evergreen rainforest</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. <em>Cedrela odorata</em></td>
<td>370-600</td>
<td>Moderately durable</td>
<td>Peeled and sliced veneers</td>
<td>-neutral to alkaline soils; -avoid shallow, stony or strongly acidic soils</td>
<td>Semi-evergreen zones</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. <em>Gmelina arborea</em></td>
<td>400-570</td>
<td>Moderately durable</td>
<td>Saw-timber, matches, pulpwood</td>
<td>- Avoid yellow clay soils, water-logging and stony or compacted profiles; - thrives best on fertile well drained soils but tolerates a range of soil conditions.</td>
<td>Afforestation of degraded sites</td>
<td>25 - 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. <em>Triplochiton scleroxylon</em></td>
<td>390</td>
<td>Non durable</td>
<td>Utility hardwood, filling for panels, veneer, matches, mouldings, internal joinery</td>
<td>-avoid swampy conditions. Susceptible to windthrow on wet and shallow soils</td>
<td>-Absent in the rainforest -semi-evergreen forest and the riverine forest of the southern savannah -strong light demander and a speedy coloniser; -attention to root competition required</td>
<td>Yes (narrow crown)</td>
<td>15 +</td>
<td>40 – 50</td>
</tr>
<tr>
<td>5. <em>Terminalia superba</em></td>
<td>450-680</td>
<td></td>
<td>Utility timber, veneer, shade or crop over-storey tree</td>
<td>-tolerates limited waterlogging; -best on freely drained soils with pH of abt. 6; -susceptible to drought and shallow or compacted soils or compacted profiles</td>
<td>-strong light demander; -spreading crowns limit productivity in plantations and mixtures; -strong provenance difference between populations</td>
<td>'?'</td>
<td>30-35 (50-60 cm)</td>
<td></td>
</tr>
<tr>
<td>6. <em>Miliaceae spp.</em></td>
<td>530-660</td>
<td></td>
<td>Quality cabinets, saw-timber, veneer</td>
<td>-avoid waterlogging or inundation; -little information on soil requirements; -Lovoa common in Ghana on base-poor soils -Eu, Ec, Ea tolerate drought and better-drained soils</td>
<td>-light demanding climax spp (NPUD); -maintain 50% shade throughout period in nursery; -planting in mixtures at 10% to 15% recommended with a nurse species of similar growth rate to give side(not top) shade to be able to be resistant to <em>Hypsipyla robusta</em> (e.g Kusia and gmelina)</td>
<td>'?'</td>
<td>30 (60 cm)</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Species</td>
<td>Average Height Meters</td>
<td>Durability</td>
<td>Board Use</td>
<td>Soil Requirements</td>
<td>Forest Type</td>
<td>Height at Age (Years)</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------</td>
<td>-----------------------</td>
<td>--------------------------</td>
<td>-----------------------------------</td>
<td>---------------------------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td><em>Mansonia altissima</em></td>
<td>600-720</td>
<td>Very durable</td>
<td>- cabinet wood</td>
<td>- fertile soils of semi-evergreen rainforest zone</td>
<td>Semi-evergreen rainforest</td>
<td>- 6m in 4 years (Howthone)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- dust causes sneezing</td>
<td>- avoid inundation</td>
<td></td>
<td>- 8 -10m after 10 yrs (Taylor)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*pest &amp; health problem limit</td>
<td>- drought tolerant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>plantation potential</td>
<td>- regeneration common in burnt areas than unburnt sites.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td><em>Pericopsis elata</em></td>
<td>600-850</td>
<td>Very durable</td>
<td>-cabinet wood</td>
<td>- neutral and free-draining soils.</td>
<td>-semi-evergreen forests;</td>
<td>5-8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*listed in Appendix II of CITES</td>
<td>-colonises gaps</td>
<td>-colonises gaps</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(60cm in Malawi with 10-15cm heartwood)</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td><em>Milicia excelsa</em></td>
<td>550-660</td>
<td>Very durable</td>
<td>Cabinet</td>
<td>-strongly acidic, compacted soils and waterlogging must be avoided</td>
<td>-more common in semi-evergreen zones and riparian forests in the savannah regions; -raised with high stumps</td>
<td>3-10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(h=16m, d=27)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15-20 (coppicing for transmission poles)</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td><em>Nauclea diderrichii</em></td>
<td></td>
<td>Very durable</td>
<td>Transmission poles</td>
<td>-neutral to acid light textured soils;</td>
<td>-strong light demander;</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-root needs to reach water table(i.e. access to water at depth;</td>
<td>-good nurse crop for the miliaceae;</td>
<td>3-10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-avoid shallow basement complex derived soils.</td>
<td>-more research needed on light requirements;</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(h=16m, d=27)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15-20 (coppicing for transmission poles)</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td><em>Eucalyptus spp.</em></td>
<td>600-850</td>
<td>Very durable</td>
<td>Industrial wood, poles, windbreaks</td>
<td>-wide range of soils;</td>
<td>-weed free and high level of nutrient content required until canopy closure; -genus adapted to surviving fire; -spp. minimises transpiration during water shortage, transpire very freely when roots have access to water.</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40-50</td>
<td></td>
</tr>
</tbody>
</table>

Source: Hardcastle et al. (1998); Taylor (1962)
Appendix 4. Species recommendation for the HFZ by the FD

1. Plantations

- Tectona grandis
- Cedrela odorata
- Gmelina arborea
- Terminalia superba
- Triplochiton scleroxylon
- Eucalyptus spp.

2. Improvement of Degraded Natural Forest

   a. Line Planting
      Milicia excelsa + Afzelia africana
      Mansonia altissima + Pterygota macrocarpa
      Chrysophyllum spp. + Aningeria spp.
      Antiaris toxicaria + Milicia excelsa
      Terminalis superba + Triplochiton scleroxylon
      Nauclea diderrichii + Mitrgyna spp.

   b. Enrichment Planting
      Afzelia africana
      Milicia excelsa
      Terminalia superba
      Triplochiton scleroxylon
      Entandophragma angolense
      Entandophragma utile
      Khaya ivorensis
      Pericopsis elata
      Heritiera utilis

Source: Apomasu (1992)

SW – Southern maginal
DSFZ – Dry semi-deciduous (Fire Zone)
DSIZ – Dry semi-deciduous (inner zone)
MS – Moist semi-deciduous
ME – Moist evergreen
WE – Wet evergreen
Appendix 5. Formal policy and legislative landmarks

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1874</td>
<td>British Colonial Office begins to develop a universal forest conservation policy to avert a perceived world-wide threat to the economic base of colonial rule from deforestation (Grove, 1994, cited in Smith, 1996).</td>
</tr>
<tr>
<td>1908</td>
<td>H.N. Thompson's Report on Forestry in the Gold Coast recommended the establishment of forest reserves, the introduction of a system of Property Marks and the establishment of a Forestry Department.</td>
</tr>
<tr>
<td>1909</td>
<td>Establishment of the Forestry Department to spearhead the reservation effort and regulate the emerging timber industry.</td>
</tr>
<tr>
<td>1909</td>
<td>Timber Protection Ordinance, 1909, provided for regulation of logging through the introduction of a system of Property Marks.</td>
</tr>
<tr>
<td>1911</td>
<td>Forest Ordinance, 1911, provided for the establishment of forest reserves by the colonial government. It was, however, never used.</td>
</tr>
<tr>
<td>1927</td>
<td>Native Authorities Ordinance No. 18 of 1927 (Cap 111) established a system of local government which revolved around a paramount chief and his traditional council of elders “native authority. These authorities had the power to constitute forest reserves under their by-laws.</td>
</tr>
<tr>
<td>1927</td>
<td>Forest Ordinance, 1927 (Cap. 157) provides for the constitution and management of forest reserves. It is still in force. Ordinance indicates that the ownership of land is not altered by its declaration as a forest reserve; forest reserves may be managed by owner or owners under the direction of the FD.</td>
</tr>
<tr>
<td>1939</td>
<td>Concessions Ordinance, 1939 (Cap. 136), and earlier similar legislation, provided for a system of grants of timber harvesting rights and the determination and collection of revenue over both reserve and off-reserve forest by the traditional land and forest holding authorities.</td>
</tr>
<tr>
<td>1948</td>
<td>Forest Policy. This first formal forest policy provided conservation and protection of the forest estate and the ultimate liquidation of the off-reserve forest.</td>
</tr>
<tr>
<td>1949</td>
<td>Trees and Timber Ordinance, No.20 of 1949 (Cap. 158) sought to regulate and control the timber trade through the registration and issuing of Property Marks to concession holders and the issuing of licenses and permits for the felling of forest trees.</td>
</tr>
<tr>
<td>1951</td>
<td>Local Government Ordinance, 1951 (No. 29) provided for the establishment of elected local councils, marked the end of the policy of indirect rule and the beginning of the decline in the participation and influence of the traditional land forest holding authorities in forest management.</td>
</tr>
<tr>
<td>1959</td>
<td>Protected Timber Lands Act, 1959 (Act 34). This Act provided for the declaration of off-reserve forest lands as protected timberlands. This gave the Forestry Department power to regulate and control farm development and expansion in these areas.</td>
</tr>
<tr>
<td>1962</td>
<td>Administration of Lands Act, 1962 (Act 123) vested the management of all stool land the collection of all stool land revenue in central government. Land has been considered to include forests and stool land revenue to include royalties and rent.</td>
</tr>
<tr>
<td>1962</td>
<td>Concessions Act, 1962 (Act 124), another product of the centralizing, statist Nkrumah regime, vested the right to grant timber concessions and the management of all timber resources, both on and off-reserve, in central government.</td>
</tr>
<tr>
<td>1974</td>
<td>Trees and Timber Decree, 1974 (NRCD 273) continued the operation of the system of Property Marks and makes it a criminal offence for a person to fell timber for export without a valid property mark.</td>
</tr>
<tr>
<td>1974</td>
<td>Forest Protection Decree, 1974 (PNDCL 46) attempts to protect the integrity of forest reserves by prohibiting virtually any activity therein if done without the prior written permission of the Forestry Department.</td>
</tr>
<tr>
<td>1983</td>
<td>Control of Bush Fires Law, 1983 (PNDCL) sought to control the setting up of bushfires, during one of the worst periods of rampant fires, by criminalizing the intentional, reckless or negligent causing of such fires and holding the offender</td>
</tr>
</tbody>
</table>
liable for all the consequences of the fire.

1983 Trees and Timber (Amendment) Law, 1983 (PNDCL 70) imposed stiffer penalties for violation of the Tree and Timber Decree.

1986 Forest Protection (Amendment) Law, 1986 (PNDCL 142) imposed stiffer penalties for violation of the Forest Protection Decree.

1990 Control and Prevention of Bushfires Law, 1990 (PNDCL 192) shifted the emphasis in the fight against bushfires from punishment for criminal offenders to regulation and prevention through educational programmes and organization of early farm burning by district assemblies.

1993 Article 296 of the 1992 Constitution provides for the establishment, composition and functions of the present Forestry Commission.

1993 Forest Commission Act, 1993 (Act 453) established the present Forestry Commission.

1994 Forest and Wildlife Policy. The present formal policy on forest and wildlife aims at "conservation and sustainable development of the .... resources for maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society".

1994 Trees and Timber Amendment Act, 1994 (Act 493) makes provision for the biannual renewal of property marks and the use of levies and other forest fees in the regulation of the timber trade. Under this Act, levies have been imposed on the export of logs and the fee for the renewal of property marks substantially increased.

1995 Interim Measures to Control Illegal Timber Harvesting Outside Forest Reserves. This introduced a new system for the harvesting of off-reserve timber introducing the farmer’s right of veto and payment of compensation for crop damage.

1996 Master Plan for the Development of the Forestry Sector. Prepared by the Ministry of Lands and Forestry, this is a comprehensive plan with strategies, proposed actions, inputs, outputs and time frames for implementing the Forest and Wildlife Policy.

1998 Timber Resources Management Act introduces Timber Utilization Contracts (TUCs) for any timber harvesting and enhanced rights for landowners and farmers over harvesting of trees on their land.

1998 Proposed Forestry Act. This proposal aims at consolidation and replacement of all existing forestry legislation. It proposes clear identification of land-and forest-holding communities as the primary clients of a proposed Forest Service, which will pursue sustainable forest management.

Source: Nii Ashie Kotey et al. (1998) *insertion by the author indicated in italics.*
**FAO - Forestry Department**

List of Working Papers on Forest Plantation


