

No.

TECHNICAL INFORMATION
ON
TROPICAL FORESTS
III

MARCH 1993

JAPAN INTERNATIONAL COOPERATION AGENCY
(J I C A)

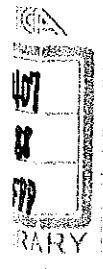
FDD

JR

93-18

TECHNICAL INFORMATION ON TROPICAL FORESTS III

MARCH 1993



JICA LIBRARY



1115092(7)

TECHNICAL INFORMATION
ON
TROPICAL FORESTS

III

MARCH 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

(J I C A)

国際協力事業団

26628

CONTENTS

1.	FOREST ENVIRONMENT	1
	- climate, ecology, forest resources, etc.-	
2.	SILVICULTURE	21
2-1	Choice of Species	21
	- trials of species, provenance trial, etc.-	
2-2	Seed (for Propagation)	28
2-3	Nursery Practice	31
2-4	Plantation Establishment	32
	- site preparation, planting, coppice, direct seeding, mycorrhiza, enrichment planting, soil, etc.-	
2-5	Tending	39
	- weeding, pruning, thinning, fertilizing etc.	
2-6	Tree Breeding	40
2-7	Natural Regeneration	42
3.	FOREST DAMAGE AND PROTECTION	44
3-1	Forest Fire	44
3-2	Pests and Diseases	46
4.	FOREST MENSURATION AND MANAGEMENT	49
4-1	Growth, Increment of Trees and Stands	49
4-2	Harvesting	52
4-3	Forest Management	56
5.	FOREST CONSERVATION	60
5-1	Watershed Management	60
5-2	Soil Conservation	68
6.	FOREST PRODUCTS	72
6-1	Timber	72
6-2	Non-timber Products	74
7.	SOCIAL FORESTRY	78
8.	OTHERS	100

APPENDIX LIST OF INFORMATION RESOURCES

READERS' GUIDE

1. Geographic coverage of information.

This paper covers mainly the African Region, focused Kenya and Tanzania.

2. Titles.

Titles are given in the original language if English is used. Japanese is given in English translation for whole publication.

3. What an abstract contains.

¹⁾Sofwan Bustomi & Komar Soemama

²⁾Regeneration and standing stock study on logged-over area in Laban forest complex, Forest District of Berau, East Kalimantan

³⁾Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia

⁴⁾No. 479, ⁵⁾1-16, ⁶⁾1986, ⁷⁾Indonesian

⁸⁾The system linear sampling with several sampling intensity have been tried as the initial study on natural regeneration and standing stock on logged-over areas at the Forest District of Berau, West Kalimantan.

The recording units were used as a line plot with 5 m width for saplings, 10 m for poles and continuous strips unit of 20 m width for standing stock of the remain stand. All tree species are grouped into commercial species that consist of Dipterocarps and non-Dipterocarps, non commercial and the total of all species.

Key words: Natural regeneration, logged-over area, Forest type, Stand condition

- | | |
|-----------------------|------------------------|
| 1) Author | 5) Page numbers |
| 2) Title | 6) Year of publication |
| 3) Journal/Book title | 7) Language of text |
| 4) Volume | 8) Abstract |

1. FOREST ENVIRONMENT

- climate, ecology, forest resources, etc.-

A.C. HAMILTON

Deforestation in Uganda

Oxford University Press, East and Central Africa, Science House, Nairobi, Kenya

92 pp., 1984, English

Uganda is an agricultural country with few proven mineral reserves and little prospect of rapid industrial development; as in the past, agriculture and forestry will continue to play important roles in the economy. It is thus of considerable concern that the tree resources of the country are being rapidly depleted, leading to an increasing shortage of firewood and other wood products as well as general environmental degradation.

During forty years since 1929, the Forest Department gradually developed efficient techniques for the sustained supply of tree products. However, unfortunately, during the last ten to fifteen years methods of forest management once well established have tended to become ineffective. This has resulted in the loss of area of the forest by illegal agricultural encroachment, a huge increase in the unlicensed exploitation of forest produce, and a virtual total failure of the Department to anticipate and meet shortages of fuel and other wood products. The wellknown recent human tragedy in Karamoja, involving many thousands of deaths through starvation, is due largely to ecological degradation at the hands of man. It can be predicted that problems of a similar magnitude will soon appear elsewhere, unless the efficiency with which natural resources are managed is radically improved. This book discusses the deforestation problems in Uganda in detail and some recommendations to tackle the problems.

Keyword: Deforestation, Forest policy, Forest management, Sustainable management of forest

A.J. AHLBACK

Industrial plantation forestry in Tanzania - facts, problems, challenges

Ministry of Natural Resources and Tourism, Tanzania

197 pp., 1986, English

This paper deals with the industrial plantation forests in Tanzania which have a great development potential and a capacity to be a dynamic force in the country's forestry and economy. To some extent, they could also help to ease the pressure on the rapidly dwindling natural forests.

Full understanding of the importance of industrial plantation forestry in Tanzania is possible only against the background of, among other things, the total forestry situation in the country dominated by natural forests. An outlook concerning industrial plantation forest - areas and tree species - also in other countries in this part of Africa gives a broader view. Man-made forests in Tanzania in general and their historical background has also been shortly presented. Certain aspects on village afforestation are also presented in this paper.

The main parts of this paper deal, then, with the plantations under Forest Division management and their tree species, their establishment, tending and utilization, their management and financing. The paper also deals, as central issues, need of more hardwood plantations, wood processing capacity, management planning and guidance, royalty rate and stumpage, and self-support management.

Keyword: Commercial tree species, Plantation, Community forestry, Forest management

E.M. MNZAVA

Tree planting in Tanzania: A voice from villagers

Forest Division and Swedish International Development Authority, Tanzania

88 pp., 1983, English

Tree planting will be of a paramount concern to the socio-economic development of Tanzania for the next two decades or so. Although the government has made appreciable strides to help farmers help themselves, there are some issues unresolved. This study attempts to identify these issues and wherever possible, suggest

option available. It has been endeavored to look at tree planting from the other side of the fence: the farmer's point of view.

The main goal of the study is to establish for the reader a sense of vision that main actors in trying to alleviate the tree planting constraints are the villagers. This publication is the result of the study on tree planting problems in local communities and it hopes that the Tanzania experience can illuminate typical problems and be helpful to other tree planting programs in the developing countries.

Keyword: Afforestation, Community forestry, Social and economic analysis, Forest policy

F.A.O.

Fuelwood consumption and supply in semi-arid areas (Tanzania)

FAO/SIDA Forestry for Local Community Development Programme, F.A.O., Rome

44 pp., 1984, English

Fuelwood is the primary domestic fuel in the semi-arid zone. The median annual per capita consumption of fuelwood was 1.0 m³ SW (solid wood). This report describes the results of a field study of fuelwood consumption and supply in semi-arid areas of Tanzania. The major aim is to provide data to the Government of Tanzania for planning village afforestation.

Although fuelwood situations among the survey villages ranged from relatively adequate supplies to acute scarcity, the general trend is towards increased scarcity. Preferred species are already difficult to find, and environmental degradation is visible around many communities. Sources of supply have become more distant from places of consumption. In some areas fuelwood has become commercialized. Many villagers are increasingly substituting crop residues and cow dung for firewood.

The report suggests that a complementary strategy of resource conservation and increased afforestation be pursued. Greater attention has to be given to sustaining and increasing the yield from existing tree and vegetation resources. The resources available for afforestation also need to be improved and increased. In planning and implementing strategies and projects, attention should focus on local needs, conditions, and capabilities. A flexible and integrated approach is required. Increasing the efficiency of current consumption patterns, including the production of charcoal, is imperative.

Keyword: Fuelwood, Semiarid, Community forestry, Afforestation

B.K. KAALE

Socio-economic aspects in respect to wood energy research and production.

Paper presented at the international symposium on wood energy research (1984)

Ministry of Natural Resources and Tourism, Tanzania, 34 pp., 1984, English

By the end of 1981, total consumption of fuelwood in Africa was about 350 million m³ of solid wood. Fuelwood accounted for 65 per cent of total energy used in the continent. Fuelwood supply and demand projections for Africa indicate that current level of consumption already exceeds the capacity that forests can supply on a sustained yield basis. If the present trend will continue, by the year 2000, over 500 million people in Africa will be facing acute fuelwood scarcity.

In spite of high consumption of fuelwood in developing countries, very little research efforts have been oriented to its production and utilization. However, efforts are now being made to intensify wood-energy research.

The objective of this paper is to give an overview of socio-economic and cultural aspects which should be considered by researchers in wood-energy in order to ensure mass and quick adaption of developed new technologies in wood-energy production and utilization.

Keyword: Fuelwood, Social and economic analysis

F.B.R. KILAHAMA

The use and production of charcoal in Tanzania (An overview)

Forest Division, Dar es Salaam, Tanzania, 49 pp., 1984, English

Charcoal is an important source of energy for the majority of the urban dwellers. Over 80% of the total

urban households depend on charcoal for their domestic energy needs. Consumption of charcoal in Tanzania has been on an increasing trend. This is due to expansion of towns and cities i.e. more industries are built, business expand and therefore more people flock into them seeking for jobs and others joining relatives.

Under current market prices for various energy sources the households depending on charcoal are paying more out of their income than using electricity or LPG. Cost comparison for the various domestic energy sources in Tanzania on a per KWH basis, shows that cost per KWH of charcoal, LPG or electricity is about Tshs. 4.85, 0.75 and 0.72 respectively. Thus it is quite cheap to use electricity or LPG than charcoal.

The competitiveness of charcoal could be very significantly increased if efficiency of cooking stove is improved substantially. Charcoal will continue to be the major source of energy for the majority of households in urban centers for a good number of years to come. The question of improving the production techniques as well as adoption more efficient stove should be accorded high priority.

Keyword: Charcoal, Wood utilization

S. THULIN

**Wood requirements in relation to plantation establishment in the savanna region of Nigeria
FAO & Savanna Forestry Research Station, Samaru, Nigeria, 53 pp., 1966, English**

The aim of the report is to forecast the future requirements of wood in both quantity and quality to the year 2000 within the savanna region of Nigeria. This will be the basis for estimates of the needs for plantations to meet the anticipated demand.

The main findings of the study are as follows.

The present consumption of wood is estimated to be about 840 million cubic feet annually of which more than 90 percent is firewood.

A forecast of the future consumption of wood indicates that it will reach some 1,000 to 1,500 million cubic feet at year 2000. The biggest item is still expected to be firewood but the roundwood equivalent of timber and paper is likely to be some 90 - 160 million cubic feet.

It is suggested that a planting scheme should be launched aiming at a total planted area some of 300,000 acres by the year 1980. The annual cost is estimated to grow gradually to reach about £2.3 million towards the end of the 70's.

The designation of area to be planted will be dependent on soil surveys as well as economic considerations.

Keyword: Savanna, Plantation, Afforestation

DENNIS ANDERSON & ROBERT FISHWICK

**Fuelwood consumption and deforestation in African countries, IBRD, West Africa Project
Department, USA, 52 pp., 1984, English**

The paper reviews recent reports on the level and growth of fuelwood consumption in Africa, and on the ecological, economic and possible micro-climatic effects of deforestation. It then reviews the economic and operational aspects of policies open to government (i) to encourage fuelwood conservation, (ii) to facilitate the substitution of commercial energy for fuelwood, where desirable on grounds of relative cost, (iii) in developing the traditional functions of the forestry services in maintaining the forest reserves and undertaking plantings in watersheds and shelter belts, and (iv) in promoting the practice of agroforestry, i.e. the planting and maintenance of trees in copses and around farms by the farm families themselves. All four are important, but it is argued that the fourth one (iv) offers considerable promise in terms of increased planting rates, low budgetary requirements, ecological benefits and good economic and financial rates of return.

The importance of the 'policy environment' for the success of each is also discussed, as are the various research, education, training and other requirements.

Keyword: Fuelwood, Deforestation, Forest management, Multiple purpose forestry, Environmental conservation, Forest policy

T.J. WORMALD

The management of the natural forests in the arid and semiarid zones of East and Southern Africa

A Report for ODA, UK, 96 pp., 1984, English

The countries included in this report are: Sudan, Ethiopia, Somalia, Kenya, Tanzania, Malawi, Zambia, Zimbabwe and Botswana. Some 60% of these countries can be considered arid or semiarid, but management is at a low intensity. Conflicting demands of livestock, agriculture and wood production compounded by traditional attitudes on the free availability of woodland produce and the misuse of fire have reduced the yields and are endangering the existence of these woodlands. Multipurpose management is recommended as a means of reducing the risk of degradation and desertification. Major constraints are noted in the land tenure system, the lack of planting and co-ordination, the inadequacy of the data base, inappropriate extension techniques and, most important, uncontrolled population growth.

The country reports of the said countries are presented as appendix.

Keyword: Semiarid, Natural forest, Degradation, Multiple purpose forestry, Forest management

MICHEL THIBAUT

General overview. Ecology-forestry of the countries of the Sahel, a summary of individual country analyses

Agrovet inc., Canada, Sahel D(83)194, 84 pp., 1983, English

The purpose of this study is to provide a regional outline of the ecology/forestry sector in the countries which constitute the membership of the International Committee for Drought Control in the Sahel (CILSS).

Following a review of the current state of the Sahelian environment, the importance of the tree in the life of Sahelians is stressed, as are the many different ways in which wood plays a role of major importance in the economy of the Sahel. Main subjects mentioned in this study are: assessment of existing supply of wood substances and fuelwood supply situation, evaluation of the major projects already implemented, the major difficulties encountered, the causes of success and major constraints related to the land tenure system etc.

Putting a stop to the process of degradation of land and forest reserves, trying to strike a new balance between a growing Sahelian population and enrichment of natural resources, better development through improved technology, must be accepted as objectives of equal importance to that of food self-sufficiency. Accordingly, it is of the utmost importance not only to increase efforts at reforestation but to encourage without delay the development of rural forestry in the context of an integrated rural development plan.

Keyword: Semiarid, Degradation, Environmental conservation, Forest policy

UNESCO

Management of natural resources in Africa: traditional strategies and modern decision-making
MAB Technical Notes 9, UNESCO, Paris, France, 81 pp., 1978, English

The modern decision-making process needed to be examined critically in order to take fully into account the impact of decisions on the environment and on human group behaviour. Indeed, rational and integrated management of natural resources cannot ignore the environmental impact of development projects, nor the values which traditional societies associate with their methods of natural resource utilization.

In modern Africa, as in traditional Africa, there are many examples of groups of people who share the same space, each group applying its own strategy to the same stretch of land. These strategies may compete or complement each other. The examples taken from the three major biogeographic zones of Western and Central Africa are representative in this respect; they constitute the three chapters of this Technical Note.

The main contents of this publication are as follows.

1. Traditional strategies, modern decision-making and management of natural resources in the Sudan-Sahel
2. Traditional strategies, modern decision-making and management of natural resources in Sudan Africa
3. Traditional strategies, modern decision-making and management of natural resources in forest and preforest zones of Africa

4. Conclusion

Keyword: Natural forest, Environmental conservation, Forest management, Forest policy

WESTERN AFRICA DEPARTMENT (WB)

Towards the development of an environmental action plan for Nigeria
Document of the World Bank, Western Africa Department, World Bank,
Washington, USA, Report No. 9002-UNI, 126 pp., 1990, English

The purpose of the Report is to provide policy makers with a framework for determining Nigeria's environmental priorities; a strategy for developing solutions to the country's environmental problems; and options for initial programs which could be introduced to alleviate the environmental concerns. The Report provides a holistic approach to the environment. It focuses its approach on the development of policies, institutional capacities, data management systems and economic mechanism designed to integrate the need for environmental quality with economic growth in Nigeria.

The Report focuses on four main areas:

1. identification of the direct and indirect causes of the key environmental problems of the country;
2. examination of the linkages between economic policies and environmental concerns and illustration of the role which economic policies might play in reversing these trends;
3. development of a framework within which to integrate environmental and economic concerns and to outline policy options targeted at redressing the environmental imbalance which currently exists; and
4. identification of areas where specific programs and projects could be developed in the pursuit of sustainable development.

Keyword: Environmental conservation, Forest policy, Sustainable management of forest

JEAN EUGENE GORSE & DAVID R. STEEDS

Desertification in the Sahelian and Sudanian Zones of West Africa
World Bank Technical Paper No. 61, World Bank, Washington, USA
62 pp., 1987, English

Desertification is defined as the sustained decline of the biological productivity of arid and semi-arid land. It is the result of pressures both human (increased population) and climatic (variable rainfall and long-term changes in climate). Three traditional production systems exist in the SSZ: agrosylvicultural, agrosylvopastoral, and sylvopastoral. Development activities have been tried in the past in the agriculture, livestock, and forestry sectors. Strategies for better resource management depend on the balance between the rural population and the carrying capacity of the land.

Within the SSZ heartland, no significant change in carrying capacities is possible without a technological breakthrough. Locally, however, the desertification threat may be arrested by selecting appropriate anti-desertification actions and working with communities that are interested, and empowered, to use their land in a sustained-yield manner. Reducing the continued rapid growth of population is crucial, and current population pressures in the heartland need to be alleviated by further encouraging the existing spontaneous movement of people to the under-populated, high-potential Sudano-Guinean zone.

Keyword: Semiarid, Desertification, Agro-forestry, Social forestry

UNESCO

The Sahel: ecological approaches to land use
MAB Technical Notes, UNESCO, Paris, France, 99 pp., 1975, English

A regional meeting on integrated ecological research and training needs in the Sahelian was held in Niamey (Niger), March, 1974. This meeting was organized by Unesco within framework of its Man and the Biosphere Programme (MAB). The objectives of the meeting were to define, on the one hand, the ecological studies that should be continued or undertaken in the region and, on the other hand, the types of land use and management practices that should be adopted. The reviews and analyses presented at the meeting have been assembled in the present publication, after having been modified and elaborated in the light of the discussion

at Niamey.

The present publication includes a number of proposals for immediate action. It should be clearly understood that the proposals put forward are derived a study of the interactions between man and his environment. They show that, in a fair number of cases, technical solutions and sound advice based on ecological research already exist. However, the application of this knowledge to regional land management and to the rational use of natural resources is largely conditioned by decisions based on social and political considerations. It is evident therefore that this Technical Note cannot ignore problems related to decisions of a social or political nature but cannot deal extensively with them.

Keyword: Semiarid, Environmental conservation, Forest policy, Forest management

GUNNAR POULSEN

**Man and tree in tropical Africa: three essays on the role of trees in the Africa environment
IDRC, Canada, 31 pp., English**

Increasing awareness has recently been shown in the ability of trees not only to produce a variety of products but also to provide and maintain favourable environmental conditions. In this time of environmental awareness and energy consciousness trees will play a more and more important role everywhere, and in particular in the tropics.

The first of the three papers in this book examines, in general, the role of the tree in tropical Africa. Highlighted are the variety of products that can be obtained from the forests, the vital role of trees in nutrient cycling and in soil and water conservation, and their influence on both the micro and macroclimate. The second essay addresses the ever important question of wood-fuel supplies. Wood-fuel shortages have led to a switch to other fuel sources such as manure and crop residues, which has in turn started a vicious circle of decreasing crop yields and environmental degradation. The final essay examines the age-old practice of shifting cultivation. Recent pressures resulting from increasing population have caused an imbalance in the system with increased erosion, leaching, etc. Suggestions advanced here for tailoring new ideas to this traditional practice may well make it possible to modify or improve the system to meet modern realities.

These papers taken together reflect a fresh approach to the role and importance of trees in Africa.

Keyword: Multiple purpose forestry, Fuelwood, Water conservation, Environmental conservation, Shifting cultivation

M.R. DE MONTALEMBERT & J. CLEMENT

**Fuelwood supplies in the developing countries
FAO Forestry Paper 42, FAO, Rome, Italy, 125 pp., 1983, English**

FAO was anxious to draw attention to the energy crisis: that of fuelwood, which affects the daily energy supplies of a great many rural people in the Third World. A study was therefore undertaken for the purpose of demonstrating the dependence of the Third World populations on fuelwood as a source of energy and identifying more precisely the emergence of ever more marked deficits, on the basis of up-to-date information.

The primary objective of the report is to draw the attention of the government concerned and of the international community to the seriousness of the problem before present trends become largely irreversible. In the second place the report aims at promoting a realistic view of the energy problem of most of the people in the Third World. The final purpose of the study is to prompt a rapid mobilization of efforts and resources with a view to immediate and large-scale action.

The study has brought out a major point: the situation regarding fuelwood supplies is deteriorating ever more rapidly in many regions owing to the growth in population and the dependence of the people on this fuel. The actions undertaken so far are, without exception, completely inadequate. Owing to the many aspects involved, action to improve fuelwood supplies can stimulate and induce a dynamic development movement based essentially on active participation and assumption of responsibility by the people concerned in efforts to meet their own needs.

Keyword: Fuelwood, Forest policy, Social forestry

R.H. SLADE & J. GABRIEL CAMPBELL

Monitoring and evaluation of social forestry in India - an operational guide

FAO Forestry Paper 75, FAO, Rome, Italy, 218 pp., 1986, English

The term 'social forestry' is difficult to define precisely, but is generally understood to mean 'tree-growing' (including associated products) for the purpose of rural development. As social forestry has a rural development focus and is heavily dependent on the active participation of people, it is also known as 'forestry for local community development' or 'participatory forestry'.

This guide has been prepared to help those responsible for monitoring and evaluating social forestry programs and projects in India. It provides detailed operational guidance on the organization, staffing and operation of monitoring and evaluation activities, and on the design and conduct of appropriate data gathering and processing systems. The guide is divided into two main parts. Part A comprises five chapters which provide an overall description of the recommended monitoring and evaluation system together with methods of organization and resource requirement. These chapters are directed particularly to program managers. Part B is composed of four largely technical chapters. These are intended to be read and studied by the staff of monitoring and evaluation units and to aid them in implementing the system. These chapters provide very specific guidance, including proformas, tables and working procedures.

Keyword: Social forestry, Evaluation, Community forestry, Guideline

I.I. ERO & J.E. ABU

Consideration of mangrove forest management in Nigeria

Paper for the Senior Foresters Conference, ITTO, Yokohama, Japan

21 pp., 1991, English

The Nigerian Mangrove belt which extends over an area of about 973,000 ha. contains numerous plants and Wildlife resources which are yet to be effectively utilized for the benefit of the people.

This paper examines the present level of mangrove resources utilization in Nigeria and identifies the research and manpower needs that will allow for a sustainable management of the resources. The need for the development of appropriate silvicultural and utilization techniques for the management of the natural forest is highlighted. Reliable data for the sustainable utilization of the area for large scale fisheries and wildlife conservation is also recommended for acquisition. The main constraint to the realization of the development of the mangrove resources is due to inadequate resources such as funds, trained manpower and materials. It is recommended that the Government seeks for external aid to support mangrove research.

Keyword: Mangrove, Sustainable management of forest, Forest development, Natural forest, Silvicultural technique, Forest utilization

MINISTRY OF FORESTRY, MALAWI

Survey and risk assessment of timber plantation

Ministry of Forestry, Malawi, 49 pp., 1986, English

The Malawi Forest Industry started in the early 20th century and Forest Reserves were declared primarily for the protection of the water catchment areas and subsequently to satisfy the demand for poles and fuelwood, previously met from indigenous forests. The Forest Reserves areas, which have been declared throughout the country, come under the control of the Forest Division. Such areas are mostly covered in indigenous forest and/or bush, and also incorporate those areas suitable for man made plantations. The initial planting were in the more densely populated areas of Blantyre, Zomba, Dedza and Mulanje. In many cases, the Eucalypts are planted in a strip varying between 50 meters and 200 meters wide along the base of Forest Reserve area to stop encroachment of the Forest Reserve and catchment areas by the local villagers. Once the trees have been planted, the villagers respect that the land is under utilization and do not encroach.

The Forest Division conducted the survey of eight plantations and had discussions with the chief foresters and/or his deputy.

This report is the results of the plantation survey.

Keyword: Plantation, Forest inventory, Forest management, Eucalypt Hard wood

UNESCO

Integrated project on arid lands (IPAL) – Kenya, project findings and recommendations
Serial No. FMR/SC/ECO/85/247 (FIT), UNESCO, Paris, France
101 pp., 1985, English

In Kenya, considerably more than half of the total land area of the country is semi-arid or arid rangeland inhabited by pastoral people with their livestock. A large proportion of this rangeland is undergoing progressive ecological degradation, resulting in decreasing levels of productivity and a reduced capacity to support the domestic herds upon which the pastoral people depend for their subsistence. An increasing number of people cannot at present be supported by the pastoral economy and are becoming dependent upon famine relief.

In order to explore these problems in depth and to develop scientifically-based strategies and guidelines for combatting desertification in areas with traditionally nomadic land use, Unesco and UNEP agreed in 1976, with the approval of the Government of Kenya, to set up a pilot operation of interdisciplinary research, training and demonstration in the Marsabit District in Northern Kenya. The Project was established, as it was entitled the Integrated Project on Arid Lands (IPAL), Northern Kenya.

This publication represents the terminal report on the implementation of Phase III of IPAL, in Northern Kenya. It is a combination of an administrative and logistic report and a summary technical report. The detailed scientific results of Phases I to III of IPAL Kenya including the Traditional Livestock Management Project (TLMP) have been presented in the IPAL Technical Notes series. A major final output of the IPAL Kenya operation is the Integrated Resource Assessment and Management Plan for the Western Marsabit District, Northern Kenya.

Keyword: Arid region, Desertification, Forest management, Degradation

WANJIKU MWAGIRU & PAL N. NJUE

A modern geography of Kenya
MWASSCO Publications, Nairobi, Kenya, 159 pp., 1986, English

This publication is a text book of the geography of Kenya, especially for students.

It contains numerous illustrations (maps, diagrams and tables), and the readers are advised to make use of these as they read through the text. Many local place names are given in the text and constant reference to the sketch maps will help the students in locating and identifying these various places. This exercise should give the students a detailed knowledge not only of their home provinces and districts, but also of the other provinces and districts within Kenya. The book also includes a comprehensive index at the back. This index contains in alphabetical order, the more important terms, concepts and words used in the text. The index is a quick reference which indicates the pages in the book where these terms and words are to be found and where they are defined and explained.

Keyword: Geographical feature, Handbook, Training

MINISTRY OF LANDS, NATURAL RESOURCES AND TOURISM

Tanzania forestry action plan, technical annexes volume 2
Ministry of lands, Natural Resources and Tourism, Tanzania, 1989, English

The Government of Tanzania has prepared the Forestry Action Plan as an important step in strengthening the country's efforts towards sustainable management of the forest resources. The Action Plan document is supported by thirteen technical annexes containing necessary background information.

This publication is technical annex volume 2.

The contents of the publication are as follows.

- VII Wildlife management
- VIII Conservation of ecosystems and genetic resources
- IX Forest and land use policy
- X People's participation
- XI Training and manpower development
- XII Forest research

- XIII Economic aspects and financing of forestry development
Keyword: Forest development, Forest management, Sustainable management of forest, Forest policy

MINISTRY OF LANDS, NATURAL RESOURCES AND TOURISM
Tanzania forestry action plan, technical annexes volume 1
Ministry of Lands, Natural Resources and Tourism, Tanzania, 1989, English

The Government of Tanzania has prepared the Forestry Action Plan as an important step in strengthening the country's efforts towards sustainable management of the forest resources. The Action Plan document is supported by thirteen technical annexes containing necessary background information.

This publication is technical annex volume I.

The contents of the publication are as followings.

- (1) Development of sustainable land husbandry
- (2) Community and farm forestry
- (3) Forest management
- (4) Bioenergy
- (5) Forest industry
- (6) Beekeeping

Keyword: Forest development, Forest management, Sustainable management of forest, Forest policy

MINISTRY OF LANDS, NATURAL RESOURCES AND TOURISM
Tanzania forestry action plan 1990/91-2007/08
Ministry of Lands, Natural Resources and Tourism, Tanzania, 128 pp., 1989, English

Our past efforts have had an insignificant impact on their contribution to the socio-economic development of the country. Deforestation is estimated to be advancing at an annual rate of 300,000 to 400,000 ha and it is rapidly accelerating. Much is due to clearing for unsustainable crop production and overgrazing which are both intermediate land uses. Forests are being converted into marginal areas and, as a result, degradation and even desertification are taking place. The nation's survival, not only in terms of soil productivity but also dessicating climatic change, will largely depend on how this fundamental problem is solved.

Recognizing these issues the Government embarked in 1988 on a long-term sectional planning effort to prepare the Tanzania Forestry Action Plan (TFAP). The main objectives were (i) to review past policies and development efforts, (ii) to formulate a long-term development strategy and to establish target; (iii) to prepare an Action Plan with development and institutional support programmes; and (iv) to present project profiles for the implementation of the plan.

TFAP is grouped into eight development programmes.

- (i) The Land Husbandry Programme
- (ii) The Community and Farm Forestry Programme
- (iii) The Forest Management Programme
- (iv) The Bioenergy Programme
- (v) The Forest Industries Programme
- (vi) The Beekeeping Programme
- (vii) The Wildlife Management Programme
- (viii) The Ecosystems Conservation Programme

Keyword: Forest development, Forest management, Sustainable management of forest, Forest policy, Forest utilization

J.A. MABBUTT & C. FLORET
Case studies on desertification
Natural Resources Research XVIII, UNESCO, Paris, France, 279 pp., 1980, English

Was the Sahelian drought evidence of large changes in the global climate? Was the Sahara expanding south? What implications did this have for the countries involved, for their neighbours and for the international community? The crucial question however was what could be done to cushion the impact of those disastrous

changes. In order to answer such questions, the General Assembly of the United Nations called a world Conference on Desertification, which was convened from 29 August to 9 September 1977 in Nairobi.

In the preparation of the conference, the conference secretariat provided a presentation of case studies that would illustrate the various processes of desertification and their causes and, more particularly, give an account of measures to combat desertification.

This included six case studies to be carried out under the direction of UNESCO, with the assistance of the Food and Agriculture Organization (FAO). To allow representative comparisons these studies comprised two regions of cool-season rainfall, two of hot-season rainfall, and two areas exemplifying the problems of waterlogging and salinization of soils under irrigation.

Each case study forms a complete background document, in sufficient detail to give a comprehensive account of the regional processes of desertification and their causes, the ecological aspects, and a review of the measures already taken or still required to be taken to reverse the processes. On the basis of this regional experience it formulates lessons learned, arising from the success of measures taken or from continuing problems.

Keyword: Desertification, Semiarid region, Degradation, Land conservation

P.E. NEIL

Problems and opportunities in tropical rain-forest management

**C.F.I. Occasional Papers No. 16, Commonwealth Forestry Institute,
University of Oxford, UK, 126 pp., 1986, English**

This thesis attempts to describe the problems and opportunities that exist in methods used to manage the complex ecosystem of the Tropical Rain Forest (T.R.F.). The emphasis is on natural regeneration (N.R.) of this forest type, although artificial regeneration methods are briefly discussed where appropriate.

Part 1 discusses the various factors that influence N.R. of T.R.F. and hence may affect the success of the silvicultural systems applied. Environmental influences are considered including the effects of water, soil, light, storms and biotic factors. This is followed by biological or intrinsic influences on N.R. and such things as population structure, abundance and growth, successional status, phenology and autotoxicity are discussed.

Part 2 is a history of T.R.F. management and looks at the development of T.R.F. silviculture from its beginnings in India and Burma in the 1850s and its spread to Asia, Africa and S. America.

Part 3 concludes the study with a discussion on the future prospects of T.R.F. of which the controversy over artificial versus natural regeneration is central.

Keyword: Tropical rain forest, Natural regeneration, Natural forest, Succession, Forest management

FAO

Operations manual for a protected area system

FAO Conservation Guide 9, Forestry Dep., FAO, Rome, Italy, 85 pp., 1984, English

Recent growth of protected area systems, particularly in the developing countries, has suffered from a lack of established system-wide policies and guidelines necessary to orient the planning, and subsequent management and administration of the protected areas as they become developed. This shortcoming has produced, in many cases, a lack of cohesion and consistency in the procedures, programs, and policies utilized by different areas within the same system.

Over the past decade, FAO has executed a number of projects related to protected areas. This has afforded the Organization unique opportunities to accumulate knowledge on the surveying, planning, establishment, development and management of national parks and various other categories of reserves. This publication is an attempt to aid the countries which have yet to prepare a document, generally called an operations manual, which would help to resolve the above-mentioned problems. It is understood that each protected area system is subject to a unique set of circumstances which will govern the content of an operations manual. Therefore, the contents of this publication will present only a potential format, and some of the different options possible for each specific topic presented. It should be viewed as a set of possible alternatives and considerations for the numerous management and administrative policies which must usually be established for a protected area system.

Keyword: Forest protection, Forest management, Environmental conservation, Guideline, Land

conservation

FAO

Role of forestry in combating desertification

FAO Conservation Guide 21, Forestry Dep., FAO, Rome, Italy, 333 pp., 1989, English

As a satellite meeting to the Ninth World Forestry Congress, FAO organized an Expert Consultation on the role of forestry in combating desertification which was held in cooperation with the Ministry of Agriculture and Water Resources (SARH) of Mexico, in Saltillo, Mexico, from 24 to 28 June 1985.

The purpose of the Consultation was to review and assess the present state of knowledge in the field of forestry in arid zones as it relates to rural development and the control of desertification, discuss research and application of existing knowledge, exchange ideas and experiences, outline actions needed and define a framework which would orientate future development programmes at the national, regional and international levels.

The Consultation formulated a strategy on the role of forestry in combating desertification, identified the main objectives of an arid zone forestry programme and action proposals to enhance the role of forestry in rural development and the fight against desertification.

The structure of the package of proposals designed to foster forestry's contribution to checking and reversing desertification corresponds to three main areas, namely:

- production, utilization and processing systems,
- conservation and restoration systems,
- policy, institutions and socio-economic aspects.

Keyword: Desertification, Semiarid, Environmental protection, Afforestation, Land conservation

FAO

Arid zone forestry: a guide for field technicians

FAO Conservation Guide 20, Forestry Dep., FAO, Rome, Italy, 143 pp., 1989, English

Half of the countries of the world lie partly or wholly in arid and semi-arid zones. These zones, together with their sub-humid margins, or the so-called dry lands, cover a total area of about 45 million km² or one-third of the total land area of the world. Ecological degradation develops at an alarming rate in the areas and threatens the livelihood of some 850 million inhabitants.

This manual has been prepared as a working guide for field technicians involved in arid zone forestry practices. As such, it is more of a "here's how" publication than a detailed explanation of the theory and practice of forestry. Field technicians interested in more details on the technical subjects presented are encouraged to review appropriate references on these topics.

In presentation, the manual is organized into ten sections, including a general description of the arid environment, the function and place of trees and shrubs in arid zones, techniques of nursery operations in arid regions, the establishment and management techniques of forest plantations, special forest plantations, irrigated forest plantations, rehabilitation of saline environment, non-wood forest products, the involvement of local people, and tree and shrub species for arid zone forestry.

Keyword: Guideline, Arid region, salinity, Silvicultural technique, Plantation, Non-timber products

FAO

Intensive multiple-use forest management in the tropics: analysis of case studies from India, Africa, Latin America and the Caribbean

FAO Forestry Paper 55, Forestry dep., FAO, Rome, Italy, 180 pp., 1985, English

Case studies on intensive multiple-use forest management were conducted in Kerala (India), Ghana, Honduras and Trinidad and Tobago. Each study describes the forest and the ecological, socio-economic, political and administrative factors influencing forest management in the area and the forest management systems themselves including multiple-use of the resource. The systems are evaluated in relation to stated socio-economic objectives and the possibilities and constraints for further development are discussed. Part I of this paper is a synthesis of the findings derived from these studies and in Part II, each study is presented in a

summarized form.

Keyword: Forest management, Multiple purpose forestry, Forestry policy, Ecology, Social and economic analysis

FAO

Small scale forest-based processing enterprises

FAO Forestry Paper 79, Forestry Dep., FAO, Rome, Italy, 246 pp., 1977, English

The work reported on in this publication forms part of FAO's programme of policy analysis studies. These are intended to provide information about the linkages between the forestry and forest products sector and rural and overall development, and to identify needs for change within the sector as the demands upon it evolve and change.

Small-scale forest-based processing enterprises comprise an important, but neglected, part of the forestry and forest industries sector. They process a large part of the raw materials from the forest and supply some of the main markets for forest products, in particular in the rural areas of developing countries. Our concern in the work reported on in this publication has been to determine the main features, prospects and problems of such small-scale enterprises and what support could enhance their developmental contribution, and therefore the developmental impact of the forest sector.

Keyword: Forest policy, Wood utilization, Industry of forest products, Wood work

FAO

Natural resources and the human environment for food and agriculture

**FAO Environment Paper 1, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
62 pp., 1980, English**

At the beginning of the present century the world population was a little more than 1,500 million; but it rose to 2,500 million in 1950 and 4,000 million in 1975. By the year 2000 it is expected to reach about 6,300 million, of which about two thirds will be in the developing countries. To feed these people and to improve their quality of life, it will be necessary in the next 25 years to more than double the production from agriculture, fisheries and forestry. The unprecedented rise in population has already placed considerable pressure on natural resources and has in many cases led to their degradation and depletion. In the future this pressure will become even greater.

Taking these factors into consideration, FAO, has prepared this report on Natural Resources and the Human Environment for Food and Agriculture. The report is a first attempt to interrelate at global level population pressure, natural resources use and management, with particular reference to increased food and agricultural demand and the ensuing environmental issues.

The attempt was made not only to review the issues and challenges to be faced in managing these finite resources to meet the increased demand for agricultural production, but also to assess the impact of the unprecedented increase in population, and the associated socio-economic changes, on the state of those resources and the environment generally.

Keyword: Environmental protection, Food production, Natural resources, Forest resources, Social and economic analysis

FAO

Environmental impact assessment and agriculture development

**FAO Environment Paper 2, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
131 pp., 1982, English**

The subject of environmental impact assessment (EIA) has generated an abundance of writings both legal and technical. Where the author has sought to introduce a fresh note is in treating of an aspect that so far has received less than its due by way of research, namely the EIA of agricultural development. The study sets out first to consider the juridical and administrative aspects, next to describe the present status of the question; and, finally, to indicate the various sources of information and the diverse avenues of research that can be followed wherever it is wished to take certain points to greater depth.

The Annexes contain two case studies.

Keyword: Environmental assessment, Forest policy, Food production, Deforestation

FAO

Management and utilization of mangroves in Asia and the Pacific

**FAO Environment Paper 3, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy,
160 pp., 1982, English**

Most studies on mangroves have dealt with only particular aspects and there is an obvious lack of comprehensive studies considering both environmental and socio-economic factors in the entire mangrove ecosystem. This publication provides basic information on the resource and its management in the Asia and Pacific region and throws light on the complex problems connected with various forms of land-use in mangrove areas.

The report concerns itself with mangrove resources, its utilization and management, it lays emphasis on the environmental relationships between forestry, fisheries and agriculture. Land-use options for mangrove areas are also discussed. In a case study in Thailand, the utilization of mangrove resources by local communities has been quantified and socio-economic aspects include estimates of the gross annual income derived from various forms of land-use. The report is primarily directed to land-use planners, forest managers, mangrove silviculturists, and development planners, and those concerned with brackish-water aquaculture and marine fisheries.

Keyword: Mangrove, Land-use, Forest resources, Forest management, Forest utilization

FAO

Mangrove management in Thailand, Malaysia and Indonesia

**FAO Environment Paper 4, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy,
60 pp., 1985, English**

A previous FAO Environment Paper, "Management and Utilization of Mangroves in Asia and the Pacific" (1982) provided basic information on the mangrove resources and their management in 14 countries in the Asia and Pacific region with special reference to the environmental relationships between forestry, fisheries and agriculture. Over a third of the total area of the world's mangroves occurs in South East Asia. It is in this region that mangroves are richest in species composition and most luxuriant in growth. Some 40 tree species are found of which less than half are used commercially.

The aim of this study is to review the present knowledge of mangroves in Thailand, Malaysia and Indonesia, assess the resources and their uses and formulate a strategy for sustained multiple use management of the mangrove ecosystems. The study addresses itself to the status and potential of integrated management of the mangrove ecosystem in three countries in the same region where this resource has been managed and utilized for many years, and where information and experience therefore exist, that may provide a more detailed insight in the problems and possibilities related to sustained yield management.

Keyword: Mangrove, Sustainable management of forest, Forest utilization, Ecosystem, Forest management

FAO

Natural resources and the human environment for food and agriculture in Africa

**FAO Environment and Energy Paper 6, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
83 pp., 1986, English**

The Tenth FAO Regional Conference for Africa recommended that a report on the state of natural resources for food and agriculture, including mineral resources, be prepared for the Africa Region to complement the development and implementation of the Food Plan for Africa.

The present report has been prepared in response to this recommendation. It surveys the state of the principal natural resources for food and agricultural production in Africa, and some of the more critical problems that have arisen from man's growing demands on these resources. It draws on the most recent information available from FAO and elsewhere.

The greater part of the report consists of an overview of present knowledge of the extent, state and

potential of natural resources for food and agricultural production (including fisheries and forestry) in Africa, and of related environmental issues. The final part of the report attempts to draw some preliminary general conclusions on the state of the natural resources for food and agricultural production in Africa, and on some of the requirements for their better assessment and management.

Keyword: Food production, Natural resources, Forestry, Environmental conservation

FAO

**Report on natural resources for food and agriculture in the Asia and Pacific Region
FAO Environment and Energy Paper 7, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
118 pp., 1986, English**

A global survey of natural resources and the human environment for food and agriculture has already been prepared by FAO (1980).

During the past decade, countries of the Asia and Pacific Region have made substantial progress in meeting their food, fuel and fibre needs. However, a growing population is making increasing demands on the natural resources for agriculture, forestry and fisheries. It is therefore vital to conserve the productivity of these resources through rational management and application of appropriate technologies. This present report surveys the state of the principal natural resources in the developing countries of Asia and the Pacific and some of the critical problems that have arisen from the growing demands being made on these resources. The report is a preliminary survey only, which will require revision and updating as better data becomes available.

The greater part of the report consists of an overview of the extent, state and potential of natural resources for food and agricultural production (including fisheries and forestry) in the Asia and Pacific Region, and related environmental issues. This is followed by a brief account of specific problems arising from the environmental impact of development activities.

Keyword: Natural resources, Forest resources, Food production, Forestry, Environmental assessment

FAO

**Report on natural resources for food and agriculture in Latin America and the Caribbean
FAO Environment and Energy Paper 8, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
102 pp., 1986, English**

Migration to urban areas is a serious problem in the region because of the numbers of people involved, and the political and economic implications. It is estimated that 75% of the population of the region will be living in cities by the end of the century. This growing urban population will make increasing demands on natural resources for agricultural, forestry and fishery products. Most of the rural people live on the more marginal lands where productive agriculture is difficult to sustain, and there is persistent poverty and intensive use of natural resources. Although colonization of new lands may eventually contribute to agricultural production, the significant increases will likely come from intensifying production on existing fertile lands.

This report examines the role of natural resources in agricultural and rural development in Latin America and the Caribbean, and reviews some of the problems in managing these resources to meet increasing needs. It is an initial attempt to relate natural resources potential and ecological conditions to food and agricultural production in the region.

Keyword: Natural resources, Forest resources, Food production, Ecology, Environmental condition

FAO

**Environmental guidelines for resettlement projects in the humid tropics
FAO Environment and Energy Paper 9, Forestry Dep. & Fisheries Dep., FAO, Rome, Italy
67 pp., 1988, English**

During the past ten years, there has been an increasing emphasis on identifying and avoiding the negative effects of development activities on the environment. Many countries, international organizations and bilateral assistance agencies use or are considering the use of environmental impact assessment (EIA) procedures as one way of dealing with environment/development conflicts.

Resettlement refers to the relocation of individuals, family groups or entire villages. There are two main forms of resettlement. The first is the spontaneous movement of individuals or entire communities that takes place largely without assistance from official government agencies. The second is the officially funded, planned and managed programmes or projects. In practice, both forms of resettlement can occur for similar reasons and can be found in similar locations. These guidelines deal mainly with planned resettlement, however they can be used to review spontaneous resettlement activities.

This report is the first result of an ongoing effort to provide practical advice and guidance to the specialists who formulate resettlement and other development projects, and to the environmental specialists who review these projects.

Keyword: Guideline, Environmental conservation, Forest policy, Deforestation, Social and economic analysis

G.C. STOCKER

**Effects of fires on vegetation in the Northern Territory
Australia Forester, Australia, 224-229, 1985, English**

Annual burning is practiced over nearly the whole of that part of the Northern Territory which has an annual rainfall of more than thirty-five inches. The remainder of the Territory is burnt at greater intervals.

Before the arrival of aboriginals fires would have been lit by natural agencies, especially lightning. The aboriginals used fires extensively for hunting and access clearing. Europeans have adopted a burning regime similar to that established by the aboriginals, for fire has been found to be a cheap and valuable tool in the management of much of the Territory's range lands.

The vegetation of the Territory in the area of annual or frequent burning appears well suited to regular burning, and is probably dependent upon fire for its maintenance. The vegetation in arid and semi-arid areas is more fire-sensitive. The interval between fires in these areas may be considerable because unusually heavy rainfalls are required to produce enough grass to carry a fire. Fires rarely occur in the small areas of monsoon forest.

Keyword: Burning, Clearing, Vegetation

A.L. McCOMB & J.K. JACKSON

The role of tree plantations in savanna development, 8-18, English

Various writers stress the roll of fire in forming and maintaining many existing savannas. Regardless of what ecological factors give rise to savannas it should be stated here that the present size and appearance of savanna trees can give an entirely erroneous picture of the potential productivity of many sites and, in fact, of their present productivity when planted with some exotics.

Keyword: Plantation, Savanna, Afforestation, Soil improvement

D.U.U. OKALI

**Africa: research to conserve the environment
Unasylya 34(136), FAO, Rome, Italy, 2-7, 1982, English**

This paper provides an overview of recent research to conserve the environment in Africa.

In setting priorities for forestry research in Africa, therefore, pride of place must go to conservation research, and here the immediate task is the elaboration of methods to increase the productivity and efficiency of ecosystem utilization. Information on productivity and carrying capacities for species of interest will be needed to plan sustained utilization. There are large gaps in the study of plant response to tropical environments. Field, or at least whole-plant, physiological studies need to be intensified in order to understand factors controlling growth periodicities in tropical environments. Much research remains to be done on tropical ecosystems before generalizations can be made on plant and animal response and behaviour patterns.

The paper indicates that every aspect of biological research can contribute something because of the great diversity of plant and animal life, the complexity of structure and organization and the variety of adaptive processes induced by these attributes.

The paper also mentions the importance of the implementation of the network idea for research in forest

resources and the means of conveying research findings to decision makers, resource developers and users.

Keyword: Environmental conservation, Research and development, Ecosystem

ANDRE MARIE A. AUBREVILLE

The disappearance of the tropical forests of Africa

Unasyiva 37 (148), FAO, Rome, Italy, 18-27, 1985, English

This article appeared in the very first issue of Unasyiva, in July–August 1947. Thirty–eight years later, it still seems relevant and timely. It shows that Africa's present crisis is not something that emerged suddenly and unexpectedly out of nowhere. It even, in retrospect, provides hope that things can be changed. And it shows how critical are forests – and reforestation – to the whole process of development in Africa.

It also indicates that the salvation of Africa is a gigantic task, requiring great tenacity for several generations, that can be achieved only if undertaken on an international scale.

Keyword: Tropical forest, Deforestation, Degradation, Reforestation

DAVID A. PERRY & JUMANNE MAGHEMBE

Ecosystem concepts and current trends in forest management: time for reappraisal

ICRAF Reprint, International Council for Research in Agroforestry, Nairobi, Kenya

No. 68, 123–40, 1989, English

Large areas of natural forest ecosystems are being converted into industrial plantations in tropical, subtropical and temperate regions. In the short term, this seems to maximize returns from investment and to homogenize the raw material base for forest industries. It is argued here that society will continue to use more wood and foresters must produce it; in doing so, however, it is imperative that the immense importance of biotic diversity in containing pests and pathogens, in maintaining current levels of production in perpetuity, and in moderating the global climate should be addressed. Current criteria for economic evaluation do not adequately address these and other important considerations accruing from the management of whole forest ecosystems.

Keyword: Ecology, Ecosystem, Plantation, Natural forest, Monoculture, Global forest management

P.L. MITCHELL & K.J. KIRBY

Ecological effects of forestry practices in long–established woodland and their implications for nature conservation

O.F.I. Occasional Papers, Oxford, UK, No. 39, 172 pp., 1989, English

Concern has been expressed about the damaging effects of modern forestry practices in Great Britain on the nature conservation values of long–established woodland. It is less often appreciated how far traditional forestry practices such as coppicing themselves altered the structure and composition of the original forests. This review compares the effects of modern and traditional forest practices on the soils, flora and fauna of British woods. Effects are allocated (as far as possible) between those due to a change of tree species, those caused by changes in stand or woodland structure and those due to other changes which take place under modern forestry management such as fertilization, or the application of pesticides.

Keyword: Environmental conservation, Ecology, Forest operation, Succession

CARLOS H. CRISOSTO, DAVID A. GRANTZ et al.

Effects of water deficit on flower opening in coffee (*Coffea arabica* L.)

Tree Physiology, Heron Publishing, Victoria, Canada, Vol. 10(2), 127–139, 1992, English

The response of coffee (*Coffea arabica* L.) floral buds to different water deficits followed by re–irrigation was investigated. Flower opening was stimulated by irrigation after one period of water deficit if predawn leaf water potential declined below -0.8 MPa. Similar stimulation of flowering was observed when less severe but more prolonged water deficits (ca. -0.3 to -0.5 for two weeks) were imposed, even if water deficit was relieved by re–irrigation several times during this period. Consistent results were obtained in the

field and in two greenhouse locations. Stimulation of flower opening by water deficit followed by re-irrigation was restricted to buds at the "open white cluster" stage of development (stage 4). Only buds at this stage exhibited development of secondary xylem. Split-root experiments indicated that a root signal stimulated flower opening, independently of predawn or midday leaf water status. Frequent irrigation to prevent flowering, followed by a controlled water deficit and re-irrigation to stimulate flowering, may represent a practical method to synchronize flowering and shorten the harvest period in leeward coffee production areas in Hawaii.

Keyword: Flowering and fruiting, Watering, Soil moisture

T.C. WHITMORE

A first look at *Agathis*

CFI Tropical Forestry Paper, Oxford, UK, No. 11, 54, 1977, English

Foresters in countries where *Agathis* occurs naturally have long been interested in the genus for its many excellent qualities, but attempts at its cultivation in plantations have met with several difficulties. A solution to these problems would be of particular value in countries outside its natural range, where *Agathis* may be considered as a crop.

In 1974, the Ministry of Overseas Development agreed to finance a research scheme for the study of *Agathis* based at the Commonwealth Forestry Institute, to be undertaken by Dr. Whitmore, who had previously investigated *Agathis macxophylla* in the Solomon Islands.

This report summarises the results of a wide ranging survey of the ecological and morphological properties of the genus particularly relevant to its silviculture.

Keyword: Ecology, Tree species, Conifer, Genetic resources

V.P. SINGH, L.P. MALL, A. GARGE & S.M. PATHAK

Human impact assessment on mangrove forests of Andaman Islands

The Indian Forester, India, Vol. 116(2), 131-139, 1990, English

A comparative study of disturbed and undisturbed mangrove forests of Andaman has been done. It was noted that mangrove forests of Andaman Islands are one of the best mangrove forests of the world having high floristic richness, complexity index and biomass production. Rapid development and population inflow in the Islands has resulted in the clearance of certain areas of mangrove forests, due to which many species *Bruguiera gymnorhiza*, *B. cylindrica*, *B. parviflora*, *B. sexangula*, *Rhizophora lamarckii*, *R. stylosa*, *Ceriops tagal*, *Lumnitzera racemosa*, *Sonneratia apetala* and *Nypa fruticans* have been affected. The values of biomass, litter-fall, litter decomposition, soil respiration were greater in undisturbed forests.

Keyword: Mangrove, Biomass, Litter layer

C.M. HLADIK, S. BAHUCHET & I. de GARINE

Food and nutrition in the African rain forest

UNESCO/MAB, Paris, France, 96 pp., 1990, English

The documents presented here, selected from the interdisciplinary work of the of the research team "Anthropologie Alimentaire Differentielle" (CNRS, Paris), illustrate this large range of variations concerning different populations throughout the African forest block. This booklet cannot pretend to cover the extensive knowledge in various areas of biology and anthropology. It was designed as an extension of a poster exhibition held in Paris. The aim of this booklet is to preserve the visual aspects of this presentation. Basic references are given and, in addition to published results, here is included data which, although they are as yet incompletely processed, already have a contribution to make towards this first synthesis about the feeding strategies of African forest people.

Keyword: Tropical rain forest, Food production, Multiple purpose forestry

UNESCO

Map of the world distribution of arid regions

MAB Technical Notes, UNESCO, Paris, France, 54 pp., 1977, English

This document could have been prepared in two different ways. It could have followed the map closely, and listed the bioclimatic features of the four main aridity zones: hyper-arid, arid, semi-arid and sub-humid. But a presentation by subdivisions of the aridity zones would have inevitably led to repetition. On the other hand, it was possible to follow a more regional and more geographical approach, by describing separately the different arid regions of the various conditions. In the end, this second approach was adopted, because it facilitated the task of those with a particular interest in a specific region.

The categories used are thus essentially geographical regions. However, for convenience, some groupings are defined by the names of the main countries concerned. It is clear that the ecological limits of these groupings do not necessarily coincide with the political boundaries of the states concerned.

In each region, climatic characteristics and dominant vegetation patterns are described, mentioning, where possible, the most characteristic or most useful plants. Hydrology, main soil types and main land uses complete the information given.

Keyword: Climatic type, Vegetation, Hydrology, Geographical feature, Arid region

G.E. WHITE

Environmental effects of arid land irrigation in developing countries

MAB Technical Notes, UNESCO, Paris, France, No. 8, 68 pp., 1978, English

Based on an international workshop held in Alexandria in February 1976, this Technical Note examines both the beneficial and negative effects of irrigation in developing countries. Analysis is made of the interrelationships among the many components of the irrigated system. Technical problems frequently associated with irrigation, such as salinization, waterlogging and alkalization are discussed as well as human biological and socioeconomic dimensions.

This Technical Note stresses the importance of using an integrated approach in research on irrigated ecosystems and in both managing and planning irrigation projects. Areas where such research is urgently needed are identified, suggestions made for improving the efficiency of existing schemes and criteria proposed for evaluating possible new projects.

Keyword: Irrigation, Salinization, Alkalinization, Environmental assessment, Arid region

C.F. JORDAN

An Amazonian rain forest

Man and the Biosphere Series, UNESCO, Paris, France, Vol. 2, 176 pp., 1989, English

The contents of this book arose from an intensive study of the ecology of the rain forest at a research site in the Amazon Territory of Venezuela, at San Carlos de Rio Negro. The book does not, however, attempt to present the results of the whole of that study, which represented a major research project with international funding and support. It concentrates, instead, on a limited range of questions related to nutrient stress in tropical rain forest, namely:

- (1) Are the plants and animals of rain forest under nutrient stress, and, if so, how have they adapted to that stress?
- (2) What are the effects of slash and burn agriculture on the nutrient status and productivity of tropical forest sites?

The answers to these questions are of crucial importance for the management and conservation of tropical forest, and it is necessary, therefore, to consider the extent to which the results obtained at San Carlos can be applied to other tropical forests.

The book is a personal assessment by the author of the results that he obtained from his work on the San Carlos project and not every tropical forest ecologist may agree with that assessment. The results are published here so that they can be read, discussed and criticized by other scientists, for that is the way in which science 'works'.

Understanding the dynamics and ecology of these forest systems is essential if we are to make the right decisions about their conservation or about their exploitation for timber and conversion to agriculture. This book deals with one important aspect of that ecology, ie. the nutrient status of the forests and the fate of those

nutrients when the forest is cleared.

Keyword: Tropical rain forest, Ecosystem, Shifting cultivation, Succession

K.S. BAWA & M. HADLEY

Reproductive ecology of tropical forest plants

Man and the Biosphere Series, UNESCO, Paris, France, Vol. 7, 421 pp., 1990, English

The international workshop on the reproductive ecology of tropical forest plants was held at the University Kebangsaan Malaysia in Bangi, Malaysia, from 8–12 June 1987.

This volume represents the principal substantive output of the Bangi workshop. It presents a review of recent research in plant reproductive ecology, defined to include all stages of reproduction from the initiation of flowering to seedling establishment. The focus is on lowland tropical rain forests of Asia, Africa, Australia and the Americas. The book explores the implications of recent findings to improved understanding of forest structure and functioning, and examines how insights gained from reproductive ecology can be helpful in the management and conservation of tropical forest resources. As such, the book complements another title in the Man and the Biosphere Series, that on *Rain forest regeneration and management*.

The content of the book comprises eight sections. The first section consists of the introductory chapter, which emphasizes the practical application of research in plant reproductive ecology. The next six sections on Phenology, Plant-pollinator interactions, sexual systems and gene flow, Seed and fruit dispersal, Seed physiology, seed germination and seedling ecology, Regeneration, and Reproductive biology in relation to tree improvement programmes, are each preceded by a commentary which seeks to provide a general perspective for the papers and highlight their main points. The final section consists of a concluding statement about the workshop and the general state of tropical forestry.

Keyword: Tropical rain forest, Ecology, Phenology, Seed, Regeneration

TIM NOAD & ANN BIRNIE

Trees of Kenya - a fully illustrated field guide

T.C. Noad and A Birnie, Nairobi, Kenya, 308 pp., 1989, English

This book is a field guide, not a botanical text-book. It includes most of the common trees of Kenya, and covers both indigenous and exotic species, meaning trees introduced from other countries. However, the 300 or so species described covers less than a quarter of the trees that may be encountered somewhere in this diverse and beautiful country, and many species that are locally prominent, often in drier areas or at the coast, have therefore had to be omitted. The main emphasis is on the trees of the Nairobi area, with a selection of outstanding trees from other parts of Kenya.

The line drawings illustrating each species will help with identification. The text is arranged to complement the drawings, and although the descriptions are detailed, botanical terms have been kept to a minimum. The measurements given are guidelines, because many variations will be found; for instance, young leaves are often much larger than mature leaves, and a tree near water may be much taller than its counterpart in a dry area.

No key has been attempted, because the botanical detail required makes it impossible to devise a key simple enough to be helpful to the non-botanist. A key is in any event probably of value only where all species have been included, which is well beyond the scope of this book.

Keyword: Tree species, Arid region, Semi-arid region, Flora

UNESCO

The vegetation of Africa

Natural Resources Research XX, UNESCO, Paris, France, 356 pp., 1983, English

This publication comprises three map sheets at a scale of 1:5000000, a legend and the present accompanying memoir.

A feature of the Unesco/AETFAT/UNSO *Vegetation Map of Africa* is that, in the legend, the mapping units are grouped in the traditional manner according to physiognomy, whereas in the text, here, they are grouped

according to the floristic regions in which they occur. There are thus two interconnected classifications, which can be used independently but are fully cross-referenced. The legend permits easy comparison of African vegetation with that of other continents, whereas in the text it is possible to deal effectively with complicated spatial and dynamic relationships.

Keyword: Vegetation

2. SILVICULTURE

2-1 Choice of Species

- trials of species, provenance trial, etc. -

JOHN B. HALL & G.M. ASGHEDOM

Assessment 1979 of *Eucalyptus camaldulensis* plantings at Kigwe, Dodoma district, Tanzania
Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam,
Tanzania, Record No. 18, 17 pp., 1981, English

In August/September 1979 performance of *Eucalyptus camaldulensis* provenances grown in three experiments at Kigwe, Dodoma District, Tanzania, were assessed for survival, mean height, mean diameter at breast height and straightness grade.

In the first experiment (756) provenances from Alice Springs, N.T., Fortesqueh River, W.A., Moree, N.S.W., Newcastle Waters Creek, N.T. and Spear Creek, N. Qld. had been planted, in December 1970. The Moree provenance had died already. Among the remaining four the 1979 assessment revealed a significant difference only in survival - there was better survival with the Fortesqueh River and Newcastle Waters Creek provenances than the others.

In the second experiment (756B) provenances from Bubbles Well, W.A. and Goodairs Creek, N.T. had been planted, in January 1972. The 1979 assessment revealed a significant difference only in straightness grading with form being better in the provenance from Bubbles Well.

In the third experiment (759) a single provenance - from Mwanza, Tanzania (initial origin unknown) was planted in January 1972. This was not replicated. No statistical comparisons could be made involving data from this experiment.

For every parameter assessed performance was poor. Only one provenance (Mwanza) displayed a mean annual height increment exceeding 1 m (1.03 m) and a mean annual diameter increment exceeding 1 cm (1.26 cm). No provenance gave survival percentages as high as 50%; the best survival (49%) was in the Goodairs Creek and Newcastle Water Creek provenances. Straightness grades were low throughout.

Regarded in the context of previous assessments of the experiments it was clear that performance had been poor throughout the duration of the experiments. The Kigwe results also compare unfavourably with *E. camaldulensis* performance elsewhere. It is concluded that there would be no advantage, nevertheless, in using alternative species. Instead, efforts could be made to obtain better performance from *E. camaldulensis* under the prevailing conditions. Additional provenances might prove more productive but the main steps recommended are increased espacement, more elaborate establishment procedures and more thorough protection from fire and termites. Before final conclusions are drawn about the relative suitability for the area of the various provenances, however, a new trial with improved management should be carried out.

Keyword: Eucalypt, Provenance test, Growth rate, Survival

FOREST DIVISION, MINISTRY OF NATURAL RESOURCES AND TOURISM, TANZANIA

Management practices in conifer plantations in Tanzania

Forest Division, The Ministry of Natural Resources and Tourism, Tanzania, 68 pp., 1982, English

Many forecasts made by FAO indicate that there will be a high demand of wood towards the end of the twentieth century which cannot be met from natural forests in many tropical countries. Tanzania is one of these countries which faces a number of problems in meeting the projected demand from natural forests because most of her natural forests have been disappearing fairly fast due to increasing population and constant misuse of the forest. With these facts in mind there were strong reasons for introducing plantations of exotic tree species in Tanzania. The first attempts of introducing conifers were made in 1902 with *Pinus radiata* D. Don. without success. The failure were associated with lack of mycorrhizal associates. Many pine species were successfully introduced later in Tanzania after being inoculated with mycorrhizal soil from the *P. radiata* plantation.

The most widely planted species in Tanzania to date include *P. patula* and *Cupressus lusitanica* followed by *P. elliotii* and *P. caribaea*. Other promising species include *P. oocarpa*, *P. kesiya* and *P. taeda*.

This publication highlights management experience gained in raising these species in plantation under Tanzania conditions.

Keyword: Pine, Plantation, Exotic tree species, Silvicultural technique

FAO FORESTRY DEPARTMENT

Food and fruit-bearing forest species 1: Examples from Eastern Africa

FAO Forestry Paper 44/1, FAO, Rome, Italy, 172 pp., 1983, English

This publication have prepared monographs of 40 forest food and fruit-bearing forest species. It describes the fruit and food and products that can be obtained from wild forest tree. Many of the species described have other useful features: they provide protection from the environment, harbour for wildlife, wood, fibres and medicines for man use.

These monographs are presented with their description and illustrations, which cover, among other things, the natural distribution; forest type and abundance in natural stands; collection and processing of the edible parts; nutritional value (when this is available); natural and artificial regeneration and, where possible, potential economic importance. The botanical descriptions and illustrations assist in identifying the species and promoting an appreciation of their usefulness.

Keyword: Fruit tree, Savanna, Natural regeneration, Artificial regeneration

DEREK B. WEBB, PETER J. WOOD & JULIE SMITH

A guide to species selection for tropical and sub-tropical plantations

Tropical Forestry Papers 15, Department of Forestry, University of Oxford, UK

34 pp., 1980, English

This publication is not a scientific treatise on the site requirements of different genotypes. The aim of the publication is to assist foresters in the selection of species for inclusion in the initial phase of forest species trials programmes. The intention is not to recommend particular species for specific site or climatic conditions, or plantation objectives. The choice of species for inclusion in the trials is one of the first steps in planting programme.

The site conditions consist of climatic and edaphic factors, each of which in turn depends on such basic elements as temperature and humidity in the case of the climate, and chemical and physical properties in the case of soil. A schematic representation of the combination of the major factors involved in species selection is given on page.

The first aim of the present publication is to provide available information on certain species in a concise and compact form. The guide is simply a compilation of previously reported data on species' characteristics, often amplified by personal experience of their performance in the field.

A total of 125 different species, varieties and provenances are presented in this publication.

Keyword: Plantation, Species trial, Site condition, Choice of species, Guideline

FAO

Databook on endangered tree and shrub species and provenances

FAO Forestry Paper 77, Forestry Dep., FAO, Rome, Italy, 524 pp., 1986, English

Based on a list of species in need of attention drawn up by the FAO Panel of Experts on Forest Gene Resources, 81 monographs on endangered woody species and provenances were prepared in collaboration with researchers and institutes from all over the world.

The list of species included is by no means a complete list of endangered woody species, but represents a cross-cut of those species which the Panel considered should urgently be included in genetic resources programmes.

The main purpose of the present book is to draw the attention of decision-makers, scientists and international and national organizations to the conservation needs of the species included in the book.

The book includes information on the botany and silvics of the species, as well as their status in terms of genetic depletion; and outline action needed to conserve existing genetic variation in them.

Keyword: Tree species, Shrub, Handbook, Genetic resources, deforestation

FAO

***Prosopis tamarugo*: fodder tree for arid zones**

FAO Plant Production and Protection Paper 25, FAO, Rome, Italy, 110 pp., 1981, English

This report offers a critical review of background material available on the species known as *tamarugo*, *Prosopis tamarugo* Phil., (Mimosaceae), native of northern Chile.

The main purpose of the analysis is to contribute further to what is already known about this interesting desert fodder tree, in the hope of stimulating more research in Chile, and encouraging experimentation in desert areas elsewhere in the world.

The initial studies defined the adaptation capacities of certain animal breeds, the resistance of *tamarugo* to salinity and how its tap roots use ground-water. The studies revealed a highly significant fact: under certain conditions of atmospheric humidity, *tamarugo* absorbs water through its leaves, transporting it to the root system and depositing it in the micro-rhizosphere, whence it is reabsorbed along with the soil nutrients.

Keyword: Salinity, Fodder tree, Arid region

FAO

Some medicinal forest plants of Africa and Latin America

FAO Forestry Paper No. 67, Forestry Dep., FAO, Rome, Italy, 252 pp., 1986, English

The 40 monographs on medicinal trees and shrubs presented in this book were prepared in collaboration with 9 institutes in Africa and Latin America. They include information on the botany and silvics as well as the chemical properties and pharmaceutical and traditional uses of each species. The book is a companion volume to earlier publications on Food and Fruit-bearing Forest trees, published for three regions.

Keyword: Non-timber products, Minor forest products, Multiple purpose forestry

FAO

Legume trees and other fodder trees as protein sources for livestock

FAO Animal Production and Health Paper, FAO, Rome, Italy, No. 102, 339 pp., 1992, English

The FAO Expert Consultation on this title was held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia, from 14 to 18 October 1991.

This book is the proceedings of the FAO Expert Consultation, contains 22 reports.

The proposed objectives of this Consultation are:

- a global review of the utilization of these species in the developing countries;
- a review of promising species already utilized by farmers and breeders in the field or investigated by scientists in different countries and agro-climatic zones;
- a short up-to-date list of species with a likely future;
- a synthesis, related to the main fodder trees and shrubs, either effectively utilized today in animal feeding or with a likely future, looking at the current state of knowledge; etc.

Keyword: Legume tree, Fodder tree, Tree species

PHANUEL O. OBALLA

Interim results of a progeny trial of *Eucalyptus grandis* at Turbo

Kenya Forestry Research Institute Technical Note, Kenya, 13 pp., 1989, English

A progeny trial from 19 trees of *Eucalyptus grandis* selected in Zimbabwe was set in 1986. The control was a provenance raised from the seed collected locally at Turbo. At the age of 2.2 years, progenies of plus tree 303 had the best overall growth followed by 252, 292, 283, 297 and 299. Generally, selection from grasslands region had the best performance compared to plus trees from Mtao. The local Turbo provenance was

the poorest indicating the need for improvement research through selection.

Keyword: Eucalypt, Progeny test, Provenance test

P.K.A. KONUCHE

Result of *Eucalyptus* species trial at Londiani

Kenya Forestry Research Institute Technical Note, Kenya, No. 6, 14 pp., 1989, English

In an effort to identify other eucalyptus for higher elevation, preliminary results from old trials indicated that *E. regnans* F. Muell (mountain ash) and *E. fastigata* Dean ex Maiden (brown barrel) were growing very fast and merited a provenance trial. Attempts were therefore made to procure seed for establishment of a provenance trial. This was not successful as seed of only one provenance of each of the two mountain eucalyptus was obtained. A decision was therefore made to establish a species trial since seed of some other eucalypts was available. The objective of the trial was to observe and compare the performance of various eucalypts for production of poles. Although not clearly spelt out, the main interest was on the performance of the mountain ash eucalypts compared with the commonly grown eucalypts such as "*E. Saligna* and *E. grandis* Hill. The trial was planted in 1970 at Londiani and the results are presented in this report.

Keyword: Eucalypt, Species trial, Tree growth

E. SPECHT & CHRISTIAN SCHAEFER

Interim recommendations for the presowing treatment of *Terminalia brownii* and *Terminalia spinosa*

Kenya Forest Research Institute Technical Note, Kenya, No. 9, 17 pp., English

Terminalia brownii Fresen and *Terminalia spinosa* Engl. are common trees in the drier parts of Kenya. *Terminalia brownii* is an often straightboled tree with a roundish crown, growing up to 15m, sometimes 25m tall. The tree grows in sub-humid woodland and savanna; in drier areas as it is confined to the vicinity of rivers. *Terminalia spinosa* is a somewhat sparsely leaved looking tree with straight stem. It reaches heights of 3-15 m. Its branching habit is strictly in whorls giving the tree a storey-like appearance. Both species produce hard, durable, termite resistant timber, that of *T. spinosa* being heavier. Both are highly valued for fencepost, poles and house construction. *T. brownii* logs of higher diameter are suited for other construction purposes as well as mortars. Both species yield high quality firewood and charcoal.

Keyword: Tree species, Tree growth, Firewood

J.G. KARIUKI

Interim results of a provenance trial of *Liquidambar styraciflua* in Kenya

Research Note Kenya Forestry Research Institute (KEFRI), Kenya, No. 5, 17 pp., 1989, English

A provenance trial of *Liquidambar styraciflua* was established on two sites at Kakamega and Lugari in 1986. Assessments for height and survival were done at ten months and two years at Kakamega and at one year at Lugari. The differences in height and survival were significant. The provenances from Honduras (Las Lajas and Tutule) had the best growth while the U.S.A. provenances (Franklin, Virginia and Huntsville, Texas) had the poorest growth. Generally the height growth increased with decreasing latitude of seed origin. However, the early growth of this species in Kenya was not as fast as expected.

Keyword: Tree species, Provenance, Provenance test, Tree growth

FOREST DIVISION, TANZANIA

Trees for village forestry

**Forest division, Ministry of Lands, Natural Resources and Tourism, Tanzania
125 pp., 1984, English**

Since 1970 the Government of Tanzania has embarked on an intensive village afforestation program in order to meet the ever increasing wood demand and maintain sound environmental conditions desired for sustained agriculture, livestock and forest development. In order to achieve this objective, an equivalent of 200,000 ha of trees have to be planted annually, mainly on self-reliance basis. For successful implementation of the program, the provision of suitable tree species, which can supply within a short period, products desired by villagers, is crucial.

The information presented has been compiled over a period of five years (1978–1983). Out of several hundred species initially considered, 54 are covered in detail in this book. They include tree species suitable for a very wide range of uses in the different climatic zones of Tanzania, which are silviculturally familiar with proven successful field adaptation. A list of 42 other promising species is also provided.

Keyword: Tree species, Plantation, Silvicultural technique, Social forestry, Village forestry

A. GREAVES & P.S. MCCARTER

***Cordia alliodora*: a promising tree for tropical agroforestry**

Tropical Forestry Papers, Oxford Forestry Institute, University of Oxford, UK

37 pp., 1990, English

Cordia alliodora is a fast-growing tree with a high-quality wood. The species is widely distributed in continental tropical America from central Mexico to northern Argentina, a range in latitude of some 50° from 25° N to 25° S. Not only does the tree produce high-quality timber but the persistent, tall, straight stem, self-pruning habit and compact crown make it suitable for growing in combination with many agricultural crops. This, combined with the ease with which the species regenerates naturally on cleared sites, has led to its incorporation in numerous agroforestry systems throughout its natural range. It can also readily be regenerated artificially by using either seedlings or stumps. On suitable sites dimensions of 30–35m height and 40–55cm diameter breast height are predicted for rotations of 20–25 years. However, the choice of provenance is important.

As many of the properties of *C. alliodora* wood are similar to those of *S. macrophylla*, it might be an acceptable substitute in uses such as boat planking and other boat parts. The resistance to decay indicates a possible role as an alternative timber to several species of cedar in situations requiring durability. The appearance suggests a use in furniture construction and panelling, and it should be acceptable for flooring where there is light traffic.

Keyword: Tree species, Fast growing tree species, Agro-forestry, Wood quality, Natural regeneration, Plantation

J.S. BIRKS & R.D. BARNES

Provenance variation in *Pinus caribaea*, *P. oocarpa* and *P. patula* ssp. *tecunumanii*

Tropical Forestry Paper, Oxford Forestry Institute, University of Oxford, UK, 40 pp.,

1990, English

An international study of provenance variation in *Pinus caribaea* Morelet and *P. oocarpa* Schiede in Central America and the Caribbean started in the early 1960s. By the early 1970s seed had been distributed to over fifty countries for many hundreds of trials. By the late 1970s the most comprehensive of these had reached seven years, the optimum age for evaluation. A coordinated assessment programme was undertaken in a set of 29 trials in which 25 *P. caribaea* and 20 *P. oocarpa* provenances were represented. Overall test site coverage was good except for *P. caribaea* vars. *bahamensis* and *caribaea*.

Eighteen traits were assessed to describe productivity, stem quality, branching, reproduction, wood density and oleoresin composition. These are summarized in provenance-locality tables. Analysis of the data revealed statistically and operationally significant general differences between provenance regions for all three species as well as local differences between provenances within the regions.

These trials have provided data that can be utilized not only to make immediate operational gains through provenance selection, but also to plan breeding strategies to enhance populations and to create synthetic varieties in a systematic genetic development for each species.

Keyword: Tree species, Pine, Provenance test, Provenance

PETER G. VON CARLOWITZ

Multipurpose trees and shrubs, sources of seeds and inoculants

International Council for Research in Agroforestry, Nairobi, Kenya, 328 pp., 1991, English

The main intention of this publication is to include more suppliers of seeds and microsymbiotic inoculants and to identify sources of seeds for a larger number of species than were included in the "Multipurpose tree and Shrub Seed Directory" of 1986. Another objective is to take into account, and promote the utilization of recent advances in research towards biological nitrogen fixation and inoculation with microorganisms. These objectives have been achieved, in as much as 113 seed suppliers are listed in this publication as compared with 96 in the "Multipurpose Tree and Shrub Seed Directory". More important is the fact that the number of species for which seed sources have been identified has gone up from 670 to more than 900. Also, the number of suppliers of inoculants has increased from 20 to 28, with more information provided on them.

Keyword: Multipurpose trees, Shrub, Seed, Nitrogen fixation, Microorganism

P.J. WOOD & J. BURLEY

A tree for all reasons (The introduction and evaluation of multipurpose trees for agroforestry)

ICRAF Science and Practice of Agroforestry 5, International Council for Research in Agroforestry, Nairobi, Kenya, 158 pp., 1991, English

This book provides guidance for the introduction and evaluation of woody perennials for use in agroforestry. By woody perennials, this book includes not only trees, shrubs and bushes, but also palms, woody grasses, such as bamboos, and climbing plants, such as rattans. Throughout the book all these are referred to as MPTs – multipurpose trees. Many plants of this kind are already well known in agriculture, horticulture and forestry, but others are little known outside quite restricted areas. This book is primarily concerned with guidelines for evaluating these less well known species for introduction into agroforestry systems.

Keyword: Agro-forestry, Multipurpose trees, Rattan, Palms, Bamboo

C.E. HARWOOD (editor)

***Grevillea robusta* in agroforestry and forestry**

International Council for Research in Agroforestry, Nairobi, Kenya, 190 pp., 1992, English

Grevillea robusta (commonly known as silky oak or silver oak) is a proteaceous tree of Australian origin which has become very important for farm forestry in the tropical highlands of East and Central Africa. Its use as a shade tree and for ornamental purposes is widespread in tropical highlands, and in subtropical and warm temperate regions around the world. The recent development of scientific study of agroforestry has seen a substantial increase in the level of scientific interest in this species, in recognition of its economic importance.

ICRAF and CSIRO, with support from the Australian International Development Assistance Bureau, organized an international workshop on a agroforestry and forestry applications of *G. robusta*, to bring together researchers actively working on the species.

Keyword: Agro-forestry, Plantation, Tree species, Useful species, research and development

GILBERT ARUM

Baobab – *Adansonia digitata*

Indigenous Trees Training Series, KENGO, Kenya, 24 pp., 1989, English

Since 1983, Kenya Energy Non-Governmental Organization (KENGO) has been studying the indigenous trees of Kenya based on the traditional knowledge found in local communities. So far, information has been compiled on most of the trees found in the arid and semi-arid zones of Kenya.

In an ongoing survey of fruit trees carried out since 1987, over 200 indigenous plant species with edible fruits have been identified. Some of these, especially *Tamarindus indica* and *Berchemia discolor*, are used as regular items of local diets especially in Eastern Kenya. When in season they are also found being sold in local markets and are also exported to the coast where they have a lucrative market.

Adansonia digitata, commonly called the baobab, plays a major role in the economy of the inhabitants

of the areas where it occurs. It has often been used as a life sustaining plant during famines. The baobab is often the only thriving food plant during such famines especially when they are accompanied by prolonged drought.

Keyword: Tree species, Arid region, Semi-arid region, Indigenous species, Fruit tree

KIHIKA KIAMBI

Tamarind - *Tamarindus indica*

Indigenous Trees Training Series, KENGO, Kenya, 16 pp., 1992, English

Tamarindus indica (Tamarind) is a medium to large shord trunked evergreen tree with a spreading frame of drooping branches forming a dense rounded canopy. It has a long life, often still productive after 200 years.

The species is especially valuable due to its edible fruit and its adaptability to the arid and semi-arid areas of Kenya. Its fruit has potential commercial value in the production of jams, concentrates, confectioneries etc.

This booklet describing the Tamarind is part of a series of booklets outlining useful information on indigenous trees.

Keyword: Tree species, Arid region, Semi-arid region, Fruit tree, Indigenous species

WAYNE TEEL

A pocket directory of trees and seeds in Kenya

Kenya Energy Non-Governmental Organizations (KENGO), Nairobi, Kenya, 151 pp., 1991, English

Tree planting is a development task of our entire Nation. Kenya is blessed with an abundant variety of trees suitable to meet the needs we face in our variety of climate conditions. The resources base is large. All that is lacking is the knowledge of good tree planting and management practices. This book provides good information and assistance for tree planting.

This directory is divided into six chapters. They are ordered in a manner which will be useful to determine the most appropriate tree for the areas and how to find the most appropriate tree for the areas and how to find seed for them, along with the best method of germination.

Keyword: Tree species, Silvicultural technique, Seed, Germination

ICRAF

A selection of useful trees and shrubs for Kenya

International Center for Research in Agroforestry, Nairobi, Kenya, 225 pp., 1992, English

Trees and shrubs are an essential part of human existence. They provide numerous products and services, including: fuelwood, timber, poles, human food, livestock fodder, medicine, soil conservation, live fences, and fertility improvement.

They are well over a thousand useful trees and shrubs in Kenya and it would have been impossible to include them all in this handbook. The present selection has been made by the principal contributors following extensive consultation and field visits. Some well known species (for example: Citrus spp., apples, pears, plums and others) were excluded because it was felt that they were adequately covered in other extension publications; whereas some lesser known species (for example: Bauhinia spp. for fodder, or 'tree tomato' for fruit production) were included because of their potential for use by Kenyan farmers and pastoralists. The selection includes both indigenous and exotic species. If the latter have been 'naturalized' since their introduction into Kenya this is mentioned in the text.

The handbook contains an information on their identification, propagation and management for use by farming and pastoral communities.

Keyword: Tree species, Agro-forestry, Indigenous species, Propagation, Shrub, Exotic tree species

2-2 Seed (for Propagation)

ATSUSHI KOKUBO

Preliminary study on mortality factors of seed of *Dipterocarpaceae*
The Tropical Forestry, The Japan Overseas Forestry Consultants Association
(JOFCA), Japan, No. 8, 21-25, 1987, Japanese

In general, matured *Dipterocarpaceae* seeds that have fallen from trees onto the ground are not very sound (that is, germinative) unless the trees drop a large number of small seeds. The flowering and fruiting of *Dipterocarpaceae* trees are known to be generally irregular. This is why their seeds are not readily available.

To determine the factors that cause seeds which have fallen from *Dipterocarpus* trees to die, a preliminary survey was carried out in the JICA-Indonesia Research Cooperation Project in Indonesia. The survey covered *Dipterocarpus cornuts* and *D. Constulatus* in the experimental forest of Mulawarman University. These trees are virtually isolated. Seeds which fell onto the ground between late December 1985 and April 1986 were gathered and examined to determine the cause of death and degree of damage.

For *D. cornuts*, 85% of the collected seeds had apparently been browsed by small animals (probably squirrels and rats), and were therefore unable to germinate. The cause of death was unknown for 10% of the seeds. *D. constulatus* seeds had the same causes of death and the same death rates as *D. cornuts*.

The seed viability rates of *D. cornuts* and *D. constulatus* were 3% and 2%, respectively.

Keyword: Seed, Dipterocarps, Mortality, Germination

Improvement of seed supply of forest and multipurpose tree species in Kenya
Proceedings of a workshop in Muguga/Kenya, Nov. 1986, GTZ-Project, Kenya
87 pp., 1986, English

The consumption of wood and timber in Kenya for various purposes will increase considerably in the foreseeable future due to a high population growth. In response to the growing demand for forest goods and services and for afforestation purposes, the seedling production is a problem to be solved. It has become clear that the main factor impeding progress in afforestation is inadequate seed procurement. Hence, a high priority must be given to the reorganization of seed collection, processing and distribution in all forestry activities and this sector has become a major objective of the Kenya-German Technical Cooperation in forestry. For this reason representatives of the forest Administration, various forestry projects and NGO's were invited in order to development their ideas about future seed demand and procurement within the scope of this workshop.

This is the proceedings of the workshop and it includes various information like multipurpose tree species, shrub species, pretreatment methods of seeds, future planting programme, etc.

Keyword: Seed, Seed production, Pre-sowing seed treatment, Seed collection

PETER KRUGER

The harvest of forest tree seed - Training course for harvest-climbers
GTZ-Project: Kenya Forestry Seed Center, Kenya, 34 pp., English

The climbing of standing trees for the purpose of seed collection is very often the only practical method of obtaining large quantities of seed. Tree climbing requires skill and some persons can be excellent natural climbers. In order to gain maximum efficiency and safety for the climber, however, the appropriate use of the climbing and safety equipment is essential. Therefore the GTZ-project "Kenya Forestry Seed Center" organized a training course on climbing techniques in Muguga and the Subcenter in Gede, etc.

At each station, 4-6 harvest climbers underwent an intensive practical 2-3 day training program.

This publication is the textbook in that training course, and several techniques for tree climbing are introduced in the textbook.

Keyword: Seed, Seed collection, Seed production

PETER G. VON CARLOWITZ

Multipurpose tree & shrub seed directory - First edition

**International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya,
265 pp., 1986, English**

The main objective of this Directory is to facilitate communication between institutions and individuals who require seeds on the one hand and suppliers on the other.

Multipurpose trees and shrubs, as referred to in the context of the Directory, are those which are used in the tropics and sub-tropics outside natural forests and more or less monopurpose forest plantation, and which can provide preferably several of such uses as, for example, food, fodder, fuelwood, resins, gums, medicines, timber, etc. This category of woody perennials also includes those species which are suitable for rendering such services as improving soil fertility by N-fixation and reducing soil erosion, and which mix well with agricultural crops.

The Directory consists of a sequence of tables each of which constitutes one chapter dealing with either species or suppliers. An additional chapter is devoted to microsymbionts for nitrogen-fixing trees.

Keyword: Seed, Multiple purpose forestry, Tree species, Nitrogen fixation, Soil conservation

R.L. WILLAN

A guide to forest seed handling

FAO Forestry paper 20/2, Forestry Dep., FAO, Rome, Italy, 379 pp., 1985, English

FAO and the DANIDA Forest Seed Centre have cooperated closely over the past two decades in the field of tree improvement and seed procurement. A representative of the Seed Centre has been a member of the FAO Panel of Experts on Forest Gene Resources while a representative of FAO's Forestry Department is a member of the Project Committee of the Seed Centre. This has ensured a high level of integration between the programmes of the two organizations. A particularly fruitful example of cooperation has been the series of training courses on tree improvement, seed handling and afforestation, jointly sponsored by FAO and DANIDA. Currently the Seed Centre is providing storage facilities for seed collected through FAO's project on Genetic Resources of Arid and Semi-arid Zone Arboreal Species for the Improvement of Rural Living.

The present publication is a further example of this cooperation. A draft edition of the Guide was published in 1983 in a limited number of copies, which were distributed for comments. The present edition has been revised in the light of comments from readers and illustrations have been added.

The increased rates of tree planting, which is apparent in so many countries today, emphasizes more than ever before the need for good seed. Seed quality comprises both the physiological viability and vigour of the seeds and their genetic quality - their ability to produce healthy offspring which are well suited both to the sites where they are planted and for the products or services which they are intended to provide. This Guide is concerned with the physiological quality of seeds.

Keyword: Guideline, Seed, Seed origin, Seed viability, Seed production, Tree improvement

CHRISTIAN SCHAEFER

Processing, storage, and germination of *Prunus africana* seeds

Kenya Forestry Research Institute Technical Note, Kenya, No. 10, 15 pp., English

Prunus africana Kalkm, formerly called *Pygeum africanum*, is a species widespread in the most tropical Africa. In Kenya, the species occurs in the highland forests of Mt. Kenya, the Aberdare Range, Tugen Hills, the western part of the Man Range, Timboroa Forest, Cherangani Hill, Mt. Elgon, Kakamega and Nandi Forests.

P. africana, local name is Muiiri, produces a useful, hard, and durable timber that is easy to work.

With the growing appreciation of indigenous trees there has been a rising demand for *P. africana* seedlings. However, most nurseries are not able to meet their targets since they depend on digging out wildlings in the forest. Seeds have hardly been available due to problems of short viability and unsuitable storage methods. This paper discusses the methods that have been tried to improve viability and make storage of the seeds of this species possible.

Keyword: Seedling, Nursery, Seed viability, Seed, Germination, Seed storage

CHRISTIAN SCHAEFER

Storage and germination of seeds of *Podocarpus milanjanus*

Kenya Forestry Research Institute Technical Note, Kenya, No. 11, 14 pp., English

Podocarpus milanjanus Rendle – the official recognized name was recently change to *Podocarpus latifolius* R. Br. ex Mirb – is a well known timber species occurring in humid mountain forests of East Africa.

Germination of fresh seeds is easy and rates of 80% are obtainable depending on the percentage of insect infested fruits. But it is reported in literature and claimed by field staff that the seed loses viability very quickly thus limiting their availability.

Keyword: Seedling, seed, Seed storage, Germination

CHRISTIAN SCHAEFER & Z. V. SIVA

Recommendations for the collection, processing and storage of *Chlorophora excelsa* seed.

Kenya Forestry Research Institute Technical Note, Kenya, 12 pp., 1990, English

One of the most important timber trees of Africa is *Chlorophora excelsa*. This tree grows in warm and seasonally moist climate from sea level to approximately 1400m.

Propagation of the species was mainly hampered by lack of seeds and knowledge about seed handling.

This paper explains flowering and fruit development, collection and processing, seed extraction, etc.

Keyword: Seed, Seed production, Seed selection, Flowering and fruiting

DANIDA-TANZANIA PROJECT

The national tree seed project – an introduction

The National Tree Seed Project, Morogoro, Tanzania, 7 pp., English

This pamphlet is a brief account of the National Tree Seed Project (NTSP). The project started July 1989 and after a preparatory phase of 6 months, implementation began in January 1990. The project is under the Forest and Beekeeping Division of the Ministry of Tourism, Natural Resources and Environment and is assisted by the Danish International Development Agency (DANIDA). Phase I of NTSP runs from 1990 to end of 1992 where a 3 year extension is foreseen (1993–1995).

Keyword: Seed, Seed production, Seed tree, Training

C. SMITH OLSEN & ANDERS AALBAEK

A seed zoning system for forestry and agroforestry

Danida-Tanzania Project, National Tree Seed Center, Morogoro, Tanzania

9 pp., 1992, English

This pamphlet gives a brief account of the seed zoning system for forestry and agroforestry that has been developed by the National Tree Seed Project.

Until provenance tests have been performed, transfer of seed has to rely on a comparison between the ecological conditions on the planting site and those in the area of seed harvesting. The seed zoning system gives an account of the ecological conditions in the country and divides the country into zones with sufficiently uniform ecological conditions to allow tree seed transfer within the zones.

Keyword: Seed, Site classification, Afforestation, provenance, Site condition

A.M.J. ROBBINS

A versatile, low-cost drying kiln for opening pine cones

C.F.I. Occasional Papers, Oxford, UK, No. 26, 54 pp., 1985, English

A batch type, forced draught kiln is described, used principally for drying cones of *Pinus caribaea* and *P. oocarpa* in the Republic of Honduras, C.A. Ventilation is by means of two, large diameter fans powered by an electric motor, gasoline or diesel engine. Air may be passed once through the kiln, or recirculated. Heating

is by means of a furnace and flue radiator, using waste cones or firewood as fuel. Temperature is controlled manually with a precision of $\pm 1^{\circ}\text{C}$. Cones or other products to be dried are placed in stacked trays, which can also be used for sundrying or procuring. Total capacity of the kiln is 3200 litres of closed cones. The design is simple, and all parts (including fans and heating system) can be made from material normally available locally in developing countries. The design should be suitable for countries that are initiating pine seed collection programmes. It is suitable for other forestry species, and should have application for drying agricultural products as well. Detailed plans are included, with notes on operation and construction.

Keyword: Pine, Seed production, Seed, Seed selection

ARSEN MBONYE & KIHKA KIAMBI

How to collect, handle and store seeds

KENGO Agroforestry Training Series, KENGO, Nairobi, Kenya, 22 pp., English

Seed is very delicate and therefore has to be handled with great care to prevent loss of viability. There are some important procedures that have to be carefully followed to ensure effective germination of the seed. These procedures include harvesting from a good mother tree, proper seed collection, good packaging and proper storage facilities.

This booklet deals with the procedures of the seed.

Keyword: Seed, Seed production, Seed collection, Seed storage, Seed viability

2-3 Nursery Practice

JAMANNE A. MAGHEMBE & LUTHER L.L. LULANDALA

Effect of different potting mixtures and nutrient treatments on the survival and growth of *Pinus caribaea* seedlings

Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Tanzania, Record No. 16, 20 pp., 1980, English

This study was designed to find a suitable potting mixture for raising *Pinus caribaea* seedlings in the nursery at Ruvu. Mixtures comprising sandy soil, forest soil, cattle manure, crushed charcoal and NPK fertilizer were tested.

Cattle manure increased seedling mortality, retarded height growth, and induced extensive yellowing of the needles. Crushed charcoal increased mortality and retarded growth but did not cause extensive yellowing. Treatments containing both manure and charcoal caused the highest mortality, showed the highest incidence of yellowing and caused a strong retardation of growth. These effects were attributed to possible nutritional imbalances resulting from high pH and high contents of exchangeable calcium in both manure and charcoal.

Soils without any amendment produced satisfactory survival but did not produce planting size, 17 cm, seedlings in 27 weeks. The best results, in terms of high survival, absence of yellowing and rate of growth were obtained in soil mixtures given NPK fertilizers as the only soil amendment.

Sandy soil is plentiful near the nursery and, fertilized with NPK, costs only 20 percent of the cost of the traditional potting mixture of 75 percent forest soil and 25 percent cattle manure, fertilized with NPK. This is largely due to savings in transport costs and corresponds to an annual estimated saving of shs. 200,000.- for a project planting 2,000 ha per year.

Keyword: Pine, Potting media, Nursery operation, Growth, Survival, Seedling

J.A. MAGHEMBE & H.P. MSANGA

Effect of physical scarification and gibberellic acid treatments in germination

***Trichilia emetica* seed**

ICRAF Reprint, International Council for Research in Agroforestry, Nairobi, Kenya 163-177, 1989, English

Seeds of *Trichilia emetica* were subjected to 3 types of physical seed coat scarification, i.e. unscarified, partial removal of seed coat at radicle end, and complete removal of seed coat. These treatments were combined in a factorial arrangement with gibberellic acid at 5 concentrations: 0, 250, 500, 750 and 1,000 ppm, and replicated 4 times. Unscarified seeds without and with gibberellic acid attained cumulative germination of up to 40%. Partial and complete removal of seed coat resulted in over 90% germination. Application of gibberellic acid to both unscarified and scarified seeds produced marginal but significant effects on cumulative germination, germination value and germination energy. Application of gibberellic acid to seeds whose seed coat had been completely removed resulted in complete emergence of all seeds sown. Observations indicate that the poor germination associated with *T. emetica* seeds is due mainly to the impermeability of the seed coat and aril to fluids (water and gases). It is recommended that the seed coat of *T. emetica* seeds be partly or completely removed before sowing.

Keyword: Seed, Germination, Pre-sowing seed treatment

2-4 Plantation Establishment

- site preparation, planting, coppice, direct seeding, mycorrhiza, enrichment planting, soil, etc. --

JIRO YANAGI

Some problems of silviculture of the tropical forest in West Africa

The Tropical Forest - Quarterly Journal, The Tropical Forestry Association of Japan, No. 14, 24-41, 1969, Japanese

Research into tropical silvicultural techniques ought not be limited to improving local and conventional techniques in a single tropical area. Rather, it should be planned steadily and conducted from a long-term perspective in the light of the results into extensive research into many other tropical areas. With this perspective, the author discusses the current state of tropical silvicultural techniques in western African in issue Nos. 6 and 7 of this journal, based on a report by Mr. Catinot, Director of Forestry Department at Le Centre Technique Forestier Tropical in France. The previous report focused on just some of the matters raised in the original report. The present report is intended to complement the previous one, and summarizes the contents of the original report to provide an overall view.

Various silvicultural methods are examined and compared with each another, and silvicultural technique for tropical savannas are examined. Readers will be provided information that will assist research into tropical silvicultural techniques, particularly in arid or semiarid areas.

Keyword: Semiarid climate, Silviculture technique, Savanna, Regeneration, Planting

JIRO YANAGI (Translator)

Tropical silviculture in West Africa rainforest (II)

The Tropical Forest - Quarterly Journal, The Tropical Forestry Association of Japan, No. 7, 47-57, 1968, Japanese

This report is continued from issue No. 6 of this journal under the same title.

The contents are:

Chapter III Artificial Regeneration System

- a. Taungya System (also described in issue No. 6)
- b. Limba System
- c. Okoume System
- d. Martineau System
- e. Layon System
- f. Placeaux System

Keyword: Artificial regeneration, Plantation, Planting, Silvicultural technique

SEIICHI OHTA

Initial soil changes associated with afforestation with *Acacia auriculiformis* and *Pinus kesiya* on denuded grasslands of the Pantabangan area, Central Luzon, the Philippines
Soil Sci. Plant Nutr., Japan, 36(4), 633-643, 1990, English

The influence of afforestation on the soil of grasslands denuded for a long period of time was studied in plantations of 5-year-old *Acacia auriculiformis* and 8-year-old *Pinus kesiya* in comparison with the soils of adjacent denuded grasslands in Central Luzon, the Philippines. Soils where *Acacia* and *Pinus* grew were Ferralic Cambisols derived from Quaternary sediment containing large amounts of ironstone nodules and Chromic Vertisols from Tertiary mudstone, respectively. Soil physical properties improved by afforestation included the bulk density and porosity, though the effect was limited to the thin (0-5 cm) superficial soil layer. Hydraulic conductivity of the surface soil increased in the *Acacia* plantation, while that of the *Pinus* plantation decreased slightly due to abundant mycelia. The values of several chemical parameters decreased with plantation establishment for the surface soils: pH values, carbon and nitrogen contents, CEC, and concentration of exchangeable cations, especially of Ca^{2+} , were generally lower in the surface soils under tree growth than in the grasslands. The decrease of these values was assumed to be a transitory phenomenon occurring only during the early stage of tree growth in the plantations in areas with a pronounced dry season. Available nitrogen content and its proportion to total nitrogen content in the top soil increased significantly by plantation establishment.

Keyword: Acacia, Afforestation, Pine, Plantation, Soil improvement, Physical characteristic, Soil

SEIICHI OHTA

Influence of deforestation on the soils of the Pantabangan area, Central Luzon, the Philippines
Soil Sci. Plant Nutr., Japan, 36(4), 561-573, 1990, English

To analyze the influences of prolonged grassland conditions after deforestation on tropical soils, soils under a natural *Dipterocarp* forest and grassland in Central Luzon, the Philippines were compared with each other in terms of morphology, clay mineralogy, physicochemical properties, nitrogen fertility, and humus composition. The influence of forest land degradation on the soil was limited to the shallow superficial horizon in the case of the Plinthic Acrisols, but extended to the E or the upper argillic B horizon for the Orthic Luvisols.

The soils of natural forest and grassland differed from each other in the following characteristics: 1) the forest soils exhibited strong structural development and various signs of high activity of the soil fauna unlike the grassland soils. 2) The physical properties of the grassland soils had deteriorated compared with those of the forest soils. 3) Comparison of the clay distribution pattern in solum suggested the existence of a weaker clay alleviation and/or more pronounced truncation of the topsoil in the grassland than under forest. 4) The grassland soils showed marked reductions in the values of chemical properties such as pH, base saturation percentage, and contents of exchangeable Ca^{2+} , carbon, and nitrogen in comparison with the forest soils. 5) Nitrogen fertility of the grassland soils was lower than that of the forest soils based on the lower content of available nitrogen and the lower rates of nitrogen mineralization and nitrification. 6) The grassland soils contained humic acid humified to a greater extent than the forest soils.

Keyword: Natural forest, Grassland, Soil, Soil fertility, Humus layer, Physical characteristic, Deforestation

W.G. WIELEMAKER & H.W. BOXEM (EDS)

Soil of the Kisii area, Kenya
Pudoc Wageningen, Netherlands, 208 pp., 1982, English

This report is the fourth in Kenya Soil Survey series of "Reconnaissance Soil Surveys". It is the first prepared jointly by the Kenya Soil Survey and another institution, the Training Project in Pedology of the Agriculture University, Wageningen, the Netherlands.

The Kisii Area, named after the Kisii District, is in the south-west of Kenya; the area surveyed covers 3000 km² and includes parts of South Nyanza and Narok District. Land-use, vegetation, climate and ecological zones, geology, geomorphology and present status of erosion are described on the basis of thematic maps.

Soils are defined by toponomy and physiography and depicted on a soil map of scale 1 : 100,000; factors in their formation are also discussed. For land evaluation, existing and proposed land utilization types are described in detail as a basis for selection of alternatives, for which land suitability is assessed. A detailed

account is given of the rating procedures on the basis of land qualities.

Keyword: Soil, Soil survey, Erosion, Soil map, Land-use

T.G. ALLAN

Mechanization in forestry plantation in Nigerian savanna

The Development of Savanna Forestry: Proceedings of the Second Annual Conference of the Forestry Association of Nigeria, August, 1971, Nigeria, 104-117, 1973, English

This paper is confined to certain aspects of mechanization in plantation establishment in Nigeria. Work and method studies are needed to decide which kinds of plantation work are done more efficiently by men or by machines, and to indicate improved methods. In general, mechanization is best suited to large-scale operations.

For pre-planting cultivation, the caterpillar D4 with Rome disc harrow can cover 2.6 acres per hour, while the Massey Ferguson 165 medium wheeled tractor with mounted 3-disc plough can only cover 1.4 acres per hour. Besides ploughing, it is probably beneficial to harrow immediately before planting. The medium wheeled tractor with Massey Ferguson 722 Tandem 7' disc harrow will cover 2.4 acres per hour.

Weeding is compared using a Howard 60" rotavator and 722 Tandem 7' disc harrow, each attached to a medium wheeled tractor. In terms of gross area, the rotavator covers 3.1 acres per hour, and the disc harrow 2.5 acres per hour. However, the actual area cultivated is 1.9 acres (rotavator) and 2.1 acres (disc-harrow).

Tractor runs of different lengths were also compared. As an example, 50-yard runs increased the time by about 50% compared with 400-yard runs.

Keyword: Savanna, Plantation, Mechanization, Silvicultural machine

FORESTRY RESEARCH INSTITUTE (NIGERIA)

Technical report: Industrial forest plantation project

Forestry Research Institute of Nigeria, Nigeria, 60 pp., 1990, English

The natural forests and existing forest plantations in Nigeria cannot sustain the present upsurge in demand for wood products. The present level of plantation development is below the 300,000 ha/year target recommended by FAO for the country's self-sufficiency in wood and wood products supply.

Active private sector participation in industrial plantation establishment is advocated to bridge this gap. Favorable climate for private sector involvement in forest plantation development has been provided in the 1988 Federal Government's Agricultural Policy.

This document is a technical report of one of the proposed projects. The plantations of the site are expected to be managed primarily for pulpwood production. *Gmerina arborea*, *Pinus* and *Eucalyptus* species are recommended as suitable species for use in the project. The document deals with technical matters on plantation establishment of these species.

Keyword: Plantation, Eucalypt, Pine, Commercial tree species, Pulp

FAO FOREST DEPARTMENT

Savanna afforestation in Africa: lecture notes for training course Africa savanna and papers from the symposium on savanna afforestation

FAO Forestry paper 11, FAO, Rome, Italy, 100 pp., 1977, English

This compilation is the result of a Training Course on Forest Nursery and Establishment Techniques for Africa Savanna which was to have been held in Nigeria, 1976. The course was planned in collaboration with the Forest Research Institute and FAO, and was to have been held in conjunction with the Symposium on Savanna Afforestation organized by the Forest Research Institute.

This report contains a set of the lecture notes in advance of the training course, the principal symposium papers and the country statements contributed by participants.

The contents of the report are as followings.

1. The Savanna environment
2. Species introduction and seed handling

3. Nursery practice
 4. Plantation establishment and maintenance
 5. Special techniques for problem areas
 6. Plantation protection
 7. Plantation planning and costing
- Keyword:** Plantation, Fruit tree, Silviculture technique, Savanna

E.O. CHIJICKE

**Impact on soils of fast-growing species in low land humid tropics
FAO Forestry Paper 21, FAO, Rome, Italy, 111 pp., 1980, English**

The impact of monoculture plantation of fast growing tree species on soils of the lowland humid tropics has been assessed by comparing soil conditions under natural forest, with those under plantations. The amount of nutrients contained in whole trees or in the stemwood at particular ages has been measured, as well as soil total and available reserves, in an attempt to determine the effect of regular harvesting on soil potential in future rotations.

The analyses of tree samples suggest that potassium, calcium and nitrogen are the nutrients immobilised in the largest amounts by *Gmelina arborea* and *Pinus caribaea*. While K appears to be the most important nutrient in 5-6 year old *Gmelina* stands, Ca seems to be the element of greatest importance in Pine growth.

Soils investigations suggest that productivity of lowland tropical lightly textured soils on sediments are more severely affected by immobilization of nutrients as a result of intensive management than are heavier soils, especially those of basement complex origin. Different management procedures may be necessary on the two types of soil.

Keyword: Soil texture, Plantation, Fast growing tree species, Natural forest, Monoculture

RANIE

Teak planting in West Africa, 258-268, 1959, Japanese

In West Africa, teak planting was introduced by German in the 19th century. Precipitation is 1000 - 1500 mm per year, and has rainy and dry seasons in this region.

Natural condition of this region is suited to teak planting. Seedlings are cultivated 150,000 pieces per ha in nursery, and planting density is 2500 pieces per ha. In this region teak planting work is done by natives and they have the right to cultivate corn and yam under trees.

Keyword: Planting, Teak, Agro-forestry, Plantation

J.M. KIMONDO & P.K.A. KONUCHE

Results of *Eucalyptus* species trials and establishment methods on seasonally waterlogged soils at Turbo

Kenya Forestry Research Institute Technical Note, Kenya, No. 4, 19 pp., 1989, English

The earlier conclusion on unsuitability of pines for planting on vlei soils is still valid. The best species for planting on these soils are *E. grandis* and *E. saligna*. The most effective and cheapest method of establishment is planting tree on top of upturned turfs as stipulated in Forest Department Technical Order No. 50 of 1971. However, as vleis are mainly covered by grass, good weeding and effective protection from animals are required for successful afforestation.

Keyword: Eucalypt, Planting, Plantation, Silvicultural technique, Afforestation

JAMES ODHIAMBO MAUA & VESA KAARAKKA

Performance of trees planted using microcatchments in Bura-Tana

Kenya Forest Research Institute Technical Note, Kenya, No. 16, 15 pp., 1992, English

The study was carried out to identify appropriate methods of establishing trees in dry areas. The

methods tried include rectangular, shallow and deep U-shaped microcatchments. The rectangular microcatchment gave the best results while the shallow U-shaped ones gave the worst results.

The results show that all the methods improved tree establishment.

Cordia sinensis, *Acacia horrida*, *Acacia nilotica*, *Acacia xanthophloea*, *Acacia zanzibarica*, *Commiphora paolii* and *Prosopis juliflora* are the species which performed well under the tried microcatchments. For large scale utilization of these structures, further modification is required, particularly to provide cheaper alternatives.

Keyword: Planting, Acacia, Silvicultural technique, Water conservation, Water storage

DAVID W. ODEE

A cross-inoculation study on indigenous rhizobia and selected tree legumes

Research Note, Kenya Forestry Research Institute (KEFRI), Kenya

No. 3, 21 pp., 1989, English

A cross-inoculation study with indigenous rhizobia was carried out on seven host legume species from where they were originally isolated. The legumes included *Acacia albida*, *Acacia mearnsii*, *Calliandra calothyrsus*, *Leucena leucocephala*, *Prosopis juliflora*, *Sesbania grandiflora* and *Sesbania sesban*. The host plant species were variably promiscuous in their rhizobial associates. Conversely rhizobia isolated from *S. grandiflora* and *S. sesban* were more specific with their host partners in terms of symbiotic effectiveness.

Keyword: Root nodule, Inoculation, Root system

ELLY J.M. MWANZA

Response of *Casuarinas* to frankia inoculation in saline unsterile sand/vermiculite medium

Research Note, Kenya Forestry Research Institute (KEFRI), Kenya

No. 4, 14, 1990, English

The response of *Casuarina cristata*, *C. cunninghamiana*, *C. equisetifolia*, *C. glauca*, *C. obesa* and *Allocasuarina decaisneana* to inoculation with crushed nodule inoculum of Frankia collected from *C. equisetifolia* was studied under greenhouse conditions in unsterile field sand/vermiculite medium. Inoculation increased overall growth, nodulation, dry weight of shoot and root and the nutrient status of all the species except for *Allocasuarina decaisneana*. The interim results indicate that inoculation of five of the above species with the endophyte is beneficial in unsterile saline sand medium in spite of the presence of natural Frankia. The endophyte showed host specificity between *Casuarina* and *Allocasuarina*.

Keyword: Root nodule, Inoculation, Soil, Salinity, Root system

L.M. MWANGI, P.B. MILIMO et al.

The effect of inoculation of *Melia volkensii* seedlings with endomycorrhiza

Research Note, Kenya Forestry Research Institute (KEFRI), Kenya

No. 6, 11 pp., 1991, English

Isolation of endomycorrhiza (vesicular arbuscular mycorrhiza) spores from five semi arid sites of Kenya revealed that the soils differed in their spore populations. No relationship was found between the spore populations and the pH nitrogen and phosphorus content of the soils. Inoculation of *M. volkensii* seedlings with vesicular arbuscular mycorrhiza (VAM) derived from Mwingi and Kiambere soils significantly increased height growth. Mycorrhiza infection was also high on inoculated seedlings in sterile soil. Slight infection was found on seedlings in unsterile soils that were not inoculated. The results indicate that inoculation of seedlings may be useful especially under adverse soil conditions.

Keyword: Mycorrhiza, Soil, Inoculation, Semi-arid region

KEFRI

A guide to tree planting in Kenya - Kenya forestry research institute

Kenya Forestry Research Institute (KEFRI), Nairobi, Kenya

13 pp., 1990, English

Sound forest development and management strives to maintain favorable trade-offs between production and conservation functions of the forests by employing the favorable attributes of fast growing species in generating a sustainable supply of raw material for domestic and industrial use. This relieves heavy cropping pressures from the indigenous forests which have more basic conservation functions, and also support the more valuable red woods that require more time to mature.

The choice of species for planting often depends on many considerations. This booklet 'A guide to tree planting in Kenya' is designed to be used by field workers and farmers involved in tree planting in Kenya. The materials are drawn from the accumulated information and experience of KEFRI's scientists. It provides a background on the requirements of various tree species with particular regard to climate and soil. Information on the management system is given for each species, its uses, and expected rotation.

Keyword: Tree species, Planting, Plantation, Rotation

KEFRI

A dryland forestry handbook for Kenya institute

Kenya Forestry Research Institute (KEFRI), Nairobi, Kenya

95 pp., 1992, English

The arid and semi-arid lands of Kenya cover about 80% of the country's area and amount to approximate 473,000 km². They support about 20% of the country's population and half of its livestock.

This handbook was written to guide the development and management of tree and forest resources in the dryland areas of Kenya. The handbook is compiled to provide information on technologies for tree planting and to address some of these constraints. It discusses not only silvicultural technology including tree species selection, seed, nursery, tending, but management system of agroforestry and irrigated forestry.

Keyword: Semi-arid region, Arid region, Silvicultural technique, Agro-forestry, Seed

ANTHONY YOUNG & PETER MURAYA

Soil changes under agroforestry (SCUAF): a predictive model

ICRAF Reprint, International Council for Research In Agroforestry, Nairobi, Kenya

No. 74, 665-668, 1990, English

An interactive microcomputer model is described, designed to predict the effects upon soils of specified agroforestry systems within given environments, and to assist soils research in agroforestry. Mark I of the model covers changes in erosion and soil carbon, Mark II includes nitrogen cycling. There are feedback factors for the effects of soil changes on plant growth. For modelling erosion, a tree proportionality factor is defined, which represents the degree to which erosion from an agroforestry system as a whole is controlled by the tree component. Results show that the effects of reduction in soil depth are usually negligible compared with losses or organic matter and nutrients. It is possible to design sustainable agroforestry systems that are productive, control erosion and maintain soil fertility. Data from field trials are needed to validate these conclusions.

Keyword: Agro-forestry, Soil conservation, Erosion, Soil, Soil fertility

ANTHONY YOUNG

The potential of agroforestry for soil conservation

ICRAF Reprint, International Council for Research In Agroforestry, Nairobi, Kenya

No. 75, 1015-1025, 1989, English

The primary aim of soil conservation is maintenance of fertility, for which control of erosion is one necessary condition, but soil physical conditions and nutrient status are equally important. Agroforestry refers to land use practices in which trees or shrubs are grown in spatial or temporal association with crops or pastures, and in which there are both ecological and economic interactions between the tree and non-tree components. It is a practicable management option for small farmers and a relatively inexpensive form of land development. In erosion control, agroforestry can contribute both to the barrier and the cover approaches. Agroforestry practices can be employed in erosion control either alone or in conjunction with earth structures. Trees improve soil fertility by maintenance of organic matter, nitrogen fixation, uptake and recycling of nutrients, and other

processes. There is substantial evidence, in part qualitative or indirect, that agroforestry can contribute substantially to maintenance of soil fertility. Research specifically directed towards agroforestry is recent, hence there are few experimental results to date. The high apparent potential for soil conservation through agroforestry, coupled with the scarcity of experimental data, indicates a clear need for research.

Keyword: Agro-forestry, Soil conservation, Erosion, Soil management, Soil fertility

Y.P. YADAY & H.B. VASISTH

**Infiltration capacity of forest soils under *Cryptomeria Japonica*
The Indian Forester, India, Vol. 115(6), 435-441, 1989, English**

This paper describes the infiltration study made under *Cryptomeria japonica* at Sonada. The initial infiltration rates, in case of site located in heavily littered soil were found to be very high ranging from 69.5 cm per hour followed by 27.24 cm per hour for non-littered soil. In the next five minutes interval the drop in infiltration rates varied from 79 to 62 per cent in heavily littered soil followed by 88 to 51 per cent in non-littered soil. The constant infiltration rate varied from 6.0 to 0.64 cm per hour.

Keyword: Infiltration, Litter layer, Soil, Soil texture

R.M. BHAGAT

**Infiltration characteristics of some hill soils of lower Dhauladhar ranges of Himachal Pradesh
The Indian Forester, India, Vol. 113(3), 222-227, 1987, English**

Based on basic field infiltration equations, five Dhauladhar range forest hill soils were studied. Experimentally derived parameters indicated entry of water into soil to increase in a coarse textured, less compact soil, whereas the infiltration is just the reverse in relatively fine textured, compact soils. The structural index of these soils was in conformity with the hydraulic parameters studied.

Keyword: Infiltration, Soil texture

P.K.R. NAIR

**Soil productivity aspects of agroforestry
International Council for Research in Agroforestry, Nairobi, Kenya, 85 pp.,
1984, English**

Shifting cultivation, the taunga system, woody perennial plantation agriculture, plantation forestry and multiple cropping are the important land-use systems of relevance to agroforestry. Research results on the productivity and management of soils under those systems have been collated and evaluated. Scientific evidence on the productive and protective value of trees on farmlands has also been gathered to indicate the beneficial effects of trees on nutrient relations and soil fertility, nutrient cycling, soil conservation, soil physical properties and ecosystem stability. A few field examples of the successful integration of trees on farmlands have also been given. These include hedgrow intercropping, multi farming, intercropping in plantation crops, and the integration of trees on farmlands in dry regions.

Keyword: Soil management, Soil fertility, Soil conservation, Agro-forestry, Shifting cultivation

R.F. BREIMER, A.J. VAN KEKEM & H. VAN REULER

**Guideline for soil survey and land evaluation in ecological research
MAB Technical Notes, UNESCO, Paris, France, No. 17, 125 pp., 125, 1986, English**

This Technical Note was developed in cooperation with the International Soil Museum in Wageningen, the Netherlands with a twofold purpose: to help define the role of soil science in ecological research, and to provide an experimental base for comparison of soil data gathered in MAB pilot projects throughout the world under different soil classification systems. The results of soil surveys produced at each site stand on their own, but are also useful as a basis for comparisons with similar ecological zones, as well as between sites and regions. This Technical Note presents the results of five years of research and experimentation on such problems in

African, Asian and Latin American MAB field research sites mainly located in biosphere reserves.

Keyword: Soil survey, Guideline, Soil ecology, Soil map

2-5 Tending

- weeding, pruning, thinning, fertilizing, etc. -

JUMANNE A. MAGHEMBE

Effect of weeding and some soil characteristics on the survival and growth of *Pinus caribaea* in plantation at Ruvu

**Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Tanzania
Record No. 8, 12 pp., 1979, English**

The objective of this study was to investigate the effects of weeding and some soil characteristics on the survival and early growth of *Pinus caribaea* in plantations at Ruvu.

Survival was determined by systematic sampling in one to nine year old plantations and field experimental trials of *Pinus caribaea*. Height was measured for one and two year old pines. Mineral soil was collected in the two year old plantation and experimental trial and analysed for texture, soil reaction, total nitrogen, available phosphorus and exchangeable K, Ca, Mg, Na, H and CEC. The history of weeding was obtained from records.

The results suggest that the survival of *Pinus caribaea* at Ruvu depends largely on intensive weeding. Only in those plantations that received six weeding in the first two years the survival exceeded 80%. However, in plantations receiving less intensive weeding, the year in which the deaths occurred and their causes are unknown. However, once the pine had survived, weed competition did not significantly retard its growth in either one or two year old plantations. Survival was unrelated to soil characters, but the organic carbon and total nitrogen of the surface soil, 0-25 cm depth, were positively correlated with height growth. Therefore studies on N-application at planting are suggested. Height and other soil characters were not significantly correlated.

Keyword: Pine, Plantation, weeding, Survival, Growth, Soil texture

SHABANI A.O. CHAMSHAMA & MICHAEL S. PHILIP

Thinning *Pinus patula* plantations at Sao Hill, Southern Tanzania

**Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Tanzania
Record No. 13, 16 pp., 1980, English**

The objective of this study was to provide information on the effects of past and present thinning schedules and the applied field practices on the development of *Pinus patula* at Sao Hill, Tanzania.

A total of 120 square or rectangular temporary sample plots of areas ranging from 0.0280 to 0.0512 ha were systematically sited in 24 stands of ages between 4 and 27 years. Sample trees were measured for diameter at breast height, height and stem quality, which was assessed in three classes. The data were analysed for total or standing yield, stand density, stems per hectare, mean diameter, dominant height and stem quality.

The main findings were that there is a high percentage of good quality stems but the densities of *Pinus patula* at Sao Hill exceed the ones prescribed in the thinning schedules. While there has been no loss in total yield, diameter growth has been sacrificed and there is an excess of small sized trees and not enough stems in the 30 cm and over diameter classes.

The importance of thinning for sawlog production is stressed because currently the growth is distributed on too many small trees of low value per cubic metre.

Keyword: Pine, Plantation, Thinning, Stand density

B.N. KIGOMO

Growth response in a thinning trial of *Cupressus lusitanica* crop

Kenya Forest Research Institute Technical Note, Kenya, No. 14, 17 pp., 1990, English

The first thinning schedules of *Cupressus lusitanica* in Kenya was developed by Grahm in 1949. This schedule recommended seven thinnings at two-year intervals starting at the age of seven years when average dominant height was 10.0m. The first thinning reduced the initial stocking from 1680 to 990 trees per hectare while final thinning at 21 years left 250 stems per ha.

This thinning regime aimed at production of a crop with mean diameter of 46 cm at the age of 40 years on average site. However, the development of the schedule was based on data from young plantations and was therefore tentative. The present experiment was therefore established to investigate the effect of four thinning regimes on development of *C. lusitanica* and to generate data on which to design the future thinning schedule of this species for various management objectives.

Keyword: Thinning, Growing stock, Plantation, Conifer, Silvicultural technique

2-6 Tree Breeding

FAO

**Report on the FAO/DANIDA training course on forest tree improvement
FAO/DEN/TF 112, FAO, Rome, Italy, 344 pp., 1974, English**

A Training Course on Forest Tree Improvement was held at the Conference and Training Center, Limuru, Kenya in 1973. The course was organized in collaboration with the East African Agriculture and Forestry Research Organization (EAAFRO) and the Food and Agriculture Organization of the United Nations (FAO). The purpose of the Training Course was to combine instruction in the basic principles of forest genetics with study of their practical application in the field, with particular reference to conditions and species in Kenya.

The Course covered both theoretical and practical aspects of tree improvement. The topics covered included the principles of variation, selection and inheritance, the relationship of heredity and environment, species and provenance trials, seed source classification, seed collection, handling and certification, individual selection, seed orchards, progeny trials, breeding for disease resistance, the economics and planning of tree improvement programmes and international programmes in forest gene resources.

This is a report on the Training Course. This report contains tree improvement status in participating countries (14), lecture notes, definitions of terms used in lecture notes, timetable of tree seed improvement in East Africa, etc.

Keyword: Tree improvement, Heredity, Environmental condition, Seed orchard, Genetic resources

FAO

**Forest tree improvement
FAO Forestry Paper 20, Forestry Dep., FAO, Rome, Italy, 271 pp., 1985, English**

The FAO/DANIDA Training Course on Forest Tree Improvement was held in Venezuela from 14 January to 2 February 1980. The Course was organized by the FAO Department of Forestry in collaboration with the Government of Venezuela, etc. It was attended by 19 experts from 17 countries of Latin America. This publication is a report on the Training Course.

The Course consisted of two weeks of lectures and practical demonstrations in Mérida and one week study trip to the states of Barinas and Monagas in western and eastern Venezuela respectively.

Lectures included the following topics: tree improvement in relation to national forest policy; elements and principles of genetics; conservation and rational use of forest genetic resources; collection and handling of forest seeds; storage, testing and certification of forest seeds; experimental designs; statistical interpretation of test results; species and provenance trials; selection and management of seed stands; selection of forest trees; vegetative propagation methods; controlled crossing systems and designs; establishment and management of seed orchards; progeny trials; genotype/environment interaction; breeding for disease resistance; strategies for tree development programmes; economic considerations of forest tree breeding programmes.

Keyword: Training, Tree improvement, Genetic resources, Seed, Vegetative propagation, Seed orchard, Breeding, Tree disease

IUFRO WORKING PARTIES

Breeding tropical trees: population structure and genetic improvement strategies in clonal and seedling forestry, proceedings of a conference held in Thailand, 28 November – 3 December 1988, IUFRO
503 pp., 1989, English

The theme of this joint meeting of IUFRO Working Parties S2.02-08 (Tropical species provenances and breeding) and S2.02-09 (Eucalypt provenances and breeding) was *Breeding tropical trees: Population structure and genetic improvement strategies in clonal and seedling forestry*. In total, ten invited papers were presented which eloquently set the scenes and brought the Conference up to date on their respective key areas. In addition, 20 'Special Papers', which described particularly outstanding pieces of research or application of techniques, were presented, reviewing a broad range of issues pertinent to the exploration, conservation, domestication and improvement of tree species for industrial and non-industrial forestry use in the tropics. Further valuable information was provided through the presentation of 69 voluntary papers and a range of posters.

It was clear from the meeting that current knowledge on variation, breeding systems, heritabilities and propagation methods has enabled significant advances to be made in the domestication and improvement of a wide range of species, principally in the genera *Pinus* and *Eucalyptus*, and this will continue in the future at an ever-increasing pace.

Keyword: Pine, Eucalypt, Breeding, Tree improvement, Research and development

J.J. LE ROUX & J. VAN STADEN

Micropropagation and tissue culture of *Eucalyptus* – a review
Tree Physiology, Heron Publishing, Victoria, Canada, Vol. 9(4), 435-477, 1991, English

Micropropagation has potential to provide very high multiplication rate of selected tree genotypes, with resulting short-term silvicultural gains. Aseptic cultures has been established from seeds, seedlings, shoots, flowers and lignotubers. Callus cultures has been established from a wide range of tissue sources for at least 30 species of *Eucalyptus*. Plant regeneration from callus was successful for 12 of these species. Micropropagation through axillary proliferation, or adventitious shoot proliferation on nodal explants, or both, has been successful. An agar-based medium of Murashige and Skoog with a low auxin/cytokinin ratio is most commonly used for shoot multiplication. Vitrification and shoot senescence remain problems. Gibberellic acid was added in some media to stimulate shoot elongation. Various media are used for *in vitro* root initiation. Suspension and protoplast culture have been achieved and plants have been regenerated from protoplasts. *In vitro* techniques are presently being applied to *Eucalyptus* to achieve genetic transformation.

Keyword: Tissue culture, Micropropagation, Eucalypt, Propagation

F.W.G. BAKER

Rapid propagation of fast-growing wood species
Casafa Report Series, CAB International, Oxon, UK, No. 3, 125 pp., 1992, English

Plant cell and tissue culture is now an established method which can be used for clonal propagation of plant material. While such propagation may be uneconomic for field crops which can be readily propagated from seed, the prospects for clonal propagation of woody perennials are greater. A number of woody plants have been shown to produce multiple shoots and roots *in vitro*, and such micropropagation methods also include embryo culture and somatic embryogenesis. These methods are now becoming established alongside more traditional methods of macropropagation. This book reviews our current knowledge of a number of aspects of these methods for rapid and mass propagation of fast-growing woody species, and is based on a conference organized by CASAFA (Committee on the Application of Science to Agriculture, Forestry and Aquaculture) of the International Council of Scientific Unions. It will therefore be of interest to research workers in plant biotechnology and forestry.

Keyword: Fast growing tree species, Seed, Micropropagation, Breeding

2-7 Natural Regeneration

JIRO YANAGI (Translator)

Tropical silviculture in West Africa rainforest (I)

The Tropical Forest-Quarterly Journal, The Tropical Forestry Association of Japan

No. 6, 43-54, 1967, Japanese

Every two months the French organization Le Centre Technique Forestier Tropical issues a journal called "Bais et Forests des Tropiques" which discusses the state of forestry in Africa.

The present report introduces a report presented previously in the above journal by Mr. R. Catinot, Director of Forestry Department at Le Centre Technique Forestier Tropical. Here, various silvicultural methods used in western Africa are described systematically and practically. The present report will continue into issue No. 7. of this journal.

The contents in issue No. 6 are:

Chapter I Natural Regeneration or Artificial Regeneration

1. Natural Regeneration System
2. Artificial Regeneration System
 - a. Taungya System
 - b. Okoume Limba System
 - c. Martineau System
 - d. Layon System
 - e. Placeaux System

Chapter II Natural Regeneration System

1. Stand Improvement
2. Natural Regeneration
 - a. Selection Cutting System
 - b. Natural Stand Improvement System
 - c. Tropical Shelter Tree System

Chapter III Artificial Regeneration System

- a. Taungya System

Keyword: Natural regeneration, Artificial regeneration, Clear cutting, Selective cutting, Planting, Improvement cutting

H.F. MAITRE

Natural forest management in Cote d'Ivoire: A paper presented at the 1986

world congress of the IUFRO in Yugoslavia

Unasylva, FAO, Rome, Italy, 157/158(39), 54-60, 1987, English

The idea of this study is to standardize the forest, modifying natural regeneration by opening up the cover to varying degrees. The problem here was the proliferation of sun-seeking creepers, and also the high cost of operations that were excessive in number and took too long, making them difficult to justify technically and economically. The study focuses on the higher stand to establish their reaction to simple and inexpensive treatments (logging and thinning) that could be carried out on a large scale.

Four years after treatments (poisoning of secondary species or logging of principal species), the forest has a more normal appearance: the candles (dead trees) have mostly disappeared and the stand consists of sound trees without creepers or drooping crowns. The upper story simply become more open, with an abundance of valuable species, particularly after thinning.

Taking into account the growth, mortality and regeneration of an entire stand, the results clearly indicated the value of silvicultural operations, which frequently resulted in a doubling of production, and also fostered the establishment of the most valuable species.

Keyword: Natural forest, Natural regeneration, Silvicultural technique, Light intensity

FAO

Management of tropical moist forests in africa

FAO Forestry Paper 88, Forestry Dep., FAO, Rome, Italy, 165 pp., 1989, English

The potential for sustained management of natural forests in the humid tropics continues to be a subject of concern and uncertainty among tropical foresters. The virtual disappearance of commercially productive tropical rain forests is imminent in some countries; in others, this is happening at a slower pace, usually because of inaccessibility.

This paper considers natural forest management in a restricted sense which may be thought of as controlled and regulated harvesting, combined with silvicultural and protective measures to sustain or increase the commercial value of subsequent stands, all relying on natural regeneration of native species. In a model management programme, negative ecological impacts of harvesting or alternative lands uses can be minimized, and the overall operation is productive and profitable while maintaining the essential ecological character of the forest. The paper also considers plantation management systems on tropical moist forest sites.

Keyword: Tropical rain forest, Natural forest, Natural regeneration, Forest management, Plantation, Sustainable management of forest

A. GOMEZ-POMPA, T.C. WHITMORE et al.

Rain forest regeneration and management

Man and the Biosphere Series, UNESCO, Paris, France, Vol. 6, 457 pp., 1991, English

The aim of this book is to explore the implications to management of present scientific knowledge on rain forest regeneration. In addition to providing an overview of scientific information on rain forest regeneration, subsidiary aims are to identify gaps in information and understanding, in respect to both scientific hypotheses and the needs of management, and to explore directions for future collaborative research and action. The intention is not to present an encyclopedic or comprehensive literature review. Rather, the concern is with a review of selected technical issues and ecological processes within the context of management. The motivation is to help bridge the gap between the sciences associated with the wet tropics and on-the-ground management.

The book is based on thematic reviews, complemented by case studies. Synthesis reviews deal with such topics as sylvigenesis and architectural diversity, regeneration dynamics at various spatial scales, physiology of fast-growing species, reproductive biology and genetics, fruit and seedling ecology, nutrient cycling, current management programmes. Case studies deal with research and management experience in particular locations and regions.

Keyword: Tropical rain forest, Natural forest, Natural regeneration, Ecology, Forest management, Silvicultural technique

3. FOREST DAMAGE AND PROTECTION

3-1 Forest Fire

FAO

Wildland fire management terminology

FAO Forestry Paper 70, Forestry Dept., FAO, Rome, Italy, 257 pp., 1985, English

In May 1977, a FAO-UNESCO technical consultation on Mediterranean forest fire problems recommended the development of a multilingual glossary of forest fire terminology. Three fire specialists were chosen to accomplish this task. The idea was to provide a basis for more precise understanding of foreign fire management literature and discussion and to provide a vehicle for sharing concepts among countries with similar fire problems.

This terminology seeks to define terms commonly used in wildland fire management discussions and literature that are not defined in a fire management context in standard desk dictionaries such as the American Heritage Dictionary of the English Language, New College Edition.

The intention here is not to standardize fire management terms but rather to provide a reasonably complete glossary of terms in current usage, with widely accepted definitions.

Keyword: Forest fire, Forest management, Forest protection

N.P. CHENEY

Bushfire disasters in Australia, 1945-1975

Australia Forestry, Australia, 39(4), 245-268, 1976, English

Conflagrations occur whenever there is a favourable combination of fuel, weather and ignition source and may be disastrous when human resources are affected; the role of these factors in past conflagrations is discussed. Some of the most severe fire seasons and the major fires between 1945 and 1975 are discussed briefly with reference to the areas burnt and the losses of life and property.

While past disaster fires have been quite variable a common characteristic is that the period when the fire exhibits violent behaviour and when most damage occurs is relatively short (generally less than 8 hours) although these periods can recur in close succession.

The frequency of large fires has been used to delineate fire-hazardous areas; the frequency ranges from once every 3 years in coastal districts of New South Wales and eastern Victoria to less than once every 30 years in central Australia. Likely changes in the patterns of large fire frequency and in the nature and intensity of disaster fires are discussed. Forest fires are likely to decrease in frequency and intensity but rural fires may become more destructive in the future.

Keyword: Forest fire, Forest protection, Fire prevention

ROSS W. WEIN

Characteristics and suppression of fires in organic terrain in Australia

Australia Forestry, Australia, 44(3), 162-169, 1981, English

The study of fires in organic terrain has been neglected since such fires occur in only a relatively small segment of the Australian landscape. These fires which burn primarily by glowing combustion, have a disproportionate significance because costs of suppression are particularly high per unit area and because the ecosystems they affect are rare. Glowing combustion fires proceed very slowly and the deep soil heating effect has difference ecological consequences than that of many types of low intensity surface fires. Two case studies of glowing combustion fires - both from Tasmania - are presented as a basis for discussing fire suppression and ecological effects.

Keyword: Forest fire, Surface fire, Ecosystem, Fire suppression, Cost analysis

A. KEEVES & D.R. DOUGLAS

Forest fires in South Australia on 16 February 1983 and consequent future forest management aims

Australia Forestry, Australia, 46(3), 148-162, 1983, English

The forest fires which occurred in South Australia on 16 February 1983 destroyed some 21,000 ha of pine plantations. This was the most extensive series of plantation fires ever recorded in Australia. The fires are discussed, together with the areas affected, the spread patterns of the fires, the weather conditions, some aspects of the fire behaviour, and the damage that resulted. In addition, the subsequent salvage operations are briefly outlined and some of the future management aims are discussed.

Keyword: Forest fire, Pine, Plantation, Forest management

JULIANNE VENNING

Post-fire responses of a *Eucalyptus baxteri*; Woodland near Penola in South Australia

Australia Forestry, Australia, 41(4), 192-206, 1978, English

An analysis of the changes occurring during pyric succession in *Eucalyptus baxteri* woodland was made using species richness, evenness and diversity measures. Each of these measures returned to its original level within two years of burning, a result attributed to the high frequency of vegetative regeneration among the 68 species of perennial vascular plants considered.

Keyword: Forest fire, Eucalypt

C.J. LEITCH, D.W. FLINN & R.H.M. VAN DE GRAAFF

Erosion and nutrient loss resulting from ash Wednesday (February 1983)

wildfires: a case study

Australia Forestry, Australia, 46(3), 173-180, 1983, English

A wildfire on Ash Wednesday (16 February 1983) near Warburton in the Victorian Central Highlands left large areas of burnt forest in a highly erodible state and, in one particular locality, an intense thunderstorm of short duration six days after the fire caused gross erosion of catchment slopes and gullies. Limited sampling and measurement were undertaken in a 35 ha study area to indicate the causes and extent of erosion and to estimate quantities of nutrients lost during and following the wildfire. Recognising the imprecision of the data due to restricted sampling, it was estimated that in the order of 800 t of ash plus loose soil were washed from the study area (equivalent to about 22 t ha⁻¹) and that this eroded material contained about 2,900 kg of nitrogen and 220 kg of phosphorus. Losses of nitrogen and phosphorus through erosion together with volatilisation and convective transfer of ash were each estimated at approximately one-third of the total quantity of these nutrients held in the above-ground biomass. Soils in the study area were observed to be hydrophobic for more than three months following the wildfire. It is concluded that burnt forests can remain in a highly erosive state for protracted periods until the soils lose their hydrophobicity and revegetation commences.

Keyword: Erosion, Soil fertility, Forest fire

A.H. GRAY & R.H. PFITZNER

Log salvage and storage operations following the ash Wednesday bushfires in the South East of South Australia

Australia Forestry, Australia, 48(3), 183-192, 1985, English

Following the fires of February 16th 1983 in the South east of South Australia, a sawlog salvage operation was implemented that had not previously been equalled in importance and magnitude in this region. The paper aims to tell how the operation was conceived, how it was implemented, what level of success was achieved and how that performance could have been improved.

The first section establishes the level of forest destruction, how the salvage targets were established and the initial strategies that were developed to salvage and process or store the sawlog.

The main section of the paper traces the steps which led to the setting up and successful implementation

of the salvage operations, including the infra-structure required for crew training, supervision and administration and road access. Running parallel with this programme was the establishment of the log storage sites -- initially the concept and planning of the storage at Lake Bonney, and then the progression to sprinkler storage areas. The paper indicates how ideas on storage requirements were consolidated and how a more pragmatic approach was developed leading to an optimal storage facility.

The third part of the paper attempts to look objectively at the decisions taken when setting up the salvage and storage components of the operation, efficiency and cost effectiveness.

Finally, the desirability for each of the major plantation areas to formulate a contingency plan to cope with a large natural disaster is advocated and the components of that plan are suggested on the basis of the experience gained during the operation conducted in the South East of South Australia.

Keyword: Logging, Forest fire, Logging operation, Cost analysis

R.B. SMITH & P.W. WOODGATE

**Appraisal of fire damage and inventory for timber salvage by remote sensing
in mountains ash forests in Victoria**

Australia Forestry, Australia, 48(5), 252-263, 1985, English

In 1983 the most severe fire in Victorian mountain forests for over forty years killed extensive areas of highly productive eucalypt forest, requiring a large scale timber salvage and forest rehabilitation program. The scheduling of these programs was dependent upon a rapid and reliable assessment of the extent and severity of damage. Damage assessment, initiated immediately following the fire, utilised five distinct but complementary phases of remote sensing, namely airborne infrared scanning, conventional colour aerial photography from both large and small format cameras and Landsat imagery in pictorial and digital forms. The paper describes how this combination of remote sensing media offered a practical and successful solution to the problem of providing accurate and timely resources data for planning purposes.

Keyword: Forest fire, Remote sensing, Eucalypt, Forst inventory, Forest operation

S.B. SHOW & B. CLARKE

Forest fire control

FAO Forestry Series, FAO, Rome, Italy, No.6, 110 pp., 1953, English

In many countries the forest fire problem has been correctly assessed and efficient protection has been organized -- not only, in fact, for forest areas but for all rural lands. But there are many countries which have not yet given the problem the attention it deserves. This study is accordingly addressed to the technical administrators and their colleagues in such countries, and to those who must size up the need for protection against forest fires, approve policy, and provide the means.

It attempts to describe the successive steps which need to be followed in the formulation of policy, the setting up of an organization to translate that policy into action, and the means by which plan can be carried to fulfillment. For many aspects of the problem greater detail is obviously required and the works listed in the bibliography should provide information on how to do various jobs that is purposely omitted from this text.

Keyword: Forest fire, Fire prevention, Cutting, Fire suppression

3-2 Pests and Diseases

A.K. PARKER

Diseases of forest nurseries and plantations

**Report to the Government of Nigeria, FAO, Rome, Italy, Report No. 1883,
38 pp., 1964, English**

No previous surveys or research projects have been conducted in Nigeria on forest disease, and the

literature contains very little pertinent information.

During the course of inspections an attempt was always made to appraise the importance of the disease encountered. The incidence and rate of spread of disease in individual trees and in the stands was recorded whenever possible. In many cases, however, the appraisal of a disease was relatively superficial because of the scarcity of plantations representing more than a very narrow range of age and site classes, the small size of a number of the plantation (many were initial, small-scale species trials) and the relatively short period of observation.

During the course of the survey, the 13 disease problems appeared potentially serious or were of major concern to forest manager. Three of the major disease problems were located in nurseries, 9 in plantation and one was common to both nurseries and plantations. These diseases are damping-off, root rot, butt rot, leaf spot, dieback, cankers, etc.

Keyword: Tree disease, Nursery, Plantation

D.H. PERRY, M. LENZ & J.A.L. WATSON

**Relationships between fire, fungal rots and termite damage in Australian forest trees
Australia Forestry, Australia, 48(1), 46-53, 1985, English**

The relationships between termites and fungal rots are complex and, in living trees, very poorly understood. However, termite attack on the heartwood of living jarrah (*Eucalyptus marginata*), karri (*E. diversicolor*) and maritime- or cluster pine (*Pinus pinaster*) in south-western Australia is

secondary to fungal attack which, in turn, depends substantially on fire scarring. A review of the available data suggests that this generalisation applies equally in south-eastern Australian forests, and that the dependence of fungal and termite damage on fire or mechanical damage has important practical implications for forest management.

Keyword: Forest fire, Forest management, Fungus, Termite, Eucalypt, Pine

D. FRASER & E.M. DAVISON

**Stem cankers of *Eucalyptus saligna* in Western Australia
Australia Forestry, Australia, 48(4), 220-226, 1985, English**

Ten plantations of *Eucalyptus saligna* in the southwest of Western Australia were surveyed for stem cankers on the lower 2 m of bole. Cankers occurred on 45% of the surveyed trees, and of these 92% were annual. The majority of the remainder, perennial cankers, were associated with galleries of *Tryphocaria solida*, the eucalypt longhorn beetle. Statistical analyses showed that the cankers did not appear to affect the growth rate of the trees. The fungi *Cytospora eucalypticola*, *Endothia havanensis* and *Botryosphaeria ribis* were isolated from both annual and perennial cankers. Pathogenicity tests showed that these fungi could cause cankers. *B. ribis* and *E. havanensis* caused larger lesions more frequently than *C. eucalypticola*.

Keyword: Plantation, Tree disease, Eucalypt, Fungi damage

J. ODERA

**Know and prevent entry of the cypress aphid *Cinara cupress*:
Kenya Forestry Research Institute Technical Note, Kenya, No. 7, 10 pp., 1990, English**

Cupressus lusitanica which was introduced into Kenya in 1910 and has since become an important industrial plantation crop. Among its favourable attributes is its relatively high resistance to pests and diseases in Kenya.

The only disease known of economic importance to *C. lusitanica* in Kenya today is *Amillaria* root rot caused by the fungus *Armillaria mellea*. *A. mellea* is normally present in forest soils and can live as a saprophyte on dead wood or stumps. It can however, attack the roots and butts of trees and cause rotting which eventually kills the trees. Small trees are more susceptible than older ones. Deaths of upto 14 percent have been observed in some plantations.

Keyword: Planting, Insect damage, Pest and disease, Plantation, Conifer

MARTIN K. KARANJA & THERESA C. ALOO

The introduction and establishment of *Tetraphleps raol* Ghauri as a control of woolly aphid in Kenya

Kenya Forestry Research Institute Technical Note, Kenya, No. 12, 11 pp., English

In January 1969 heavy infestations of woolly aphid were on several pine species at Muguga. The history of the introduction and subsequent establishment of this pest on all pine crops in country has been reported by Odera (1972) and Mailu (1979). The rapid spread of this pest posed a major threat to pine plantation in the country.

The woolly aphid had already spread rapidly to other pine growing areas in the country and control measures were required. So chemical and biological control measures were tried with varying degree of success.

Keyword: Pine, Insect damage, Control measure, Plantation

KEFRI

Chemical control of cypress aphid

Kenya Forestry Research Institute (KEFRI), Kenya, 7 pp., 1990, English

Cypress and cedar are important trees in Kenya. Cypress is widely planted both in farmlands and in gazetted forests for production of timber. The tree is also popular for establishment of hedges in rural and urban areas. Cedar is highly valued for its durable fencing posts. It is also an important tree in main water catchment areas. These two tree species as well as some other lesser known trees of cypress family, are currently being threatened by the recent outbreak of cypress aphid.

This leaflet provides information on the aphid and some insecticides that can be used to reduce the damage to trees.

Keyword: Conifer, Insect damage, Insecticide, Forest protection

4. FOREST MENSURATION AND MANAGEMENT

4-1 Growth, Increment of Trees and Stands

DEVENDRA PANDEY

Growth and yield of plantation species in the tropics
FAO, Rome, Italy, 115 pp., 1983, English

The report is the output of a study made Mr. Devendra Pandey, a member of the Indian Forest Service, during his fellowship at FAO under the Programme for Training in Agricultural development in 1983.

The study reviews growth and yield under plantation conditions. It covers 76 tropical countries and 29 major species found there. First, basic concepts and methodology are explained, then a survey of the plantation areas in the tropics is made to serve as a basis for the selection of species for the study. This is followed by the main section, which includes description of the species' natural distribution and their main characteristics, established area by country, review of volume, growth and yield studies, with specifications of ecological conditions, such as locality, rainfall, altitude, etc., of the source data and number of plots used for the investigation. The report ends with a set of recommendations for future studies and suggestions for the eventual revision of the present report.

Keyword: Plantation, Growth, Yield volume, Site quality, Tree species, Distribution

WINSTON J. MATHU & MICHAEL S. PHILIP

Growth and yield studies of *Cupressus lusitanica* in Kenya
Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam,
Tanzania, 16 pp., 1979, English

The growth and yield of *Cupressus lusitanica* Miller under the current saw timber management schedules in Kenya were studied using the 133 permanent sample plots already established in 1974 by the Kenya Forest Department.

The relationship between dominant height and age was examined and the results of earlier experiments were compared with additional subjective and objective analyses of the data derived from the permanent sample plots. Base site index curves were derived from the two analyses. The large variation in the growth rates of different plots of the same age was noted; examination in the field of some of the fastest and slowest growing plots at different ages is needed to provide information on the causes of this variation and for more efficient grouping of plots and the definition of more homogeneous site types.

The effect of stand density, defined by the ratio of average tree spacing to dominant height, on basal area increment was analysed. The large variation in the growth rates of different plots with similar stand densities frustrated an attempt to define the effect of stand density on basal area increment, although there is some evidence that increment is up to 15% lower in understocked stands of age 10 compared with stands managed according to the prescribed schedules or with stands overstocked compared to these schedules.

A yield table for stands managed according to the prescribed schedules was constructed based on:

- the subjective base site index curve
 - an equation predicting basal area before first thinning, after 7 years, using dominant height and numbers of stems per hectare as predictor variables
 - an equation predicting basal area increment using dominant height alone as the predictor variable
 - an equation predicting the diameter of the tree of mean basal area thinned using the diameter of the tree of mean basal area of the crop before thinning as the predictor variable
 - a single tree volume equation using tree diameter at breast height and crop dominant height as predictor
- By this table the maximum mean annual increment for the average site in Kenya was 24 m³/ha/year at age 23 years. However, additional work is needed to verify the model, especially:
- the limits to the numbers of stems at different ages within which the basal area increment predictive equation is valid
 - the accuracy of the basal areas predicted by iteration of the basal area increment predictive model

the accuracy of the predictions of total volume derived through the diameter of tree of mean basal area, the dominant height of the crop, and the number of stems.

Keyword: Site quality, Growth, Yield table, Stand density, Basal area, Mean annual increment

P.W. WEST & D.J. INGLIS

Present value of regrowth eucalypt forest in Southern Tasmania

Australia Forester, Australia, 47(4), 259-265, 1984, English

Costs and returns at 1980/81 prices and yield data were obtained for 41 plots, aged 24-81 years, at even-aged high quality *Eucalyptus regnans/E. obliqua* forest in Southern Tasmania. The present value of each of these plots was determined at a variety of discount rates from 1% to 20%. Even at moderate rates (5-6%), the high regeneration cost in these forests (\$283/ha) dominated the computation of present value because this cost is compounded over the whole rotation and is by far the largest cost involved in managing these forests. Because of this, variation in present value due to differences in age and site productivity of the plots was much reduced. At discount rates of 5-6%, present value was -300 to -500 \$/ha. Present value of these forests might be increased by developing more cost efficient management practices, by altering royalties on harvested timber, by thinning the forest to provide intermediate returns or by using timber that is presently wasted as fuelwood or pulpwood.

Keyword: Eucalypt, Planting, Forest management, Yield volume

IAN ABBOTT & OWEN LONERAGAN

Growth rate of jarrah (*Eucalyptus marginata*) in relation to site quality in cut-over forest, Western Australia

Australia Forestry, Australia, 46(2), 92-102, 1983, English

The growth rate of jarrah was measured in 47 plots situated in high and low quality cut-over forest between Mundaring and Collie. Mean growth increments per decade for jarrah in high and low quality forest respectively were: diameter, 1.7 and 1.0 cm; basal area, 1.9 and 0.6 m²ha⁻¹; volume, 11.8 and 2.0 m³ha⁻¹. In high quality forest, diameter increment varied inversely with initial basal area whereas basal area increment and volume increment varied directly with initial number of stems per hectare. From diameter growth curves calculated with these data the average diameter attained by trees in high or low quality forest after 400 years would be about 70 cm or 50 cm respectively. When only trees with above average increments are considered, 70 cm diameter would be attained after 250 years in high quality forest and 310 years in low quality forest. If only the 25% of the trees with the greatest increments are considered, these figures would be 200 and 250 years respectively.

Keyword: Eucalypt, Cut-over area, Site quality, Increment, Hight increment, Diameter increment

E.J. LOCKETT & S.G. CANDY

Growth of eucalypt regeneration established with and without slash burns in Tasmania

Australia Forestry, Australia, 47(2), 119-125, 1984, English

Early height growth of mixed eucalypt species regeneration established by clearfall, burn and sow treatments at four locations taking in a range of different forest sites in eastern and north-eastern Tasmania has been compared with that of natural regeneration on adjoining areas which were clearfelled at the same time but not burnt. The natural regeneration was of various origins but was generally still quite small at the time of the burn and sow treatments, which it pre-dated by up to 12 years. Height has been measured several times at each site during the period 2-10 years post-burn.

On two relatively wet sites (approximately 1250 mm and 1000 mm mean annual rainfall) the burn and sow treatments produced significantly faster early height growth than the unburnt treatments, but on the two drier sites (approximately 850 mm and 800 mm mean annual rainfall) growth rates did not differ significantly between treatments. On the drier sites the unburnt treatment allowed vigorous coppice shoots to establish an initial height advantage which has so far been maintained.

These early results suggest that, on productivity grounds, the case for slash burning is not so strong in

Tasmania's drier, more open, lower quality forests as in the wetter, higher quality forests. Nevertheless, in the drier forests slash burns are still used more often than not, mainly to facilitate future fire protection.

Keyword: Eucalypt, Regeneration, Burning, Tree growth

THOMAS HAWKINS

**Biomass and volume tables for *Eucalyptus camaldulensis*, *Dalbergia sissoo*,
Acacia auriculiformis and *Cassia siamea* in the Central Bhabar - Terai of Nepal**
O.F.I. Occasional Papers, Oxford, UK, No. 33, 43 pp., 1987, English

Single entry biomass tables of oven dry and fresh weight, based on the equation $\text{Ln Weight} = a + b \text{ Ln DBH}$, (diameter at breast height) are presented for *Eucalyptus camaldulensis* Dehn., *Dalbergia sissoo* Roxb., and *Acacia auriculiformis* A. Cunn. ex Benth. Over dry and green weight single entry tables are given for *Cassia siamea* Lam. using diameter at ground level (5 to 10 cm height) as the predictor variable. Single entry overbark and underbark total volume tables are given for *E. camaldulensis* and *D. sissoo* using DBH as the predictor variable.

The *E. camaldulensis* biomass and volume regressions were compared with two *Eucalyptus tereticornis* and two *E. camaldulensis* provenances. There was no significant difference between the equations of the four provenances for volume or stem biomass. The tables for all of the species have been validated for short rotation clean weeded plantations in the Bhabar-Terai region of Central Nepal.

The yield of the four species was estimated for different sites, ages, and spacing using the equations developed. *E. camaldulensis* and *C. siamea* are the most productive species with an oven dry fuelwood (stem and branch) MAI at age 4.5 and 2.5 years of 14 and 10 tons per ha respectively. *E. camaldulensis*, at the short rotation stocking of 10,000 stems per ha did not produce appreciably greater yields than a stocking of 2,500 stems per ha by age 1.5 years.

Keyword: Eucalypt, Acacia, Stem volume, Breast height diameter, Yield volume, Biomass

P.G. ADLARD

**Growing stock levels and productivity conclusions from thinning and spacing trials in
young *Pinus patula* stands in Southern Tanzania**
C.F.I. Occasional Papers, Oxford, UK, No. 8, 17 pp., 1980, English

Data from six experiments laid out to test the effect of spacing and growing-stock level on the growth of *Pinus patula* to age 15 on the southern Highlands of Tanzania have been summarised and analysed. Increased stand density resulted in creased total volume production and reduced mean tree size, with no clear effect on height growth.

A close relation was found between mean size and volume increment and Assmann's relative basal area, an index of stand density. The results are summarised for one site class in the form of a variable density yield table where density is defined either as stocking or as relative basal area.

Keyword: Pine, Growth, Tree density, Thinning, Planting interval

J.L. STEWART, A.J. DUNSDON et al.

Wood biomass estimation of central american dry zone species
Tropical Forstry Papers, Oxford Forestry Institute, University of Oxford, UK
No. 26, 83 pp., 1992, English

This paper arose from a project at the Oxford Forestry Institute (OFI) to evaluate a network of international trials of Central American dry zones species of potential value to farmers for fuelwood and a range of other uses. A major part of the study was the development of a standard methodology for wood biomass estimation, to allow comparison of results from different sites. Biomass data were collected from trials on 13 sites throughout the tropics, and used not only to test the validity of the methods but also to construct generalized biomass tables for 16 species.

The biomass tables are species-specific, and are only applicable to trees of a certain size range, which have not been subjected to management interventions such as pollarding, and which are grown on sites broadly

similar to those used in the study. The standard methodology developed at the OFI for biomass prediction at individual sites has been vigorously tested for its validity for all 26 species originally included in the dry zone hardwood trials; it has been found to give consistently reliable results for species with widely differing growth characteristics, and may therefore be used for small trees of any species.

Keyword: Biomass, Tree growth, Arid region, Growth, Hardwood

D. ALDER & T.J. SYNNOTT

Permanent sample plot techniques for mixed tropical forest

Tropical Forestry Papers, Oxford Forestry Institute, University of Oxford, UK

No. 25, 124 pp., 1992, English

This manual provides a reference guide to permanent sample plot (PSP) techniques in mixed tropical forests. The manual considers the objectives of PSPs as that of providing data for growth and yield models which will be used to assist forest management. The PSPs are a means of measuring tree growth, mortality, and regeneration in relation to stand density. They may be laid down either as a network of sample plots, passively sapling existing forest management practices; or as measurement plots within an experimental design. Both approaches are properly required for the optimum capture of data. Experimental designs should concentrate on the effects of extremes of stand density, from controlled logging or poisoning, and always include untreated and unlogged forest as a control to define maximum basal area and growth under maximal competition. The manual covers site assessment briefly, including topographic indicators based on altitude, slope and aspect, soil sampling and classification methods, the use of vegetation associations as site indicators, and the use of quantitative stand parameters such as mean height and form height.

Keyword: Tree growth, Measurement, Stand density, Stand condition, Growth, Stand composition

P.G. ADLARD

Procedure for monitoring tree growth and site change

Tropical Forestry Papers, Oxford Forestry Institute, University of Oxford, UK

No. 23, 188 pp., 1990, English

This publication presents procedures for monitoring the growth of forest plantation, principally in the tropics.

The procedures include methods of setting up a system of both, temporary and permanent sample plots located objectively within managed plantations and replicated field experiments. The experiments test the effects of silvicultural management on tree- and stand-growth patterns. Together the information collected provides the basis for the management of the plantation (in the form of volume and yield tables and functions) and for detecting site change, for example when applied to related studies on tree water use and nutrient cycling.

Method for collection of data in the field and its processing using small personal computers is suggested.

Recommendations for the assessment of above- and below-ground phytomass production are given in addition to procedures for measuring and recording the conventional tree and stand variables.

Model field forms are included as an aid memoire to planners of continuous inventory and monitoring programmes.

Keyword: Tree growth, Measurement, Tree form, Plantation

4-2 Harvesting

JOSEPH O. ADEGBEHIN & MICHAEL S. PHILIP

Studies of dominant height development and yield of *Pinus patula* at Sao hill forest project, Southern Tanzania

Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Tanzania, Record No. 6, 21 pp., 1979, English

- Three general and inter-related topics concerning *Pinus patula* at Sao Hill were studied:
- the construction of site index curves
 - the applicability of the Tanzanian Standard Volume tables
 - the derivation of preliminary yield tables

Data was collected from 108 temporary and 18 permanent sample plots. Most of the plots were in the relatively small areas of the Msiwasi and Mninga blocks that contained the older plantations, with few in the extensive recent plantings in the Irundi South and Ngwasi blocks because these areas lack older plantations. Consequently the sample is not truly representative of all the Sao Hill plantations.

Dominant height development was studied by stem analysis. A base Dominant Height on Age curve was constructed using the method advocated by Tweite (1969). Site index curves harmonized with the base curve were constructed to define the average dominant height on age trend for three sites; they passed through dominant heights of 24, 27 and 30 m respectively at age 20 years.

Comparison of these site index curves with others from Kenya, Malawi, Natal and Tanzania indicated that the Sao Hill curves were nearest to those published for Kenya.

Tests of the Tanzanian Standard Volume Table for *Pinus patula* indicated that these tables are both inaccurate and imprecise when applied in Sao Hill. There is an urgent need for a local volume and compatible taper table.

A preliminary yield table was made based on the relationship of Total Volume Production on Dominant Height. The age of maximum mean annual increment and the maximum mean annual increment for the three Site Index curves of 24, 27 and 30 m dominant height at age 20 years were:

Site Index	30 - 22 years	- 35 m ³ /ha
	27 - 23 years	- 30 m ³ /ha
	24 - 24 years	- 25 m ³ /ha

Thinning and main crop yields were predicted for two different thinning regimes, but these results provide a guide only and are not authoritative as the data on thinning yields and stem numbers were insufficient for more precise predictive models. The preliminary yield table will need revision when the extensive new plantations in the Irundi South and Ngwasi blocks mature.

Keyword: Pine, Plantation, Site quality, Standing tree volume table, Yield table, Dominant tree

RAPHAEL E.L. OLE MEILUDIE & HARALD OMNES

The use of sulkies in thinning softwood plantations

Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Tanzania, Record No. 9, 13 pp., 1979, English

This study was carried out at Sao Hill Forest Project in October, 1976. The aim was to compare suitability, production and costs for three different types of sulkies when used in thinning operations. The sulkies were used both in skidding and for pulling down hangups. 318 loads and 79 hangups divided among three different crews and the three different sulkies were studied. Each crew consisted of two men.

Felling, cross-cutting and skidding up to roadside were combined and carried out sequentially for each tree. The sulkies, named A to C, varied in design, weight and strength, A being the lightest and C the heaviest.

The main results were:

- only about 15% of a 7 hours day was spent on skidding. Felling and cross-cutting occupied 33-45% and necessary delays another 24-30% of the 7 hours. Unnecessary delays amounted to 8-26%
- sulky A had the highest production and the lowest cost. At the average skidding distance of 31 metres the production was 2.4 m³ per effective hour or 1.6 m³ per hour, standard time. The corresponding cost was shs. 3.20 per m³
- sulky B achieved almost the same production but at a slightly higher cost than sulky A. With sulky C the production dropped by 30% and the cost was almost 100% higher
- for distances shorter than 10 metres the logs were taken directly to roadside without using a sulky, at a production rate of 2.0 m³ per hour, standard time
- sulky C proved to be far better for pulling down hangups than the other and was the only one strong enough to handle the large trees

Based on these results it is recommended that each working crew should be equipped with a light skidding sulky, A and a heavy sulky, C for hangups.

Keyword: Logging machine, Pre-yarding, Thinning, Felling

MICHAEL S. PHILIP, SHABANI A.O. CHAMSHAMA, MUSA K.L. ENYOLA et al.
Studies of volume estimation of *Pinus patula* in Tanzania
Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es
Salaam, Tanzania, Record No. 11, 19 pp., 1979, English

Methods of estimating standing volume were studied at Sao Hill, Meru and North Kilimanjaro (Rongai) Forest Projects. New local volume tables for *Pinus patula* at Sao Hill were produced using 140 felled trees covering the range from 7 to 50 cm diameter at breast height over bark-dbh. One table estimates total volume over bark and the other, derived from the first, estimates volume over bark to 15 cm top diameter. The tables were tested on a separate random sample of 37 trees ranging in diameter from 17 to 47 cm dbh, and gave a total error of -1.3%. No indication of bias in different tree size classes was detected.

Local volume tables were constructed for *Pinus patula* at Meru and North Kilimanjaro (Rongai) Forest Projects also. They were based on a relatively small sample of trees measured standing with a Spiegel Relaskop. Their accuracy has not been tested against felled trees. Nevertheless the study concludes that separate tables are needed for the two projects and that at Meru the more complex three dimensional table based on dbh, total height and diameter at half total height is warranted, whereas at Rongai a one parameter table based on dbh alone is more efficient.

In the final study a test of British Forestry Commission-type Tariff Tables was done. The results of a limited trial based on felled trees suggested that unbiased estimates of standing volumes of thinnings and crops to be clear felled can be obtained using between 30 - 50 felled trees and a systematic sample of standing trees to define the diameter distribution. Further study of the application of these tables is recommended. Such tables would be a useful tool in controlling the efficiency of a felling operation to ensure that as much as possible of the standing tree is harvested. The standing volume per hectare estimated with Tariff Tables can be compared with the sold volume in order to determine the percentage of the standing volume harvested.

Keyword: Pine, Stand tree volume, Stand tree volume table

AARON S.M. MGENI

Use of a normal yield table in forecasting increment for understocked stands
- a case study at Sao Hill

Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es
Salaam, Tanzania, Record No. 28, 12 pp., 1981, English

The tool developed for increment forecasting at Sao Hill Forest Project is a normal yield table which, when applied to over- or understocked stands, requires adjustments. Since understocked stands are common in Sao Hill, their approach to normality has to be included in increment forecasting. Thus Gehrhardt's formula was investigated for this purpose.

Forty one plots were subjectively sited in understocked areas of some stands of site classes I, II, III and IV, with an age range from 11 years to 19 years, distributed all over Sao Hill. Thinned or fire-damaged crops were avoided.

Plot volumes were computed using free hand height-diameter curves in combination with The Tanzania Standard Volume Table for *Pinus patula*, while the last 5-year volume increment was determined by a ratio estimate method. The determination of the constant "c" incorporated in Gehrhardt's formula was solved as a constrained simple linear regression problem.

The constant *c* of *Pinus patula* was found to be 0.81 with confidence limits of 0.776 to 0.844 at the 95% level. The reliability of this result is discussed. For practical purposes the result is regarded as sufficiently reliable and the Gehrhardt's formula as applicable at Sao Hill is presented.

Keyword: Yield table, Thin forest, Stand

FAO

Basic technology in forest operations

FAO Forestry Paper 36, Forestry Dep., FAO, Rome, Italy, 132 pp., 1982, English

In the course of recent years it has become apparent that forest operations in countries whose development is at the initial or intermediate stage are overmechanized. Machines and equipment much too

sophisticated and expensive are often being introduced with far reaching results, mostly negative.

Two categories of technology exist today: hard and soft (Goulet, 1975). Hard technology is expensive, capital-intensive and complex. Soft technology is relatively inexpensive, labour-intensive, flexible and adaptable to local materials of non-standard quality which can be installed, repaired and maintained by people with modest technical knowledge. This is Basic Technology.

This Handbook on Basic Technology for Forest Operations deals with the manufacture and utilization of tools and mechanisms meant to reduce the expenditure of physical energy and improve productivity in labour-intensive forestry operations.

The aim is to make forest work easier, to promote self-reliance at the community level and to decrease dependence on foreign currency. It is not meant to support or encourage heavy labour-intensive operations.

Keyword: Handbook, Logging operation, Felling, Logging, Community forestry, Logging machine

FAO

Appropriate wood harvesting in plantation forests

FAO Forestry Paper 78, Forestry dep., FAO, Rome, Italy, 266 pp., 1987, English

One of the main difficulties in efficient forest harvesting is the lack of experienced and competent personnel capable of making sound managerial and operational decisions. This usually results in high production costs, increased accident rates and lack of motivation of the forest workers. It also has a negative impact on the effective use of the forest resource base and on the environment.

The FAO/Finland Training Course on Appropriate Wood Harvesting Operations was held from 9 to 26 June 1986 at Mutare and Troutbeck in Zimbabwe.

The course placed emphasis on the following aspects of wood-harvesting operations: planning of raw-material procurement; selection of appropriate technology; cost control; forest road construction; felling, bucking, skidding; wood transport; equipment maintenance; safety, ergonomics; log grading and interrelated subjects on the forest resource base and forest industry.

This document is a compilation of the lecture papers presented at the training course.

Keyword: Plantation, Training, Logging operation, Harvesting, Forest operation, Felling, Logging

VIRGILIO DE LA CRUZ

Small-scale harvesting operations of wood and non-wood forest products involving rural people

FAO Forestry Paper 87, Forestry Dep., FAO, Rome, Italy, 77 pp., 1989, English

This report is a case study on harvesting operations involving rural people.

Part I of the report refers to the results of a case study on harvesting a bamboo plantation and a natural bamboo stand in the Philippines. The harvesting operation was divided into work phases and elements. In the bamboo plantation, three work phases were defined; pole preparation, minor transport and major transport. In the natural bamboo stand, pole preparation and minor transport were studied. Time and work studies were carried out on the harvesting work phases. Time and production standards of each harvesting phase were calculated and are presented in his report. General figures on the establishment cost for the bamboo plantation are also presented.

Part II of the report refers to the results of a case study on the production of firewood from the bark of dipterocarp species in the Philippines. Bark from dipterocarp logs is a good potential source for fuelwood. Bark firewood production is a profitable small-scale forest-based enterprise for rural communities situated close to forest industries in the Philippines, which can serve as an example to other countries. The study dealt with the identification of work phases and the market outlets for the bark firewood enterprise.

Part III of the report refers to the results of a case study on a harvesting operation in a mangrove forest in Malaysia.

Keyword: Harvesting, Fuelwood, Non-timber products, Logging, Bamboo, Dipterocarps, Bark