VOLUME XV – Nos. 1 & 2
(NEW SERIES)
JAN. – DEC., 1981

Local – Rs. 5.00
Foreign – US $ 2.50

THE SRI LANKA FORESTER

(THE CEYLON FORESTER)

PUBLISHED BY THE SRI LANKA FOREST DEPARTMENT

PRINTED AT THE DEPARTMENT OF GOVERNMENT PRINTING, SRI LANKA

THE SRI LANKA FORESTER

(THE CEYLON FORESTER)

The Sri Lanka Forester (*The Ceylon Forester*) is published in June and December (biannually) by the Sri Lanka Forest Department.

The new series was started in 1953 and the journal publishes articles, reviews and research communications pertaining to forestry and allied subjects.

Articles published express the opinions of the authors and do not necessarily represent the views of the Forest Department.

SUBSCRIPTION RATES

Foreign :

Annual (2 numbers) ..	..	U.S.$.	2.50
Half-Yearly (1 number)	..	U.S.$.	1.50

Local :

Annual (2 numbers) ..	..	Rs.	5.00
Half-Yearly (1 number)	..	Rs.	3.00

Cheques/Money Orders/Postal Orders should be drawn in favour of the 'CONSERVATOR OF FORESTS' and crossed.

All correspondence regarding contributions, subscriptions, etc., should be addressed to—

THE EDITOR
"SRI LANKA FORESTER"
FOREST DEPARTMENT, COLOMBO 2
SRI LANKA

Editorial Office
FOREST DEPARTMENT
P. O. BOX 509
COLOMBO 2
SRI LANKA

THE SRI LANKA FORESTER
(THE CEYLON FORESTER)

Journal of the Sri Lanka Forest Department

Editor
K. VIVEKANANDAN

Editorial Office
FOREST DEPARTMENT
P. O. Box 509
COLOMBO 2
SRI LANKA

THE SRI LANKA FORESTER
(THE CEYLON FORESTER)

VOL. XV Nos. 1 & 2 (NEW SERIES) JAN. - DEC. 1981

CONTENTS

2—A 67450—1,520 (82/12)

THE SRI LANKA FORESTER
(THE CEYLON FORESTER)

VOL. XV Nos. 1 & 2 (NEW SERIES) JAN. — DEC. 1981

" The forest is a peculiar organism of unlimited kindness and benevolence that makes no demand for its sustenance and extends generously the products of its life activity : it affords protection to all beings, offering shade even to the axeman who destroys it." — GAUTAMA BUDDHA

NEWS BRIEFS

***Editor's comment**

We once again apologize to our readers for the delay in putting out this issue as the editor was away on overseas leave. We are hoping to publish the forthcoming issues without further delay. We sincerely hope our readers will bear with us.

***Articles for Publication**

We welcome articles and research notes pertaining forestry and allied subjects from our readers for publication. The articles should conform to the general guidelines appearin in the last page of this issue. 25 free copies of reprints of each contribution will be provided to the author.

***Revision of Subscription Rates**

Because of rising printing costs we are reluctantly compelled to increase the subscription rates of the *Sri Lanka Forester*. The new rates will become effective from 1983 commencing with Volume 16.

The new rates are as follows :—

	Annual Subscription (2 Numbers)	*Half yearly Subscription (1 Number)*
Local	.. Rs. 15.00	.. Rs. 7.50
Foreign	.. US $ 10.00 (Post free)	.. US $ 5.00 (Post free)

Back numbers upto 1982

Local	.. Rs. 5.00 per number
Foreign	.. US $ 2.50 per number (Post free)

Re-prints of articles

Local	.. Rs. 1.50 per re-print
Foreign	.. US $ 0.50 per reprint (Post free)

Training

Mr. Anton Soyza, Research Officer (Timber Technology) returned to the island after completing an M.Sc. degree at the University of Bangor, U.K.

Mr. S. Sahajananthan, Assistant Conservator of Forests, returned to the island after completing an M. Sc. degree at the University of Oxford, U.K.

Forestry Projects

Community Forestry Project

The Forest Department will undertake a Community Forestry Project with the assistance of the Asian Development Bank in mid 1982.

The main objective of the project is to augment fuelwood supplies. It will also increase the supply of poles and constructional timber and fruit trees. The project is expected to act as catalyst in creating community awareness and also to build up the institutional capacity within the Forest Department.

The project is estimated to cost US $ 13.67 million of which A.D.B. is expected to finance US $ 10 million.

UNDP/FAO Forest Inventory Project — Inventory for Management Planning

This Project is designed for the collection of qualitative and quantitative information on Forest Resources both of plantations and natural forests with the ultimate objective of preparing management plans for wet zone productive forests and plantations.

The project period is three years and is expected to commence in the latter part of 1981. The output of the project would be :

(*a*) An updated forest resources map at a scale of 1 : 250,000 for the whole country.

(*b*) An updated forest resources condition map at a scale of 1 : 50,000 for the wet zone and upland areas.

(*c*) Management plans for two management units in mixed natural forests in the wet zone of about 20,000 ha. each.

(*d*) Management plans for plantations estimated at roughly 25,000 ha.

(*e*) Establishment of 80 to 100 Permanent Sample Plots for assessment of growth, regeneration and mortality.

(*f*) Provision of indicative inventory and the establishment of a data-bank for long-term land-use policy decisions for the wet zone and upland forest areas covering approximately 200,000 ha.

(*g*) Trained personnel capable of undertaking forestry/land-use and management planning.

UNDP inputs for the project is US $ 557,329 and Government's inputs is Rs. 4,004,000. Mr. M. Pushparajah, Deputy Conservator of Forests, (Working Plans and Inventory) will function as the Project Director.

Forestry Courses at Commonwealth Forestry Institute — Unit of Tropical Silviculture, Oxford

The following courses are available in 1982 —

(*a*) Social and Community Forestry (30 August to 8th October 1982)

(*b*) Forest Protection (21st June to 27th August 1982)

(*c*) Fifth Planning and Management Course for Forestry (2nd July to 1st October 1982)

(*d*) Tropical Moist Forest Resources, Management and Conservation (25th October to 3rd December, 1982).

In 1983 in addition to the tenth *Forest Research Course*, the sixth *Planning and Management Course for Forestry* and the second *Social and Community Forestry Course* there will be a six-week course on *Forest Resource Utilization.*

A number of other courses are in preparation and details will be released in due course.

IUFRO — XVII World Congress — Kyoto, Japan, 6 — 17 September 1981

We give below the declaration of the XVII — IUFRO World Congress —

Research Today for Tomorrow's Forests :

Considerations.—Wood is the world's major renewable commodity and world demand for wood and other forest products and services is increasing with population growth and improved living standards.

There is a finite area of land in the world for the production of goods and services and the proportion available for forestry is steadily diminishing.

Unless appropriate measures are taken, increased exploitation will endanger not only the future supply of goods and services from the forest but also the forest gene resources, agricultural production, water resources and the human environment.

There is a considerable potential for increasing the productivity of forests and for integrating the various demands upon the land.

The distribution of forests in relation to human populations is unbalanced and there is an imperfect understanding of the ecology of both natural and man-made forests especially in some tropical regions.

Forest research is necessary to develop the forest potential, to overcome the constraints and difficulties and to alleviate the hunger, poverty and unemployment that are suffered by man in many regions.

Declaration.—The priorities of research are to gain a fuller understanding of the ecology of the world's forests, to increase their productivity both in quantity and quality and to improve conversion and utilization of forest products.

Inter-agency research into integrated land use should be encouraged, especially in tropical regions.

Forestry research should take account of the social, cultural, operational and economic factors in different regions.

There is a special need for research into the production of fuelwood in deforested regions and into the use of forest biomass for energy throughout the world.

There should always be close co-operation among policy makers, forest managers and research workers, both nationally and internationally, to ensure the formulation of realistic and productive research programmes and the effective implementation of research results.

In the face of financial stringency, governments and other supporting organizations should provide reasonable funding for forest research to enable forest research workers to make an effective contribution to human progress.

Representations at Overseas Meetings

Mr. V. R. Nanayakkara, Conservator of Forests and Dr. K. Vivekanandan, Chief Research Officer attended the 17th IUFRO World Congress in Kyoto, Japan from 6 to 17th September, 1981. They are Sri Lanka's Representative and Vice Representative in the International Council of IUFRO.

Mr. V. R. Nanayakkara, Conservator of Forests, also participated in a Forestry Study tour of North Thailand on his way back from Japan. This Study Tour was arranged by the Royal Thai Forest Department.

Mr. K. P. Sri Bharathie, Deputy Conservator of Forests attended a workshop on "Environmentally sustainable Agro-forestry and fuelwood production with Fast Growing, Nitrogen Fixing Multipurpose Legumes" at the East-West Centre, Hawaii from November 12 to November 20th 1981.

Mr. E. W. Seneviratne, Deputy Conservator of Forests represented Sri Lanka at the following meetings :

(*a*) "Forestry Education Development for the Asia and Pacific Region" — Los Banos Laguna, Philippines from 30 March — 3rd April 1981.

(*b*) "International Conference on Environmental Education" New Delhi, India from December 16 to 20, 1981.

Mr. Seneviratne was also invited by the FAO, Rome to participate in the drafting of a new project document regarding the programmes and organization of the Centre for Forestry Education, Research and Development for the Asian and Pacific Region (CFER DAP)Los Banos, Laguna, Philippines. He worked at the FAO Headquarters from May 9 to 17, 1981.

Mr. M. Pushparajah, Deputy Conservator of Forests attended the following meetings :

(*a*) "Fixing criteria for Mass selection of Fuelwood Species" Los Banos, Laguna, Philippines from 4th to 7th March, 1981.

(*b*) "Familiarisation Session of FAO Forest Inventory Data Processing System" — Rome, Italy from 16 to 28th March, 1981.

Foreign Assignment

Mr. S. Muttiah, Deputy Conservator of Forests, continued to be away in Laos as a Forestry Consultant for A D B

The Sri Lanka Forester, Vol. 15 (1 *and* 2), *Jan.* — *Dec.* 1981.

National Forest Policy Development in Sri Lanka

V. R. NANAYAKKARA

(*Conservator of Forests, Forest Department, Colombo 2*)

Sri LANKA has been in the past in the fortunate position of having had a very large extent of forest cover, around seventy percent of the land area, at the turn of the last century. However, with population growth, development of agriculture, colonization schemes and later on industry, this percentage has dwindled down to twenty five percent today. It is in this context that I wish to discuss the subject of the Development of a National Forest Policy in Sri Lanka, how a Forest Policy originated in our country, its present situation in relation to the expansive development programmes being initiated and being implemented by the Forest Department, and future trends in its development. For this purpose it is necessary to first sketch briefly the historical development of Forestry Activities and Forest Policy in the country.

During the pre–British periods the main forest produce was Cinnamon and Ebony timber which were exported. During that period, the consumption of timber in the country was very small and much timber was also available in private lands. The large extents of Forests found in the country at that time which included the present Tea lands in the Up-Country helped in creating better climatic conditions, less soil erosion, less floods and provided better top soil for agriculture. However, especially during the Dutch period large quantities of timber of certain species of timber like Calamander were cut wholesale and exported to Holland and other European countries for furniture making which resulted in these species becoming almost extinct in this country.

The commencement of the Coffee industry after 1830 in British times led to the establishment of a regular timber trade. Felling operations were on a permit system controlled by Divisional Revenue Officers under Government Agents. Fellings were controlled by local Village Headmen which led to several abuses. This kind of Forest administration without any Forest Policy soon got out of hand and came to the notice of the British Auditor General who in 1871 made proposals for the improvement of Forest administration in the country.

In 1873 and succeeding years, Foresters were appointed by the Colonial Government to assist Government Agents in carrying out forest duties. These officers were selected from the old Public Works Department. This too led to many abuses and was found to be unsatisfactory.

In 1879, a timber supply scheme by contractors who were given a share of timber and a share of tihe proceeds was implemented. This too was found to be unsatisfactory.

The Government then probably felt the need for technical advice on Forest administration in the country and in 1882 appointed Mr. F. d' A. Vincent of the Indian Forest Service as Forestry Adviser. Mr. Vincent an Englishman stressed the need for a Forest Act, regulation of chena cultivation, forest reservation, and the need for a Conservator of Forests. Forests in the country were thenceforth administered by technical men except for short periods when suitable technical men could not be found.

In the ye ar 1885, a Forest Ordinance was passed and on 25th June, 1887 Mr. A. Thompso was appointed the first Conservator of Forests which makes the Office of the Conservator of Forests now 94 years old.

Sole administration of the main forests of the country went into the hands of the Conservator of Forests from 1899 with the creation of a new Forest Department, although a few less valuable forests called " Provincial Forests " continued to be administered by Government Agents, and the Island was divided into 6 Forest Working Circles as an administrative arrangement.

However, the defects of a dual administration were pointed out by one Mr. J. L. Pigot another Forestry Consultant from the Indian Forest Service, and in 1904 the control of the entire forest estate was placed under the charge of the Conservator of Forests, Government Agents ceasing to administer the so called Provincial Forest areas. The 6 Working Circles were amalgamated with the Provincial Forests and converted to 5 Forest Divisions with Ranges and Beats, later on to be increased to 7 Forest Divisions. However, still, the Government had not thought it necessary to lay down a Forest Policy for the country probably because it did not think that there was any necessity or urgency for one and timber was still plentiful. However a new Forest Ordinance was brought into effect in 1907 to cover the protection of the entire forest estate.

In 1921, Mr. P. M. Lushington also of the Indian Forest Service was appointed by the Colonial Government to report on the Forests of the country. Incidentally it may be mentioned that the Indian Forest Service in British Colonial times consisted mainly of British and German foresters of the Classical schools of Forestry in Europe and it is they who laid the foundation for Tropical Forestry development in India and other British Colonies including Sri Lanka. Mr. Lushington's report was considered by a Conference of Heads of Department which was subsequently enlarged into a Forest Committee consisting of Unofficial Members of the Legislative Committee and some Heads of Departments under the Chairmanship of the Controller of Revenue.

The deliberations of this Committee were protracted and their report issued in 1928, but in view of the appointment of a Land Commission, the implementation of its recommendations was put off except in the matter of the commercialization of the Forest Department and the free collection by villagers of minor forest produce to meet their legitimate requiremenst. It must be stated here that even though a National Forest Policy had not been laid down and inspite of the fact that the British Colonial rulers permitted the vast destruction of our Montane catchment forests for planting Coffee and subsequently Tea, on their credit side they had considered the necessity, for granting free collection rights to poor rural people both of firewood and minor forest produce within a 3 mile radius of their villages if located near forest areas.

What I have stated so far involves the pre–1929 period of Forestry in this country. The year 1929 is significant as it was in this year that the first authoritative enunciation of a Forest Policy was made. It came from the British Governor at the time Sir Herbert Stanley. The Forest Policy was stated as follows —

(1) to make the Island self supporting in timber (including fuel) and other forest produce, both by the systematic exploitation of existing natural resources and the artificial reforestation of selected areas,

(2) to provide for export such timbers and forest produce as have a World Market,

(3) to conserve water supplies and to prevent erosion, and

(4) to co-ordinate forest operations with the requirements of the preservation of the indigenous fauna and flora.

One conspicuous feature of this Forest Policy was the continued importance given to timber supplies and export of timber obviously in keeping with British foreign rule policies to further exploit the natural resources of her Colonies. However, the fact that reforestation, conservation of water and preservation of indigenous fauna and flora were mentioned in the Forest Policy showed that the technical advice of qualified trained and experienced Foresters had also been heeded by the authorities. However, the inclusion of the objective of " export " was responsible for creaming out certain valuable species of indigenous timber almost to extinction.

In 1930, in pursuance of the Land Commission a new land policy was enunciated and this involved the mapping out of all Crown lands for different specific purposes. This mapping out programme laid the groundwork for Forest Reservation in the country.

In 1931, the Donoughmore Constitution placed the Forest Department under the Ministry of Agriculture and Lands. The Executive Committee of Agriculture and Lands appointed a Sub-Committee to inquire into the activities, organization and establishment of the Forest Department. The report was out in May 1932.

After considering the report, the Executive Committee decided upon certain changes in the Forest Policy. In pursuance of the new policy laid down by the Executive Committee, from 1934 the forests of the country were divided into 2 categories as follows : (*a*) Forest land set aside for systematic management in perpetuity for some definite purpose, whether such areas had already been reserved or still await reservation under the Forest Ordinance, and (*b*) Forest areas not required for such purposes, but which would eventually be utilized for agricultural development, colonization and other requirements and known as " Other Crown Forests ". The Forest Department was vested with the administration, protection and management of the forests mentioned in category (*a*). These were the Forest Reserves and Proposed Forest Reserves. The administration and protection of " Other Crown Forests " in category (*b*) was handed over to Government Agents, reserving the right to the Forest Department to exploit such areas for commercial purposes.

In 1934 the Government obtained the services of Mr. H. G. Champion of the Indian Forest Service who later became Professor of Forestry at Oxford University, to report on and recommend measures to be taken for the development of forestry for the benefit of the whole community in the country. Champion's recommendations were incorporated by the Government to form the basis for the development of Forestry in the country and were clearly spelled out in his report which was published as Sessional Paper No. VII of 1935. It would not be incorrect to state that the foundations of the Forest Department were strengthened as a result of the recommendations of the Champion report. The services rendered by Mr. Champion, later Sir Harry Champion, were so much appreciated that he was invited to address the 12th Annual Sessions of the Sri Lanka Association for the Advancement of Science in November 1956 in Colombo.

In 1938, the policy of this Government was further clarified with regard to Montane forests in view of the alarming situation created by the clearing of Montane forest areas and conversion to Tea. The following decisions were taken : (*a*) All forest areas over 5,000

elevation to be regarded primarily as Climatic and Protective reserves to be maintained as such in the interests of the Island as a whole and not as economic forests to be a possible source of supply of timber on a large scale, (*b*) Felling indigenous Montane forests in order to reafforest with fast growing exotics to end within a 5 year period, (*c*) Start a scheme of increased " patana " wet montane grassland planting in approved centres, and (*d*) gradual conversion of plantations to valuable indigenous species if and where possible.

The Forest policy originally enunciated by Sir Herbert Stanley in 1929 and ratified by the State Council in December 1935 was further supplemented in October 1945 by a policy decision of the Minister of Agriculture and Lands. The policy decision was that in the future, all requirements of Government Departments for timber, poles and fuel should be provided through the organization of the Forest Department from local resources, wherever possible, and in cases where local supplies are either inadequate or unsuited for particular types of work, by imports.

Forests not reserved and village forests which were placed under Revenue Officers in 1934, were reverted to the Forest Department in August 1952. Other Crown Forests now called Other State Forests reverted to the Forest Department in 1960 leaving Government Agents with small blocks of 500 acres and less in the Dry Zone and 50 acres and less in the Wet Zone.,

In 1951, the declaration of the Principles of Forest Policy by the FAO Conference (6th Session) clearly indicated the vital importance which is attached to forests " in the economic social and physical balance of the World ". In terms of this pronouncement and in relation to the needs of the country, in 1953, 5 years after Independence from the British it was thought necessary to redefine a National Forest Policy for the country, emphasizing the importance of forests in relation to agriculture and other forms of land use.

A new National Forest Policy was therefore defined in 1953 and presented by the Conservator of Forests Mr. J. A. de Silva which was accepted by the Government in the following terms : (1) To maintain, conserve and create forests for the preservation or amelioration of the local climatic conditions and the soil and water resources, and for the protection of the local fauna and flora, where they are required for aesthetic, scientific, historical or economic reasons. (2) To ensure and increase, as far as possible, the supplies of small wood for agricultural requirements and firewood for domestic consumption. (3) To maintain a sustained yield of timber and other forest produce for the general housing, industrial, communications and defence requirements, of the country, and (4) To work the forests to the highest possible economic advantage as is consistent with the foregoing objectives.

This National Forest Policy was amplified and details outlined as to how the objectives were to be achieved. This covered the fields of conservation, windbelt planting, stream reservations, catchment forests, forest administration, legislation, working plans, management, afforestation, tree planting, research, education and financial provision. However, all these objectives could not be achieved in view of various constraints mainly those of shifting cultivation in Natural Forests, population pressure on forest land resulting in encroachments, illegal felling, competing claims by other forms of land use, staffing problems and probably the most important of all financial restrictions.

The Forest Ordinance was amended from time to time especially with regard to control of illicit fellings and illicit transport of timber, the most recent of which was in 1980.

Another important Administrative change was the breaking off of the Wild Life section from the Forest Department at the end of 1949 with the creation of a Department of Wild Life which later became the Department of Wild Life Conservation.

Another major decision of the Government was the creation of a State Timber Corporation in 1968, to handle logging, extraction, saw milling and sales of timber and fuelwood. This released the Forest Department from timber supplies and marketing operations enabling it to step up conservation and reafforestation programmes which have been carried out very successfully in the recent years. In 1978 the reafforested acreage was 17,338 acres, in 1979 20,365 acres and in 1980 the record year an acreage of 31,236 acres.

The country's population in the meantime multiplied over 4-fold and the country's total forest cover dwindled to twenty five percent of the total land area of the country. To add to this depletion was the spectre of clearing natural forests in the Mahaweli Development Scheme area which would bring down the total forest cover to twenty percent of the land area with consequent adverse effects on the micro climate of the region, erosion, floods and adverse effects on the overall environment in general. With this in mind the Forest Department has recently launched massive reafforestation programmes, tree planting campaigns, conservation programmes and forest protection programmes. In view of this situation I have thought it necessary to lay once again an emphasis on a National State Forest Policy with added emphasis on tree planting and preservation of the environment.

Keeping this in mind a redefined National or State Forest Policy has been enunciated carrying through the important objectives of the Policy of 1953 which are still valid today. In this Policy which was also presented to the Commenwealth Forestry Conference in Trinidad and Tobago in September 1980, emphasis is given to the need to preserve the environment, and a new objective include namely ; " to involve the local community in the development of private woodlots and forestry farms through a programme of social forestry ". Emphasis is also given to the preservation of the environment and a somewhat lesser importance to the sustained yield of timber in view of the present policy of the Government to allow a certain amount of timber imports. However, it is felt that with enhanced forestry development activities that are now being implemented and with the maturing of already planted forests now totalling around 342,000 acres, it would be possible to achieve self-sufficiency in timber again, and to renew exports of timber not as the Colonial powers did to bleed the country of its natural resources but to earn much needed foreign exchange for the country. Already, these man-made forests especially those of Caribean Pine and Eucalypts raised on predetermined patana grassland sites have not only increased the timber potential of the country but have also changed and beautified the landscape of the countryside.

To summarize, the 1980 National Forest Policy objectives are as follows :—

(i) To maintain, conserve and create forests for the preservation and amelioration of the environment, soil and water resources, and for the protection of the local fauna and flora when they are required for aesthetic, scientific, historical, and socio-economic reasons.

(ii) To ensure and increase, as far as possible the supplies of small wood for agricultural requirements and fuelwood for domestic consumption.

(iii) To maintain, as far as possible, a sustained yield of timber and other forest produce for general housing, industrial, communication and defence requirements of the country.

(iv) To work the forest to the highest possible economic advantage as is consistent with the foregoing objectives, and

(v) To involve the local community in the development of private woodlots and forestry farms through a programme of Social Forestry.

The Forest Department has also implemented a further proposal to achieve the objective of preservation of the environment by demarcating and preserving for perpetuity over 325,000 acres of natural forest ecosystems in the different zones of the country under the " Man and Biosphere " programme of the UNESCO. One such Reserve is the now well known 22,000 acre Sinharaja Forest Reserve Complex of Wet Evergreen Tropical Rain forest in the Kalawana region.

Having said this much on the historical development of Forest Policy in Sri Lanka, it is necessary also to think of the future. What sort of Forest Policy is indicated in the future ? One thing is certain, and that is, the new Forest policies to come will have to come to terms with renewed competition for land especially by Agriculture and Livestock Management, and also with population increases already running at 1.7% per annum especially in areas near traditional forest areas for example Vavuniya, Mullaitivu, Anuradhapura, Polonnaruwa and Ampara Districts of Sri Lanka. This Department's enhanced reafforestation programmes will also have to be considered in drawing up a future Forest Policy. In fact it may be necessary to enunciate a new Forest Policy even as early as two years from now especially in view of recent trends to develop tree planting at a community level.

The main thinking in this regard will have to be on the lines of integrating man with forest and forest with agriculture and livestock management. Among the objectives of such a Forest Policy would be (1) to develop further the practices of " Social forestry " of planting fuelwood and domestic timber on the " door step " principle in homestead woodlots and in collective or communal woodlots in new settlement areas such as Mahaweli, (2) to further develop and refine the " Co-operative " or " Taungya " reafforestation scheme so that permanent forestry and permanent agriculture could be practised on the same land adopting the principles of agrisilviculture and Farm forestry, and (3) even integrating Forestry with Agriculture and Livestock Management.

All these 3 new objectives would take Forestry to new areas of the country and not confine Forestry development to degraded State forests, chenaed or shifting cultivation areas, patanas and land handed over to the Forest Department by the State Land Reform Commission. This trend will tend to increase the total forest tree cover in the country thereby not only increasing the timber wealth of the nation but also improving environmental conditions throughout the country.

A future Forest Policy should also seriously consider vesting all catchment areas of water reservoirs in the Forest Department including all Tea areas located within catchment areas which should be promptly reafforested on scientific lines. Most of the country's water and hydropower problems are due to the fact that the water draining into these reservoirs are loaded with silt removed from Tea lands in the montane catchments surrounding these reservoirs. A carefully planned reafforested catchment of selected tree and shrub species will not only provide water with a low silt content but will also ensure a reasonable dry weather seepage into a reservoir and will be an answer to the perennial hydropower situation which has become a major problem in our country today.

Still another matter which should be considered in a new State Forest Policy would be the need to obtain the best use of Wild Life areas which now comprise 40% of the forested area in the country. Wild Life forest areas are generally poorly stocked with timber and have a tendency to go into scrub and grass owing to poor Wild Life Management and Management which favours the development of mammalian fauna on a large scale. In a country like India better use is made of Wild Life areas. Such areas which are under the charge of State Forest Departments are also managed for timber, firewood as well as for recreational and touristic purposes. Sri Lanka cannot afford to have vast extents of land purely for Wild Life some of which in recent times have become hunting grounds for game poachers and a haven for illegal Canabis cultivators. They should also be managed by trained Foresters for Forest Produce including some timber, small wood and firewood, not Wild Life alone.

Therefore, in a small country like ours with a rapidly increasing population a Multiple use approach in formulating a National Forest Policy will bring more benefits to the poeple. A new National State Forest Policy will in my opinion therefore have to take into consideration not only preservation of the environment and meeting the timber requirements to the nation, but also integration of Man with Forest, Forest with Agricultural Farms and Livestock, and should also consider a dual use system of both Forest Management and Wild Life Management in Wild Life areas in the country. A National Forest Policy on these lines will by and large be in the greater and long term interests of the Nation.

The Sri Lanka Forester, Vol. 15 (1&2), Jan.-Dec. 1981.

An Appraisal of Trained Manpower Requirements for Forestry Development in Sri Lanka

EARDLEY W. SENEVIRATNE

(Deputy Conservator of Forests, Management, Research and Education)

INTRODUCTION

Several studies have been made on the requirements, present and future, of trained manpower for forestry development and assessing the educational requirements for producing this trained manpower.

Recently a reappraisal of Forestry Education and Training needs in Asia and the Far East was undertaken (Lantican 1978).

In recent years there has been a vast improvement in the forestry contribution in Sri Lanka towards national welfare, chiefly through large-scale reforestation and build up of forest plantations, whose potential worth amounts to several billion rupees.

Action has been initiated to increase the forestry contribution by massive reforestation projects under normal Departmental programmes and special projects funded by Foreign Agencies, chief of which are the Watershed Management of the Upper Mahaweli Catchment, Fuelwood plantations in the Mahaweli basin, the National Agricultural Diversification and Settlement Authority relating to the rehabilitation of derelict tea and rubber lands, the Integrated District Development Projects and the Community Forestry Projects. It is therefore imperative to determine the staff required by the Sri Lanka Forest Service to implement these Forestry Development Programmes.

Certain norms have been laid down by Shirley and Prats Llaurado (1970) in regard to the trained manpower requirements for different types of forest work in South America. The word " technician " used in this study refers to the Forest Ranger in Sri Lanka's Forest Service and the latter term will be used in this paper.

The same norms used in this FAO Study will be used here, except that norms will be set for forest protection which has not been considered in the South American Study. This may be due to the fact that the illicit felling and transport of timber and encroachments on forest land are not serious problems or because trained manpower in considered unnecessary to cope with these problems, as it is purely a policing function. In Sri Lanka, it is impracticable to separate protection functions from the technical duties of Foresters and it is therefore inevitable that all technical officers undertake forest protection as well.

---

* Paper prepared for the Seminar on Forestry Education Development, Los Banos, Phillippines, 30 March — 3 April 1981.

THE NORMS

The norms set in the South American Study (in the areas of work relevant to Sri Lanka) are as follows :

Plantations :

Establishment (including related operations).—1 Technician per 200 hectares.

This norm is retained although the establishment of Teak plantations involves extremely laborious and time consuming operations of dividing all the earmarked plantation areas into blocks of not more than 5 acres (maximum allowable under the co-operative Reforestation Scheme — " Taungya " system), entering into separate agreements in respect of each of these blocks, assessing the performance of each lessee separately during the first three years of establishment for eligibility to payment of rewards and subsequent cultural operations.

On the basis of an annual planting programme of 8,000 ha of Teak a total of 40 Forest Rangers will be required.

In addition, a further 6,000 ha of compensatory man-made plantations of species such as Eucalyptus, Pines, Albizzia, Ipil Ipil and indigenous species are presently being raised under special foreign aided projects. This will necessitate an additional requirement of 30 Forest Rangers.

The total for Establishment therefore will be 70 Forest Rangers.

Management.—Two norms are given, namely 1 Technician per 2,000 ha in Argentine, Brazil and chile and 1 Technician per 1,500 ha in other countries of South America. A mean figure of 1 technician per 1,750 ha will be used in this study.

The annual planting target of 14,000 ha will virtually remain the same for the next 4 years, so that by 1985 a further 56,000 ha will be added on to the present plantation area of 136,000 ha making a total of 192,000 ha Hence a total of 110 Forest Rangers will be required

Natural Forests :

(1) Supply of industrial timber and fuelwood.

(*a*) For log production — 1 technician per 10,000 m^3 of roundwood removals per year. Sri Lanka's supply averages 170,000 m^3 so that 17 Forest Rangers will be required.

(*b*) fuelwood production — 1 technician per 100,000 m^3. Sri Lanka's requirement will be 2 Forest Rangers.

(2) Management for production — 75% of the numbers required for supply of industrial timber and fuelwood. The requirement will be 14 Forest Rangers.

Protection :

The norms vary depending on whether the areas are plantations or Dry, Wet, Intermediate or Montane zone natural forests, the pressure on forest land on account of settlement schemes, agricultural development, encroachments etc. It is rather difficult to estimate the staff requirements and hence a flat norm of 1 technician per 40,000 ha will be used. On this basis the Forest Ranger requirement is 60.

3—A 67450

Ancillary Activities (development and extension, research, education and training) :

The requirement is 15% of total trained man-power requirement for Plantations, Natural Forests and Protection. The requirement of Forest Rangers will be 15% of 273 or 41.

SUPERVISION RATIOS

In terms of the ratios given by Shirley and Prats Llaurado (1970) the Sri Lanka requirement will be as follows :—

Activity	*Supervision Ratio*	*Technical man-power required*	*Professional man-power required*
Plantations :			
(*a*) Establishment	1 : 7	70	10
(*b*) Management	1 : 6	110	18.3
Natural Forests :			
(*a*) Timber Supply	1 : 8	19	2.3
(*b*) Management	1 : 6	14	2.3
Protection	1 : 8	60	7.5
Ancillary Activities	1 : 2	41	20.5
Total requirement		314	61

Below the technical grade is the sub-technical grade which in Sri Lanka's Forest Servies consists of Forest Guards. The ratio of professional to sub-technical has been placed at between 45 and 49 (Wyatt – Smith 1970). Taking the lower level of 45, the requirement of Forest Guards for professional staff of 61 would be 2,745.

The table below shows the requirement of manpower as computed above compared with the actual numbers in the Forest Department cadre.

Level	*Requirement*	*Actual number in Cadre Grade*	*Numbers*	*Total*
Professional	61	Conservator	1	
		Deputy Conservators	5	
		Asst. Conservators	20	
		Research Officers	4	
				30
Technical	314	Foresters	48	
		Forest Rangers	189	
		Technical Assistants	4	
		Research Assistants	4	
				245
Sub-technical	2,745	Forest Guards	453	453

In terms of percentage, the actual cadre in relation to requirements is as follows :

Professional	49%
Technical	78%
Sub-technical	16%

From the above table it is evident that all grades are understaffed with the sub-technical grade grossly under-staffed. Of the professional grade of Assistant Conservators, 40% are promotees from the rank of Forester without professional level training. They are therefore not available for work connected with inventory, research etc.

FORESTRY EDUCATION IN SRI LANKA

Sri Lanka Forest College

The Sri Lanka Forest College was established at Monkey Bridge, China Bay during the early part of 1960 and is the only Institution available for Forestry Education in Sri Lanka. Prior to the change in the status of the forest College, it was known as the Forestry field Training School, originally established at Waga in Colombo District and shifted to China Bay in 1958. At this School, practical training was afforded to Forest Guards and Forest Rangers on the basis of an In-Service training programme over periods ranging from 3 to 6 months. This practical training was converted into a one year In-Service training course in Forestry and Allied Subjects, with the author being appointed its first residential Principal in February 1960.

This was followed by the introduction of a one-year intensive Forest Ranger Course in 1961, subsequently converted to a 2-year course, but unfortunately failed to gain ground after 1964 for various reasons, especially the lack of professionally qualified academic staff, field, laboratory and library facilities.

Training Needs :

The training courses available at the College at present are —

(*a*) Forest Guards one-year course ;

(*b*) Two to three months orientation course for new recruits to the grades of Forest Rangers and Forest Guards ;

(*c*) Two-month training courses to other state officers e.g. State Timber Corporation, Department of Wild Life and Nature Conservation etc.

There is at present a massive backlog in the training of staff in the technical and sub-technical grades as the Forest Department cannot afford to release a larger number in the sub-technical grades for training although desirable to do so, in view of its expanded development Programme.

At present, as many as 242 Forest Guards and 178 Forest Rangers are in service without any basic training in Forestry. As a result there is not only a severe strain on the qualified staff assigned to the various Ranges in the country both in performing the actual work and training, but also has an adverse effect on the phase of development work being undertaken.

DEVELOPMENT OBJECTIVES OF FORESTRY EDUCATION

Training in Forestry at the technical and professional level is not available in Sri Lanka at present. Traditionally, Forest Rangers were afforded Diploma level training in Coimbatore and Dehra Dun and directly recruited Assistant Conservators of Forests have been trained at the Indian Forest College, Dehra Dun, followed by further post-graduate training at the Commonwealth Forestry Institute, Oxford. In recent years places secured at the Forest Colleges in India and at Oxford have been limited.

Consequently, project proposals have been submitted to the Government of Sri Lanka very recently, with a view to introducing training courses in Forestry at both the Professional and technical levels and improving the existing training facilities.

The aims of these projects are :—

(*a*) To widen the scope and quality of the one-year Forest Guards training course.

(*b*) To improve the nature and content of the 3 months orientation course for new recruits to the grades of Forest Rangers and Forest Guards.

(*c*) To provide short-ter ı training courses to Assistant Government Agents, Divisional Revenue Officers and Gramasevakas (Village Headmen), particularly on Forest Protection, Forest Law, measurement of timber and standing trees and the identification of species.

(*d*) To provide short-term training courses for officers of the State Timber Corporation on logging techniques, maintenance of tools and equipment and the identification of species.

(*e*) To establish a first Degree Course in Forestry at the University of Sri Jayawardenapura.

(*f*) To train Sri Lankan Foresters at post-graduate level in Sri Lanka itself without recourse to foreign training.

(*g*) To improve research activities so as to improve the quality of forests and forest produce.

(*h*) To provide trained man-power required for the expanded Forestry Development Programme and for most of the timber-based industries in Sri Lanka.

In the preparation of these Project proposals, the author chaired two of these Committees and was a member of the third Committee relating to the post-graduate training.

Immediate Objectives :

The immediate objectives are —

(*a*) To improve the present training given to Forest Guards and commence the training of Forest Rangers.

(*b*) To provide trained man-power that is required urgently to expand the activities of the Forestry Department with regard to Forest Conservation, Protection and Development of Forest Resources to meet domestic and industrial requirements through the establishment of man-made forests.

Future Manpower Requirements :

As shown above the available manpower of professional, technical and sub-technical grade officers is grossly inadequate considering that there is now a greater need for more intensive management of both the natural and man-made forests. One of the constraints to meet these demands has been the limited trained man power at all levels.

REFERENCES

SHIRLEY, H. L. AND PRATS LLAURADO, J. (1970) — Forestry Education and Training in Latin America, *Unasylva* 24(1) *No.* 96 : 4 — 16.

TISSAVERASINGHE, A. E. K. (1975) — Trained Manpower Requirement for Forestry Development in Sri Lanka, *The Sri Lanka Forester, Vol.* XII, (1) : 4 — 7.

WYATT-SMITH, J. (1970) — Training requirements for forestry in Tropical Africa, *Unasylva* 24 (1) No. 96 : 26 — 35.

The Sri Lanka Forester, Vol. 15 (1 & 2), *Jan—Dec.*, 1981

Forestry Extension Programme in Sri Lanka

A. D. R. RATNARAJAH

(*Deputy Conservator of Forests, Special Projects*)

SUMMARY

Until very recently, Forestry in Sri Lanka has followed the traditional concept of Forestry without people's active participation. About a decade ago, a tree planting campaign was launched by the Forest Department both in urban and rural areas by selling plants at subsidised rates to the public for planting in their homesteads but maintaining or after-care was not done due to the lack of an Forestry Extension Service. From about 1978 a concerted effort is continuously being made by the Ministry of Lands and Land Development with the assistance of not only the Forest Department but also the Water Resources Board, Department of Land Development, State Timber Corporation and voluntary organisations to plant more trees not only in homesteads but along roads, avenues, irrigation channel bunds, any wasteland, school premises, boundaries of Tea, Rubber and Coconut Estates, etc. During 1981 about 3 million plants were distributed for planting in the areas mentioned above.

There is no Forestry Extension Service in existence in the 24 administrative districts of Sri Lanka. The future programme of the Forestry Extension Service to cover the entire island are :—

(*a*) Under the USAID/Sri Lanka Reforestation and Watershed Management Project, establishment of a National Forestry Extension Service between 1982 and 1985 is envisaged covering 19 administrative districts in the island ;

(*b*) In the other 5 administrative districts, the Community Forestry Project to be financed by the Asian Development Bank will become operational very soon. This too has a component of Forestry Extension Service to establish fuelwood lots in 5,830 villages during the 5 year period commencing in 1983 ;

JUSTIFICATION FOR AN EXTENSION PROGRAMME

In any resource development programme, the public should be made fully aware of the facts and made to understand the benefits that would accrue to them and their generations.

Actually propaganda and communication, particularly in respect of the importance of Forestry development, are an exceedingly difficult activity (to be carried out by the existing staff and resources) from the point of view of what is desired, said or done and what is understood by the Public. For this reason, establishment of a Forestry Extension Service is a dire necessity as a means of achieving the conservation of the existing resources and help in the raising of individual trees and plantations with mass participation.

---

* Paper prepared for the FAO/SIDA Seminar on Forestry Extension Seminar, Indonesia, 18 — 30 January 1982.

The clearing of large extents of natural forests within the next few years for the Mahaweli Development Scheme has brought into sharp focus, the immediate need to grow trees in homsteads, along roads, channels, etc. in order to meet atleast a part of the future fuelwood and commercial wood requirements of the settler population within the command area of the Mahaweli Development Scheme.

Fast growing trees like Ipil-Ipil (*Leucaena leucocephala*) if planted in homesteads in sufficient quantity should provide the fuelwood requirements of the settler population. There is bound to be a scarcity of fuelwood in this area in the near future and growing of Ipil-Ipil in homesteads is the only answer as this species in three years can provide the required fuelwood. This is a further justification for the establishment of a Forestry Extension Service.

Few people have any conception as to how long it takes for trees to grow from seedling to maturity. For this reason a continuing educational programme by the extension service is required so that the planted trees are tended and protected against fire, disease, browsing by animals, etc.

There is provision in the Forest Ordinance for punishment of persons committing Forest Offences, but from the point of view of conservation the damage has already been done by the offenders. Therefore prevention of such damage can only be achieved by educating the public on the harmful effects of deforestation through an extension service.

Although the Forest Department is now carrying out an annual reforestation programme of about 20,000 acres, the population explosion coupled with a high rate of deforestation and the limited extents available for raising large-scale plantations, the need for people's activite participation as against the State in growing individual trees and wood lots wherever possible is the answer to improve the environmental conditions and meet a part of the fuel and timber requirements of the community. It will not be economical for the Forest Department to raise, protect and manage small community wood lots.

Currently none of the functions of the Forestry Extension Service referred to above are being implemented due to lack of staff and resources. Further, the technical expertise in Forestry extenison service is lacking. Therefore capital assistance and technical co-operation in this field are required to implement this service.

INSTITUTIONAL STRUCTURE OF EXTENSION PROGRAMME

As Forestry Extension Service is mainly aimed at educating and motivating the people for active participation, the importance of having an effective organisation of selected officers need not be over-emphasised. There is provision under the USAID and ADB Projects to train selected personnel both locally and abroad. This programme will commence in 1982 and emphasis will be on extention methodology and audio-visual techniques.

Under the USAID Programme, seven mobile Forestry Extension Units covering the 19 districts will be established. Each Unit will consist of a Forester, 2 Forest Rangers, 4 Forest Guards and one Audio-Visual specialist. The seven units will be under the charge of an Assistant Conservator of Forests. The target group of these units will be the Urban, Rural and new settlers within the Mahaweli Development Schemes. Institutional structure in the 5 districts with ADB assistance will be on a similar pattern.

Programming and constant monitoring of same by the National Extension Service will be the responsibility of the Assistant Conservator of Forests in charge.

Each Extension Service is required to have frequent meetings with the villagers and village elders and plan out a schedule of operations so that planning commences at the grassroot level.

GENERAL OBJECTIVES OF THE PROGRAMME

The main objective is to promote social forestry or rather forestry for local community development through a Forestry Extension Service. This envisages mass participation in the production of fuelwood, food crops and general utility timber, and thereby improve the social and economic condition of the Community. The target group is both rural and urban population.

This objective is to be achieved by providing mass education and propaganda at grassroot level in order that the people are made aware of the importance of forest and trees to man and environment so that they may be motivated to plant trees along roadsides, irrigation channels, homesteads, wood lots etc. and protect the existing forest resources.

GENERAL IMPLEMENTATION STRATAGIES

Forestry Extension in Sri Lanka is a new concept and its implementation has to be gradual. The socio-economic conditions vary from village to village in the rural sector. Further conditions in the urban sector are totally different from those in the rural sector so much so it is virtually impossible to lay down a uniform prescription.

Therefore the Forest Department has selected initially certain areas for an intensive Forestry Extension Service on the basis of fuelwood shortage areas such as Matale, Kandy, Nuwara Eliya, Badulla, Batticaloa districts and in certain parts of the Mahaweli Development basin.

Having identified the needs of the people for forest products (firewood, timber, medicinal herbs etc.) the availability of land for meeting these needs will be a diminishing resource (population explosion, irrigated agricultural land coupled with hydro-power generation schemes, slash and burn agriculture, village expansion, etc.). In this context where forestry is competing with other forms of land use, a proper and final land use survey plan is very important. This is being carried out at the moment by a multi-disciplinary team consisting of Ecologists, Agronomists, Foresters, Economists, Sociologists, etc. in lands to be earmarked for development under Mahaweli Development Scheme and other schemes.

In the urban areas with high rise buildings, asphalt roadways, smoking factories and belching vehicles, the strategy is definitely different. From 1977 onwards propaganda by way of posters, advertisements, meetings with environmentalists and the private sector have had a desired effect in planting trees along roadsides, roundabouts and home gardens is an index of the awareness of the people in the importance and role of trees in improving the environmental conditions in the urban areas and providing better living conditions free of dust and glare.

The Forestry Extension Service will provide the necessary expertise and assistance in this regard.

Another strategy undertaken is to insist on the State- owned tea and rubber estates to plant at least 10% of their land with fuelwood species so that their dependence on fossil fuel is minimal.

PROBLEMS IN IMPLEMENTATION OF FORESTRY EXTENSION SERVICE

As this service is to be practised in Sri Lanka for the first time, the problems envisaged are as follows :—

(*a*) In the urban areas, plants planted along roadsides can be damaged by anti-social element ;

(*b*) When the plants are not provided with tree guards, cattle could either browse or trample them;

(*c*) Lack of trained staff, vehicles funds for travelling expenses, fuel and lubricants could slow down the progress at the beginning.

IMPORTANT ADVANCES MADE

As stated earlier Forestry Extension Service is non-existent at the moment. It will be established in mid-1982, under the USAID/Sri Lanka Project (1982—1985) in 19 districts and supplemented by the ADB Project in the other 5 districts hopefully from mid-1982.

During 1981 one million plants were distributed to the Public for planting in their homesteads throughout the island.

PRIVATE PARTICIPATION

As the institutional capacity of the Forest Department is limited to afforest the country to the desired extent private sector participation was invited to afforest with tree crops in the chenaed (abandoned slash and burnt lands) on long-term agreements as a yield-sharing basis (70% to lessee). The lessees are entitled to inter-cultivate the area with quick growing cash crops while planting and maintaining the forest tree crops (Agro-Silviculture and Agro-Forestry).

The Sri Lanka Forester, Vol. 15 (1 and 2), Jan. — Dec., 1981

Management of Forest Resources

M. PUSHPARAJAH

(*Deputy Conservator of Forests, Working Plans and Inventory*)

INTRODUCTION

The forest is a renewable resource which provides timber and other products for home and industry, food and cover for wild and domestic animals, conservation of soil and water and facilities for recreation. A forester is essentially a resource manager whose responsibility is to make sure that these are assured not just for the immediate present but for all times. In contrast to other fields of resource management the problems associated with forest resource management are complex ; the goals are difficult to achieve and the effects are far reaching. The forests of India which were brought under planned management still exist today while those which were exploited without management plans have completely disappeared. The special features of forest resource, such as the multiplicity of uses, the long term planning, the high intrinsic values, and often unique economic benefits which cannot be quantified, demand the utmost skill in the application of technical knowledge and business principles in forest management.

The management of forest resources requires complex training in a broad variety of disciplines. In addition to timber management, forest resource management include watershed management, game management, range management, and recreation management.

PRESENT STATUS OF OUR FOREST RESOURCES

The area under forest cover today (1981) is generally estimated to be about 25% of the total land area or 4.2 million acres (1.7 million ha.) compared to 7.2 million acres (2.91 million ha.) in 1956. The principal reasons for the rapid depletion of the forest resource over the last two decades are agriculture colonization and shifting or chena cultivation. In addition encroachment, illicit felling for timber and fuelwood, and over exploitation too, have reduced both the quality and quantity of the island's forest resources to a marked degree. The estimate of deforestation per year for the last two decades is about 160,000 acres (64,751 ha.). In the modern context chena cultivation is seen to be a wasteful use of land ; one that gives extremely low yields and a poor financial return. Some forest reserves such as Hambantota and Usangoda reserves in the South of Sri Lanka have been completely taken over by shifting cultivation. There is no justification for shifting cultivation, whatsoever, in present day Sri Lanka where there are pressing needs for intensively cultivated land to supply the food needs of a rapidly growing population and for productive forest, to supply timber and fuelwood for domestic purposes. It is significant to note that in 1956 alone about 550,000 (222,581 ha.) acres was covered with well stocked forest excluding plantations. The rest, more than 6.5 million acres (2.63 million ha.) was low yield or non-productive forest. At present the acreage under well stocked forest cannot exceed more than 200,000 (80,938 ha.) acres, excluding plantations. The area under plantations as at December, 1980 is about 340,000 acres (137,596 ha.).

The three main constraints faced by the Forest Department in implementing a sound management programme for its resource are :

(1) Lack of data on land and forest resources,

(2) Lack of trained manpower,

(3) Inadequate finances.

FOREST INVENTORY

The pre-requisite for formulation of any form of management plan for our forest resources, is basic data, on the quality and quantity of the resources. This information for forest resource management is obtained through forest inventories. There are three main types of inventories depending on the information you require and the management needs.

National Forest Inventory (NFI).—It provides basic data for the planning and control of the forest resources at the country level. It is designed for strategic planning and to provide data on the present forestry situation and past changes. It is used to define a national forest policy, express this policy as a set of laws and national programmes and create the necessary organisational structure to carry out and execute these programmes.

Pre-investment Inventory.—Its objectives are fairly close to some of the objectives of a national forest inventory the main difference being that it is concerned with a delineated forest area. The objectives require an area estimation, a volume estimation through volume sample plots, details on volume composition, species, dimension and grades which necessitates analysis of sample trees, and construction of volume tables and special studies on felled trees to estimate the defective wood. Operative and relevant classification of area and growing stock from the point of view of management and logging systems to be applied are also collected during these studies.

Management Inventory.—It is an extensive type of inventory primarily designed to ensure a continuous flow of information about the general conditions of the forest resources, more specifically information about the quality and quantity of wood currently available, its rate of change over time due to growth, mortality or drain, the approximate location of the mature stands that may be ready for harvesting in the near future, etc. The management inventory data are primarily used for medium and long range planning by the management. More specifically, the data from management inventories are generally used in the calculation and scheduling of the allowable cut, in the planning for the increase in the overall forest production through either stand improvement activities or the shift to a different species composition or wood quality, etc. To fulfil this type of needs, the management requires a continuous flow of information about both current values and rates of change of the resources of its forest land.

PRINCIPLES OF FOREST MANAGEMENT

The aim of forest management is to achieve a balance between growth and harvest taking into account of the fact that the forest is a renewable resource as contrasted with fossil fuels which cannot be replenished over a geologic time span. This concept of managing a forest in perpetuity for production of timber and fuelwood is referred to as sustained yield Forest Management. Any form of sustained yield management requires the maintenance of an adequate growing stock which is defined as the current standing volume ; this is equivalent to the capital in financial management. Annual or periodic cut is determined in such a way that

the actual growing stock, capital, is not depleted or gradually liquidated. On the contrary, the growing stock must gradually approach an ideal or so called normal volume capable of producing adequate yields or return (interest) of the product or products desired.

The normal volume (desired capital) of a forest will vary according to the average size and quality of timber to be produced. An estimated normal volume adopted as the goal of management must be periodically re-evaluated and readjusted, in keeping with changing silvicultural and economic requirements. After each harvest, enough growing stock must be left within an area to ensure production of a new crop of mature trees for another cut after a period of years.

According to the NFI of Sri Lanka completed in 1961 the growing stock of the island was about 4,534 million cu.ft. (128.4 million m^3) and the annual growth (the increment) was 77.4 million cu.ft. (2.2 million m^3).

The annual increment or the growth, plays an important place in forest management. The skill of the forester is directed towards sustained production through growth by application of genetic principles, tree-breeding programmes etc. Growth or increment determination are made from permanent sample plots or yield tables. The re-measurement of permanent sample of plots for growth or increment determinations give the net growth which is obtained from the difference between any two inventories, plus intermediate cuttings, less mortality, less the ingrowth.

The organisation and control of the growing stock for sustained yield of forest products from a specific forest area has been traditionally called forest regulation. In modern industrial terminology this is the counterpart of productoin control.

What is available for the forester to harvest from a forest is theoretically the annual increment or growth. However, the total annual increment from a forest is not available for harvest. For example the increment on small diameter trees cannot be harvested.

The net growth that can be safely allocated for annual removal is known as the allowable cut. Though the annual growth of the island's growing stock as per the 1960 NFI is 77.4 million cu.ft. (2.2 million m^3) the allowable cut is only 60.7 million cu.ft. (1.7 million m^3). This figure is too high as reductions had not been made for cull and for reduction in forest area.

The data on the present growing stock and annual growth are inadequate to forecast a meaningful figure for production of timber and fuelwood from our forest resources. But the fact that we are certain, is that our growing stock (Forest capital) has decreased tremendously during the last two decades due to reasons mentioned earlier. That is the actual volume of our forests *i.e.* growing stock (capital) is far below the desired level and the amount of cut must be much less than the actual net growth for the accumulation of additional growing stock volume. This principle must be followed at all cost for sometime till the actual volume of our forests reach the desired volume (Capital).

FOREST PLANTATION

Another important resource which the forest department has been building up is the man-made plantations. The annual increment and the final yield from our plantations are very much higher than that of natural forests. By increasing the extent of plantations and

managing these on sound silvicultural principles it would be possible to meet a major portion of our requirements of timber and fuelwood.

CONCLUSION

In conclusion it would be pertinent to stress the following facts —

(1) The depletion of Forest resources should be checked at any cost,

(2) The growing stock in natural forests have decreased below the desired level and the cut should be minimised to allow the annual increment to accumulate and reach the desired level,

(3) The Forest resource base should be increased by increasing the extent of man-made plantations and this should be managed on sound silvicultural principles.

It is hoped to achieve some of these objectives in the near future with the assistance of FAO and World Bank, through a National Forest Inventory and preparation of management plans for our productive forests and plantations.

The Sri Lanka Forester, Vol. 15 (1 *and* 2), *Jan.—Dec.*, 1981

Timber Strength of Local Timbers

E. W. SENEVIRATNE
(*Deputy Conservator of Forests, Research and Education*)

INTRODUCTION

The strength of timber is influenced by many different factors, some of them inherent in the wood itself, such as anatomical structure, density, knots and other growth defects, and others due to conditions of use, including moisture content, temperature and the incidence of decay. Tests of the strength properties of clear timber and the influence of all the relevant factors provide the basic data necessary for the determination of design stresses for structural use. To enable timber to be used as economically as possible and with adequate safety, further investigations are carried out on beams, struts, joints, etc.

Tests were carried out on 32 local timbers and timbers their working stresses obtained. The working stresses given in Table I are applicable to standard structural grade timber used indoors, that is, protected from the weather.

Tests were also carried out on 16 additional species and their basic stresses obtained are shown in Table 2.

TABLE 1

WORKING STRESSES OF 32 SPECIES OF LOCAL TIMBERS

	Density at 12% moisture content (*lb./ft³*) (*kg/m³*)	*Modulus of elasticity* (*poundals per sq. inch*) (*Nm⁻²*)	*Extreme fibre stress in Bending and Tension along grain* (*poundals per sq. inch*) (*Nm⁻²*)	*Shear* (*poundals / inch²*) (*Nm⁻²*)		*Compression* (*poundals / inch⁻²* (*Nm⁻²*)	
				Horizontal	*Along grain*	*Parallel to grain*	*Perpendicular to grain*
1. *Albizzia odoratissima*	57	62.15×10^{6}	85,330	7,084	9,982	61,180	33,166
Suriyamara	(912)	(1.35×10^{5})	(185.5×10^{4})	(15.4×10^{4})	(12.7×10^{4})	(133×10^{4})	(72.1×10^{4})
2. *Artocarpus integra*	43	37.67×10^{6}	57,960	4,669	6,601	38,640	21,252
Jak	(688)	(0.82×10^{5})	(126×10^{4})	(10.2×10^{4})	(14.4×10^{4})	(84×10^{4})	(46.2×10^{4})
3. *Berrya cordifolia*	49	61.18×10^{6}	86,940	5,152	7,406	51,520	25,116
Halmilla	(784)	(1.33×10^{5})	(189×10^{4})	(11.2×10^{4})	(16.1×10^{4})	(112×10^{4})	(54.6×10^{4})
4. *Chloroxylon swietenia*	64	53.13×10^{6}	80,500	6,279	9,016	53,130	30,912
Satin	(1,024)	(1.16×10^{5})	(175×10^{4})	(13.7×10^{4})	(19.6×10^{4})	(115.5×10^{4})	(67.2×10^{4})
5. *Chukrasia velutina*	50	47.66×10^{6}	69,230	4,669	6,762	45,080	18,676
Hulanhik	(800)	(1.04×10^{5})	(150.5×10^{4})	(10.2×10^{4})	(14.7×10^{4})	(98×10^{4})	(40.6×10^{4})
6. *Dipterocarpus zeylanicus*	54	58.28×10^{6}	64,400	3,703	5,313	40,250	14,168
Hora	(864)	(1.27×10^{5})	(140×10^{4})	(8.1×10^{4})	(11.6×10^{4})	(87.5×10^{4})	(30.8×10^{4})
7. *Mimmsops elengi*	63	56.67×10^{6}	78 890	5,796	8 211	49 910	25,438
Munamal	(1,008)	(1.23×10^{5})	(171.5×10^{4})	(12.6×10^{4})	(17.9×10^{4})	(108.5×10^{4})	(55.3×10^{4})
8. *Pterocarpus massupium*	50	47.01×10^{6}	67 620	4,347	6 118	41 860	18,676
Gammalu	(800)	(1.02×10^{5})	(147×10^{4})	(9.5×10^{4})	(13.3×10^{4})	(91×10^{4})	(40.6×10^{4})
9. *Schleichera oleosa*	72	74.70×10^{6}	103 040	7,406	10 626	69,230	38,962
Kon	(1,152)	(1.62×10^{5})	(224×10^{4})	(16.1×10^{4})	(23.1×10^{4})	(150.5×10^{4})	(84.7×10^{4})
10. *Tectona grandis*	45	51.52×10^{6}	74,060	4,508	6,440	48,300	20,286
Teak	(720)	(1.12×10^{5})	(161×10^{4})	(9.8×10^{4})	(14×10^{4})	(105×10^{4})	(44.1×10^{4})
11. *Terminalia arjuna*	44	35.42×10^{6}	56,350	5,152	7,406	33,810	23,828
Kumbuk	(704)	(0.77×10^{5})	(122.5×10^{4})	(11.2×10^{4})	(16.1×10^{4})	(73.5×10^{4})	(51.8×10^{4})
12. *Vitex pinnata*	58	59.57×10^{6}	83,720	5,313	7,567	57,960	43,792
Milla	(928)	(1.30×10^{5})	(182×10^{4})	(11.6×10^{4})	(16.5×10^{4})	(126×10^{4})	(95.2×10^{4})
13. *Calophyllum inophyllum*	38	43.79×10^{6}	40,250	4,186	5,957	28,980	9,660
Domba	(608)	(0.95×10^{5})	(87.5×10^{4})	(9.1×10^{4})	$13\times10^{4})$	(63×10^{4})	(21×10^{4})
14. *Mitragyna parvifolia*	40	35.74×10^{6}	38,640	4,830	6,762	25,760	10,948
Helamba	(640)	(0.78×10^{5})	(84×10^{4})	(10.5×10^{4})	(14.7×10^{4})	(56×10^{4})	(23.8×10^{4})

15.	*Adina cordifolia*	..	46	..	41.86×10^{5}	..	62,790	..	4,347	..	6,118	..	38,640	..	16,744
	Kolon ..	..	(736)	..	(0.91×10^{9})	..	(136.5×10^{4})	..	(9.5×10^{4})	..	(13.3×10^{4})	..	(84×10^{4})	..	(36.4×10^{4})
16.	*Albizia lebbek* ..	..	39	..	51.2×10^{6}	..	61,180	..	4,991	..	7,084	..	40,250	..	20,286
	Mara ..	..	(624)	..	(1.11×10^{9})	..	(133×10^{4})	..	$10.9\times10^{4})$	..	(15.4×10^{4})	..	(87.5×10^{4})	..	(44.1×10^{4})
17.	*Anogeisus latifolia*	..	56	..	52.16×10^{5}	..	77,280	..	5,313	..	7,567	..	43,470	..	25,438
	Dawu ..	..	(896)	..	(1.13×10^{6})	..	(168×10^{4})	..	(11.6×10^{4})	..	(16.5×10^{4})	..	(94.5×10^{4})	..	(55.3×10^{4})
18.	*Bridelia retusa* ..	..	62	..	43.15×10^{6}	..	53,130	..	4,025	..	5,796	..	32,200	..	18,354
	Ketakela ..	..	(992)	..	(0.94×10^{9})	..	(115.5×10^{4})	..	(8.8×10^{4})	..	(12.6×10^{4})	..	(70×10^{4})	..	(39.9×10^{4})
19.	*Careya arborea*	..	46	..	38.32×10^{5}	..	59,570	..	4,669	..	6,762	..	35,420	..	24,150
	Kahata ..	..	(736)	..	(0.83×10^{9})	..	(129.5×10^{4})	..	(10.2×10^{4})	..	(14.7×10^{4})	..	(77×10^{4})	..	(52.5×10^{4})
20.	*Casuarina equisetifolia*	..	48	..	52.49×10^{5}	..	67,620	..	5,796	..	8,211	..	37,030	..	18,032
	Kasa gas ..	..	(768)	..	(1.14×10^{9})	..	(147×10^{4})	..	(12.6×10^{4})	..	(17.9×10^{4})	..	(80.5×10^{4})	..	(39.2×10^{4})
21.	*Cullenia zeylanica*	..	39	..	56.99×10^{6}	..	67,620	..	2,898	..	4,186	..	41,860	..	12,236
	Katuboda ..	..	(624)	..	(1.24×10^{9})	..	(147×10^{4})	..	(6.3×10^{4})	..	(9.1×10^{4})	..	(91×10^{4})	..	(26.6×10^{4})
22.	*Cupressus torulosa*	..	32	..	38.64×10^{6}	..	40,250	..	2,576	..	3,703	..	32,200	..	10,626
	Cypress ..	..	(512)	..	(0.84×10^{9})	..	(87.5×10^{4})	..	(5.6×10^{4})	..	(8.1×10^{4})	..	(70×10^{4})	..	(23.1×10^{4})
23.	*Diospyros melanoxylon*	..	51	..	35.10×10^{6}	..	49,910	..	3,864	..	5,635	..	32,200	..	15,134
	Kadumberiya ..	..	(816)	..	(0.76×10^{9})	..	(108.5×10^{4})	..	(8.4×10^{4})	..	(12.3×10^{4})	..	(70×10^{4})	..	(32.9×10^{4})
24.	*Gmelina arborea*	..	30	..	34.13×10^{5}	..	45,080	..	3,542	..	5,152	..	25,760	..	15,778
	Etdemata ..	..	(480)	..	(0.74×10^{9})	..	(98×10^{4})	..	(7.7×10^{4})	..	(11.2×10^{4})	..	$56\times10^{4})$	..	(34.3×10^{4})
25.	*Holoptelea integrifolia*	..	40	..	34.13×10^{6}	..	54,740	..	4,025	..	5,796	..	30,590	..	12,880
	Godakirilla ..	..	(640)	..	(0.74×10^{9})	..	(119×10^{4})	..	(8.8×10^{4})	..	(12.6×10^{4})	..	(66.5×10^{4})	..	(28×10^{4})
26.	*Launea grandis* ..	..	36	..	25.76×10^{6}	..	38,640	..	2,898	..	4,186	..	22,540	..	10,304
	Hik ..	..	(576)	..	(0.56×10^{9})	..	(84×10^{4})	..	(6.3×10^{4})	..	(9.1×10^{4})	..	(49×10^{4})	..	(22.4×10^{4})
27.	*Anthoceaphalus cadamba*	..	30	..	37.35×10^{6}	..	43,470	..	3,220	..	4,508	..	27,370	..	9,016
	Ela Bakmi ..	..	(480)	..	(0.81×10^{9})	..	(94.5×10^{4})	..	(7×10^{4})	..	(9.8×10^{4})	..	(59.5×10^{4})	..	(19.6×10^{4})
28.	*Grewia latifolia*	..	48	..	67.94×10^{4}	..	83,720	..	5,957	..	8,533	..	54,740	..	27,370
	Daminiya ..	..	(768)	..	(1.48×10^{9})	..	(182×10^{4})	..	(12.9×10^{4})	..	(18.6×10^{4})	..	(119×10^{4})	..	(59.5×10^{4})
29.	*Machilus macrantha*	..	34	..	35.10×10^{6}	..	46,690	..	3,220	..	4,669	..	28,980	..	10,948
	Ululu ..	..	(544)	..	(0.76×10^{9})	..	(101.5×10^{4})	..	(7×10^{4})	..	(10.2×10^{4})	..	(63×10^{4})	..	(23.8×10^{4})
30.	*Mangifera indica*	..	39	..	41.86×10^{6}	..	56,350	..	4,347	..	6,279	..	33,810	..	14,168
	Amba ..	..	(624)	..	(0.91×10^{9})	..	(122.5×10^{4})	..	(9.5×10^{4})	..	(13.7×10^{4})	..	(73.5×10^{4})	..	(30.8×10^{4})
31.	*Messua ferrea* ..	..	72	..	74.70×10^{5}	..	106,260	..	5,635	..	8,050	..	70,840	..	26,726
	Na ..	..	(1,152)	..	(1.62×10^{9})	..	(231×10^{4})	..	(12.3×10^{4})	..	(17.5×10^{4})	..	(154×10^{4})	..	(58.1×10^{4})
32.	*Terminalia chebula*	..	57	..	56.67×10^{6}	..	78,890	..	5,152	..	7,406	..	53,130	..	30,590
	Aralu ..	..	(912)	..	(1.23×10^{9})	..	(171.5×10^{4})	..	(11.2×10^{4})	..	(16.1×10^{4})	..	(115.5×10^{4})	..	(66.5×10^{4})

(Figures in parenthesis represent Metric Units)

TABLE 2

BASIC STRESSES AT 12% MOISTURE CONTENT

Static Bending

Species		Density (Kgs./m³)	Modulus of elasticity (1,000 psi.) (Nm⁻²)	Modulus of Rapture (psi.) (Nm⁻²)	Shear parallel to grain average shear stress (psi.) (Nm⁻²)	Compression parallel to grain Maximum crush stress (psi.) (Nm⁻²)
Botanical Name	Local Name					
1. *Anisophyllea cinnamomoides*	Welipenna	622	49,169 (10,689 × 10⁵)	442,847 (962.7 × 10⁴)	46,593 (101.3 × 10⁴)	227,590 (494.8 × 10⁴)
2. *Carallia brachiata*	Dawata	647	—	—	—	324,512 (705,5 × 10⁴)
3. *Carallia calycina*	Ubberiya	737	78,933 (16,268 × 10⁵)	566,720 (1232 × 10⁴)	61,953 (134.7 × 10⁴)	322,612 (701.3 × 10⁴)
4. *Cocos nucifera*	Coconut (A)	579	37,835 (8,225 × 10⁵)	291,732 (634.2 × 10⁴)	14,168 (30.8 × 10⁴)	196,098 (426.3 × 10⁴)
	(B)	390	2,214 (4,816 × 10⁵)	117,949 (256.4 × 10⁴)	9,048 (19.7 × 10⁴)	103,137 (224.2 × 10⁴)
	(C)	789	65,334 (14,203 × 10⁵)	483,644 (1,051.4 × 10⁴)	50,683 (110.2 × 10⁴)	411,709 (895.0 × 10⁴)
5. *Cyathocalyx zeylanicus*	Ipetta	347	—	146,446 (318.4 × 10⁴)	—	—
6. *Diospyros malabarica*	Timbiti	608	—	285,775 (621.3 × 10⁴)	48,944 (106.4 × 10⁴)	253,446 (551.0 × 10⁴)
7. *Diospyros ovalifolia*	Kunumella	757	64,561 (14,035 × 10⁵)	535,422 (1,164 × 10⁴)	93,155 (202.5 × 10⁴)	272,412 (592.2 × 10⁴)
8. *Dryobalanops spp.*	Kapur*	619	54,515 (11,851 × 10⁵)	358,128 (778.5 × 10⁴)	48,300 (105 × 10⁴)	218,735 (475.5 × 10⁴)
9. *Filicium decipiens*	Pihimbiya	723	—	—	—	349,563 (759.9 × 10⁴)
10. *Koompassia malaccensis*	Kempas*	674	57,863 (12,579 × 10⁵)	506,764 (1,101.7 × 10⁴)	50,168 (109.1 × 10⁴)	238,216 (517.9 × 10⁴)
11. *Mastixia tetrandra*	Diyataliya	391	34,583 (7,518 × 10⁵)	247,103 (537.2 × 10⁴)	25,985 (56.49 × 10⁴)	144,095 (313.3 × 10⁴)

12.	*Neolitsea cassia*	..	..	Divul Kurundu	..	572	..	49,717 (10,808 × 10^5)	..	383,985 (834.8 × 10^4)	..	59,441 (129.22 × 10^4)	.. 316,429 .. (687.9 × 10^4)
13.	*Pleurostylia opposita*	..	..	Panakka	..	725	..	48,719 (10,591 × 10^5)	..	487,959 (1060,8 × 01^4)	..	90,096 (195.9 × 10^4)	.. 238,409 .. (518,3 × 10^4)
14.	*Pterospermum canescens*	..	..	Welang	..	601	..	—	..	369,978 (804.3 × 10^4)	..	45,660 (99.3 × 10^4)	.. 230,777 .. (501.7 × 10^4)
15.	*Tectona grandis*	..	..	Teak (Poles)	..	483	..	39,799 (8,652 × 10^5)	..	332,787 (723.5 × 10^4)	..	49,749 (108.2 × 10^4)	.. 178,871 .. (388.9 × 10^4)
16.	*Xylopia parvifolia*	..	..	Netavu	..	527	..	—	..	344,379 (748.7 × 10^4)	..	—	.. —

(Figures in parenthesis represent Metric Units)

* Imported species. (A) Aged 20 years or less ; (B) Corewood ; (C) Aged more than 20 years. Psi = poundals per sq. inch.

The Sri Lanka Forester, Vol. 15 (1 *and* 2), *Jan.–Dec.*, 1981

Results of Seasoning Trials with some Local Timbers

E. W. SENEVIRATNE

(*Deputy Conservator of Forests, Research and Education*)

INTRODUCTION

Wood is seldom used in the green condition, when it may contain as much as 75% by weight of water. It is generally brought to a more or less dry condition, depending on the use to which it will be put, either by air seasoning in the open or under cover, or by drying the timber under controlled conditions in a klin. The value of timber for industrial purposes depends to a large extent on its being dried to the appropriate moisture content with the minimum of degrade due to distortion and splitting.

Air seasoning and kiln seasoning trials were carried out on boards of a few local species and the results are given in Tables 1 and 2.

TABLE 1

AIR SEASONING

Local Name	Latin Name	Thickness (in inches) (in metres)	Average initial M.C. %	Average M.C. at end of period — %	Period in months
1. Rubberwood (Boron treated)	*Hevea brasiliensis*	1/8″ (0.3 × 10⁻²)	74.6	18.2	1½
2. Etamba	*Mangifera zeylanica*	5/8″ (1.6 × 10⁻²)	71.9	16.9	1½
		1 1/8″ (2.9 × 10⁻²)	83.3	18.0	1½
		2 1/8″ (5.4 × 10⁻²)	72.6	22.6	2
3. Kekuna	*Canarium zeylanicum*	5/8″ (1.6 × 10²–)	80.2	17.7	1½
		1 1/8″ (2.9 × 10⁻²)	86.9	19.1	1½
		2 1/8″ (5.4 × 10⁻²)	78.9	19.2	2
4. Timbiri	*Diospyros malabaricum*	5/8″ (1.6 × 10⁻²)	48.1	15.1	1
		1 1/8″ (2.9 × 10⁻²)	54.3	14.6	1½
		2 5/8″ (6.7 × 10⁻²)	58.3	17.1	3
5. Welang	*Pterospermum canescens*	5/8″ (1.6 × 10⁻²)	43.6	13.9	1
		1 1/8″ (2.9 × 10⁻²)	45.3	13.5	2½
		2 5/8″ (6.7 × 10⁻²)	41.7	16.6	3
6. Buhedawaka	*Chaetocarpus pubescens*	1 1/8″ (2.9 × 10⁻²)	42.7	14.5	3½
		2 5/8″ (6.7 × 10⁻²)	47.1	15.7	6
		2 1/8″ (5.4 × 10⁻²)	29.0	15.8	5
		1″ (2.5 × 10⁻²)	32.8	16.0	9
7. Cypress	*Cupressus macrocarpa*	5/8″ (1.6 × 10⁻²)	70.9	16.7	1
		1 1/8″ (2.9 × 10⁻²)	67.3	14.6	2
		2 1/8″ (5.4 × 10⁻²)	53.4	18.3	3
		2 5/8″ (6.7 × 10⁻²)	59.1	17.4	4½
. Teak	*Tectona grandis*	1″ (2.5×10⁻²)	56.3	12.4	5

(Figures in parenthesis represent Metric Units)

TABLE 2

KILN SEASONING

Timber partially air seasoned

	Local Name	*Latin Name*	*Date* From	To	*No. of days*	*Original M.C. %*	*Finel M.C. %*	*Remarks*
1.	Hulanhik	*Chuckrasia velutina*	17.01.56	22.01.56	5	16.9	12.7	—
2.	Helamba	*Mitragyna parvifolia*	31.01.56	28.02.56	29	53.8	13.7	Difficult to season but did well
3.	Suriyamara	*Albizia odoratissima*	28.05.56	04.07.56	7	34.5	13.5	—
4.	Ubberiya	*Carallia calycina*	10.07.56	04.07.56	9	18.6	12.9	Notoriously refractive difficult to season but did well
5.	Dawata	*Carallia brachiata*	21.07.56	02.08.56	12	18.4	12.9	Notoriously refractive difficult to season but did well
6.	Hulanhik	*Chuckrasia velutina*	09.08.56	17.08.56	8	19.1	12.3	—
7.	Kelamaduwa	*Ficus nervosa*	25.08.56	12.09.56	18	71.4	12.5	—
8.	Aridda	*Campanosperma zeylanica*	25.10.56	27.10.56	2	67.0	21.0	—
9.	Saligna wood	*Eucalyptus grandis*	21.11.56	04.12.56	13	20.8	12.5	—
10.	Tallow wood	*Eucalyptus microcorys*	18.12.56	23.12.56	5	17.5	13.0	—
11.	Hora	*Dipterocarpus zeylanicus*	26.01.57	25.02.57	30	72.2	12.4	—
12.	Mountain ash	*Eucalyptus regnans*	05.03.57	25.03.57	20	14.6	8.0	—
13.	Tawenna	*Palaquium rubiginosum*	18.06.58	04.07.58	16	18.6	12.8	—

RSULTS AND CONCLUSIONS

The following results were obtained —

(*a*) Rubber boards containing tension wood tended to warp and spring,

(*b*) Etamba and Kekuna can be air-seasoned without any appreciable degrade,

(*c*) Timbiri and Welang can be air-seasoned without any perceptable degrades,

(*d*) Bu-hedawaka is a refractory timber and liable to surface splitting and warping while in the process of air-seasoning,

(*e*) Cypress can be air-seasoned fast. It dried quickly without any perceptible defects except for cracks in knots during air-seasoning. However, the knots do not loosen,

(*f*) Teak is an easy species to air season. It dries quickly without any perceptible defects.

The Sri Lanka Forester, Vol. 15 (1 *and* 2), *Jan. – Dec.*, 1981

The Status of Forestry Research in Sri Lanka

K. VIVEKANANDAN

(*Chief Research Officer*, Forest Department, Colombo 2)

DEVELOPMENT OF FOREST RESEARCH

In Sri Lanka, the Forest Department came into existence in 1899 and it was not until 1937 a small research section to deal with Silvicultural Research was established. This section dealt with mainly seed testing, natural and artificial regeneration, growth studies and other silvicultural investigations.

In 1949, the Timber Utilization Research Branch was established as an appendage to the already existing Silvicultural Research Branch. It was created to deal with problems associated with timber and its uses.

In 1930's and 1940's plantation or man-made forestry was in its formative stage and all research efforts at that time were concentrated on natural forests.

From 1950 there was a shift towards the creation of man-made forests. From small beginnings, the plantation forestry programme gradually expanded over the years and from 1970 there was an accelerated planting programme covering nearly 5,000 ha. per annum. The planting programme was again expanded in 1978 and in 1980 alone the Forest Department planted over 12,000 hectares mainly with exotics like *Pinus*, *Eucalyptus*, *Albizia*, *Swietenia*, *Casuarina* etc.

With the advent of the accelerated planting programme there had been a shift in our research activities and great emphasis was placed on research areas encompassing reforestation activities.

RESEARCH ORGANISATION

The present Research activities of the Forest Department is carried out by two divisions namely the Silvicultural Research Division and the Timber Utilization Research Division. The staff, full-time engaged in research, in the respective divisions at present (1981) are given below :

Position	*Silviculture*	*Timber Utilization*
Chief Research Officer ..	1 ..	—
Research Officer ..	1 ..	2
Technical Assistants ..	3 ..	3
Foresters	3 ..	1
Laboratory Technicians ..	2 ..	1

Funding is provided from the Departmental budget.

Limited laboratory facilities are available in both the divisions.

CURRENT RESEARCH ACTIVITIES

Silvicultural Research

Because of limited staff and funds, the research activities in this division are concentrated mainly on problem-oriented and applied research rather than pure research.

Our current research activities encompass the following areas :

(*a*) Species trials
(*b*) Varietal trials
(*c*) Provenance trials
(*d*) Seed research
(*e*) Growth and yield studies
(*f*) Entomological studies
(*g*) Pathological studies

Utilization Research :

The main research activities are —

(*a*) Determination of strength properties of indigenous and plantation species,
(*b*) Natural durability of timbers,
(*c*) Determination of the efficacy of wood preservatives on inferior species of timber,
(*d*) Utilization of lesser known species.

CONSTRAINTS TO THE DEVELOPMENT OF FORESTRY RESEARCH

The chief constraints which have hindered the development of forestry research are funds and trained personnel. In 1960, the total number of active professional research workers was only 2 and this number has now after 20 years increased to 4. The supporting staff, *i.e.*, Technicians and Laboratory Assistants was 3 in 1960 and now it has increased to 7. The funds available for the research section is less than 1 % of the total budget of the department.

Although we have a very comprehensive programme of work it is an uphill task to accomplish all of them to the desired level of expectation with the limited money and man-power we have in hand now. We are therefore compelled to concentrate only on priority areas which are associated with our development projects.

COLLOBORATION IN RESEARCH

Like many research institutions our research work is not always done in total isolation. As far as possible we undertake research projects in collaboration with other institutions. At present we are collaborating in the International provenance trial for *Pinus* and Teak and we also have a collaborative programme with University of Hawaii on *Leucaena*. We also have a few collaborative research programmes with local research institutions. We are also getting assistance from CSIRO, Australia, in the form of seed supply for research work.

PROBLEM ORIENTED RESEARCH

During the past few years forestry has gained much prominence than what it enjoyed a few decades ago. With our dwindling forest resources, and over increasing demand for timber and fuelwood, research has to be oriented to meet these challenges.

Under the USAID Programme we are undertaking a Watershed Reforestation Project and a Fuelwood Project. These new ventures will rely heavily on research to build up the array of acceptable species, the methods of propagation, spacing, fertilizing, after-care, etc. In the light of these our research programme has to be geared to meet these demands. Fortunately a reasonable amount of funds are being provided under the USAID programme to carry out research.

THE FUTURE OF RESEARCH IN SRI LANKA

In Sri Lanka we have full-fledged Research Institutes for the three major crops — Tea, Rubber and Coconut. There are separate Research Institutions for Agricultural Research Medical Research, Fisheries Research and even sugar cane. It is a pity we have only a small division to handle Forestry Research in this country despite the fact that about 25% of the land area is under forest and we are undertaking a massive planting programme unprecedented in the annals of forestry in this country.

If we look around, all our neighbours, India, Bangladesh, Pakistan, Malaysia, Thailand, Indonesia have all well established Forest Research Institutes.

If Forestry is to pay dividend in this country the research arm should be strengthened and it is time we had a full-fledged Forestry Research Institute in this country with more trained personnel and sufficient budgetary allocation.

Research problems in the future will concentrate on —

(*a*) Diversifying our species base,

(*b*) Identifying species, varieties and provenances with rapid growth rate and desired wood quality for our wood-based industries,

(*c*) Development of an expanded tree improvement and breeding programme and the possibility of propagating some species through tissue culture methods,

(*d*) Modernising our nursery practices, planting methods and fire control measures,

(*e*) Building up a data bank on the growth and yield of the various species,

(*f*) Critically evaluating the impact of the exotics on soil fertility and hydrology,

(*g*) Develop effective methods of pest and disease control,

(*h*) Embark on expanded research on agro-forestry, minor forest produce, medicinal plants, dendrothermal (energy) plantations, improved wood utilization, etc.

The Sri Lanka Forester, Vol. 15 (1&2) *; Jan-Dec.*, 1981

Soil Conservation Needs in the Upper Mahaweli Catchment Watershed Management Project

RAY R. WEIL

(*Assistant Professor, University of Maryland**)

SUMMARY

The problems of soil conservation in the Upper Mahaweli Catchment were surveyed with special reference to lands allocated to reforestation under the Upper Mahaweli Catchment Watershed Management Project. While the reforestation lands have suffered severe sheet erosion in the past, the establishment of forest cover should minimize this process in the future. Gully erosion, however, will require some structural measures as well. These measures are described in detail and guidelines given for their application. The role of reforestation is also discussed in the context of the impact of other land uses in the catchment.

BACKGROUND

Most of the water for the many agricultural and hydropower developments in the Accelerated Mahaweli Development Program originates in the Upper Catchment of the Mahaweli Ganga. The reforestation program in the Upper Catchment is a major facet of the overall management of this watershed to provide an optimum supply of useable water. A second value of the reforestation program is the production of forest products : fuelwood, fiber and timber. Soil conservation is a vital concern in the management of the Upper Catchment area in general and in the reforestation program in particular. The concern is fourfold.

1. to protect and preserve the soil resource as the basis of the upland's productivity ;
2. to protect downslope arable land from becoming choked with sediment ;
3. to minimize the sediment loads of rivers which can reduce the storage capacity of reservoirs and the operating efficiency of hydro-turbines ; and
4. to otimize the infiltration characteristics of the watershed land surface so that flooding will be less severe in the wet season and dry season stream flows will be greater.

The Upper Catchment of the Mahaweli covers approximately 3,000 km² of the hilly and mountainous country in the south-central part of the island (TAMS, 1980). The land is characterized by rather steep slopes (20—100%) except for the valley bottoms which are in terraced paddy fields and some high plateaus such as the Horton Plains area. Significant areas have very steep slopes ranging from 45% to over 100%. These are prinicipally the upper slopes and mountaintops and the side slopes of several deeply inicised river valleys. The Upper Catchment extends into both the wet and intermediate zones, with less than 1500 mm. rainfall per year in isolated areas east of Kandy and Minipe to over 5000mm in the south-eastern part of the watershed. Much of this rain falls as brief torrential downpours with great erosive power.

* Dr. Ray R. Weil served as Soils Consultant for the South-East Consortium for International Development (SECID), who are assisting the Sri Lanka Forest Department in the implementation of the Reforestation and Watershed Management Project funded by the USAID.

The principal crop grown in the Upper Catchment is tea, which occupies approximately one third of the Upper Catchment land area, especially the fairly steep slopes. There are also significant areas of cultivated crops on steep slopes. Very little of the natural hardwood forest remains, but degraded and scrub forest occupies many of the steepest slopes. A kind of coarse grassland known as " Patana" covers scattered mountaintops as well as the extensive Horton Plains (Perera, 1969). In the drier eastern portion shifting cultivation or "Chena" farming is still practiced. The Upper Catchment is mid-and up-country in elevation. Many of the hills rise above 1000m and some areas near Nuwara Eliya are above 2000m.

NATURE OF SOIL EROSION AND ITS CONTROL

If the necessary quantitative information were available it would be possible to estimate the amount of soil lost per HA from any given site by applying the Universal Soil Loss Equation, A=RKLSCP, where :—

A = amount of soil loss per unit area each year.
R = rainfall erosivity factor.
K = Soil erodibility factor.
L = slope length factor.
S = slope gradient factor.
C = soil cover or vegetation factor.
P = soil conservation practices factor.

The right hand side of the equation lists the factors which determine the severity of erosion. The erosive power of rainfall (R) involves not only the amount of rain a site receives, but more importantly, the intensity of the rain or how fast it falls. If 20 mm of rain falls evenly over a 24-hour period, the likelihood of it causing erosion is very slight. It the same 20 mm fell in one hour, this would be a torrential downpour and a great deal of erosion damage could result.

The erodibility of the soil (K) is a measure of how easily a particular soil can wash away. This factor can be determined by measuring the amount of soil eroded from a plot of standard length and slope during a standard (artificial) "rain storm". It can also be estimated on the basis of physical soil properties. Basically 2 properties are involved. The more porous the soil, the more rapidly rainwater can enter it by infiltration. If rain falls faster than it can enter the soil, the portion in excess will runoff down slope. This runoff can then carry away small soil particles that have been detached from the mass of soil by the impact of falling raindrops. The second property is the strength with which the tiny particles of soil adhere to one another to form larger aggregates that cannot easily be washed away. This "resistance to detachment" or soil "stability" varies greatly from soil to soil depending on the texture, organic matter and types of clays present. Thus the most erodable soils are those from which particles are easily detached and which cannot absorb rainwater fast enough to prevent runoff from occuring. In general the order of erodability for the great soil groups in the Upper Catchment is Immature Brown Loams and Mountain Regosols>Reddish Brown Earths>Red-Yellow Podzolic Soils> Reddish Brown Latosolic Soils.

The slope gradient factor (S) simply implies that water will runoff at a greater velocity if the slope is steeper and therefore will be able to transport more soil. A longer slope (L factor) will allow a greater volume of water to gather and its velocity will also increase as it accelorates

(1) ROCK
(2) SOIL
(3) SEEDLING
(4) CLEAN-WEEDED TERRACE
(5) ORIGINAL SOIL SURFACE
(6) BRUSH BUNDLE AND STAKE

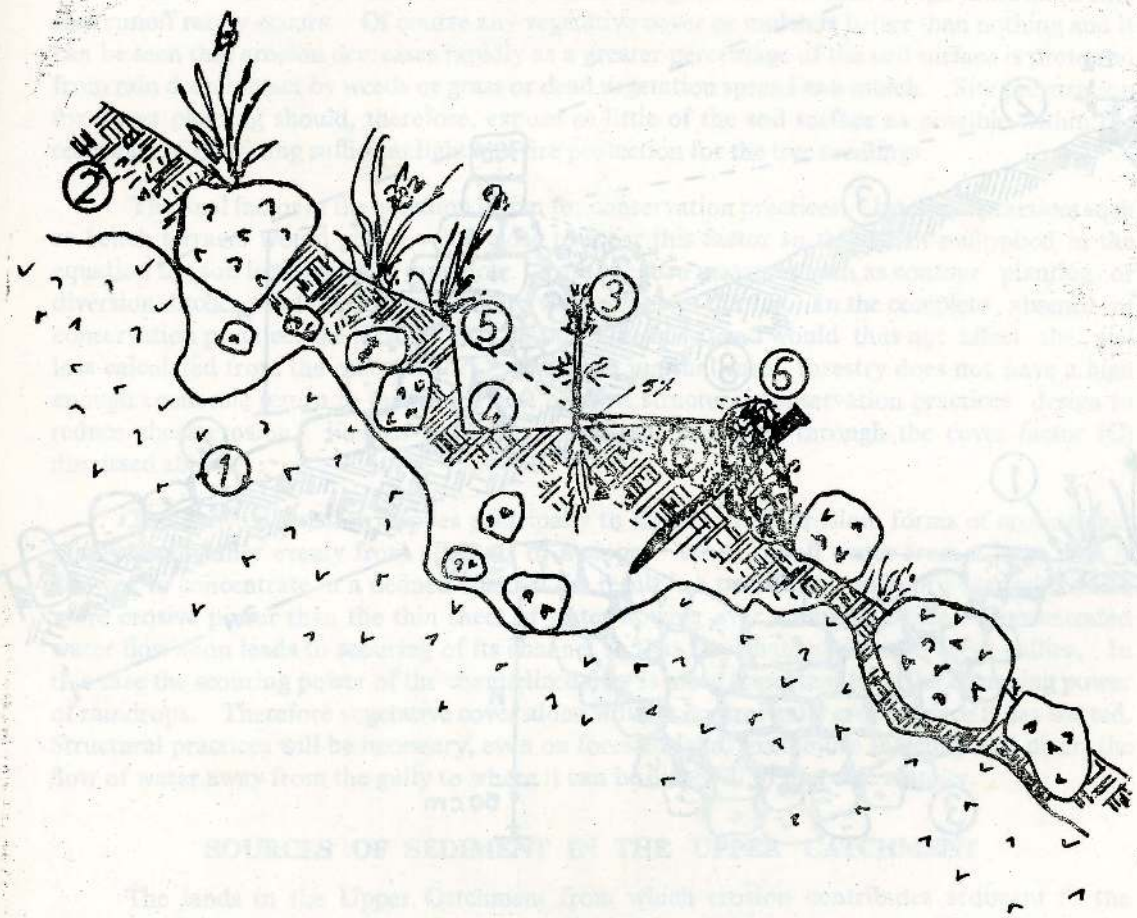


FIGURE 1. PATCH TERRACE FOR USE ON VERY STEEP SLOPES

(1) SOIL SURFACE
(2) STABLE SLOPE
(3) GULLY FLOOR
(4) APRON
(5) ROCK DAM WALL-LARGE STONES
(6) SMALL STONES
(7) SOIL FILL BACKSLOPE
(8) SOIL

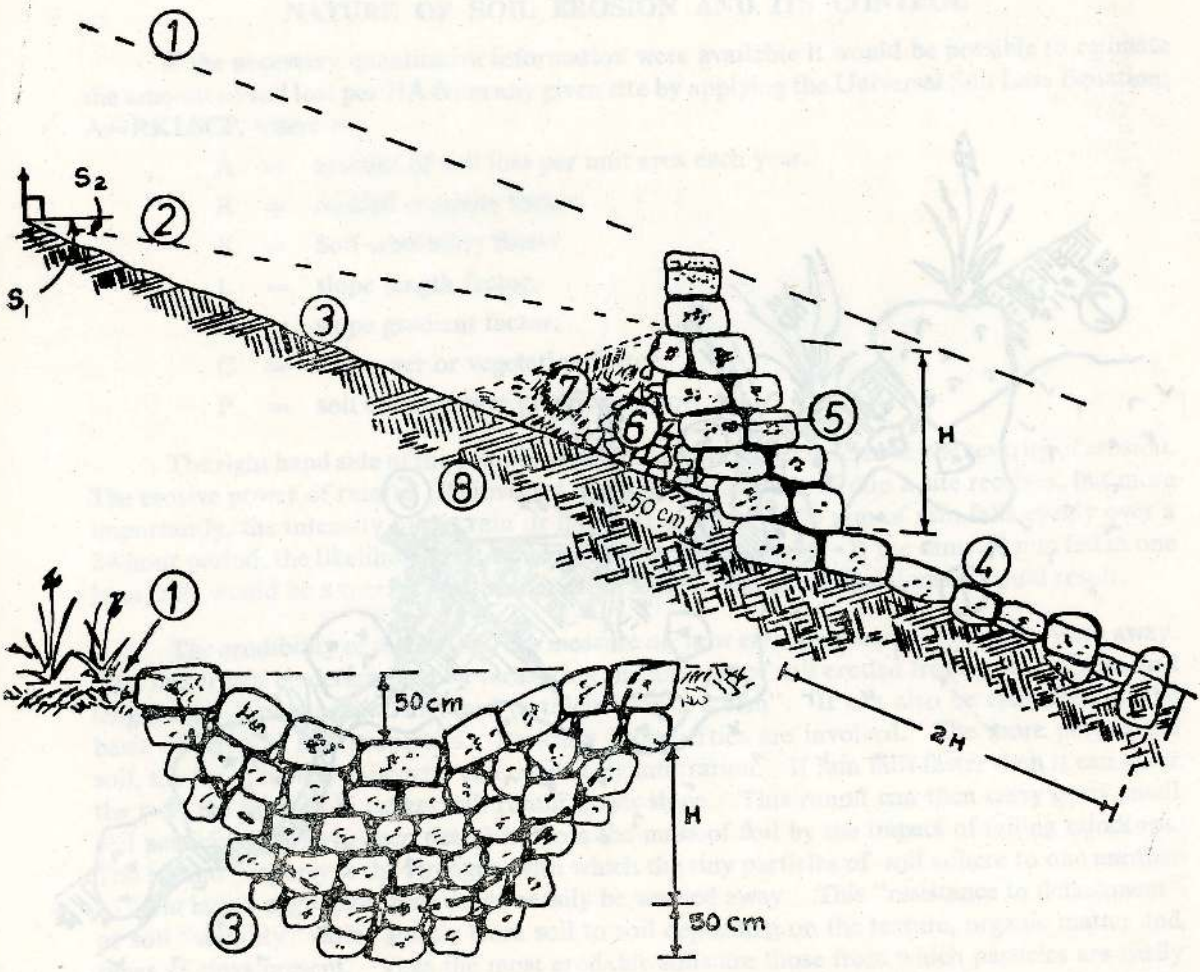


FIGURE 2. LOOSE ROCK CHECK DAM AND APRON.

down the slope. The slopes in the Upper Catchment are often both steep and long and this is the major reason why erosion is such a problem in this region of the country.

The vegetation or cover factor (C) is extremely important for two reasons in terms of the role of forestry in conserving the soil. First, its value can vary from 1 to 0 and therefore when multiplied in the equation can override (or nearly so) all other considerations. Second, it is one of the factors which can be readily changed to control erosion. Thus a forest cover with a good canopy and a well developed litter on the forest floor can reduce soil loss to virtually nil even on long steep slopes of erodable soil in regions of intense rainfall. In doing so, the forest floor is probably more important than the canopy. Water dripping from tall trees would have nearly the same erosive power as direct rainfall. The understory vegetation and leaf litter on the soil surface are what absorb the energy of the raindrop impact and thus protect the soil from the detachment process with which erosion begins. The litter also encourages a stable soil structure which, along with the network of tree root channels, gives the soil such a high infiltration rate that runoff rarely occurs. Of course any vegetative cover or mulch is better than nothing and it can be seen that erosion decreases rapidly as a greater percentage of the soil surface is protected from rain drop impact by weeds or grass or dead vegetation spread as a mulch. Site preparation for forest planting should, therefore, expose as little of the soil surface as possible within the restraints of providing sufficient light and fire protection for the tree seedlings.

The final factor in the equation is that for conservation practices. Intensive practices such as bench terraces would give a value close to 0 for this factor so that when multiplied in the equation the soil loss would be quite low. Less effective measures such as contour planting or diversion ditches would be assigned higher values but lees tha 1.0. In the complete absence of conservation practices the factor would have a value of 1.0 and would thus not affect the soil loss calculated from the other factors. Except in unusual cases, forestry does not have a high enough economic return to justify the cost of most structural conservation practices design to reduce sheet erosion. Forests generally control sheet erosion through the cover factor (C) discussed above.

The above discussion applies principally to sheet and rill erosion, forms of erosion that remove soil rather evenly from all areas of a slope. When runoff water from a large area is allowed to concentrate in a defined channel the result is a turbulent stream of water with much more erosive power than the thin sheet of water flowing over an even surface. Concentrated water flow soon leads to scouring of its channel so that tiny channels become large gullies. In this case the scouring power of the channelized flow is more important than the detaching power of raindrops. Therefore vegetative cover alone will not control gully erosion once it has started. Structural practices will be necessary, even on forested land, to stabilize the gully and divert the flow of water away from the gully to where it can be disposed of in a safe manner.

SOURCES OF SEDIMENT IN THE UPPER CATCHMENT

The lands in the Upper Catchment from which erosion contributes sediment to the Mahaweli Ganga and its tributaries can be divided into three main types with respect to the reforestation project. These are :

(1) Lands likely to be turned over to Forestry under present policies.

(2) Lands in agricultural production unlikely to receive forest plantings.

(3) Lands disturbed by construction activities.

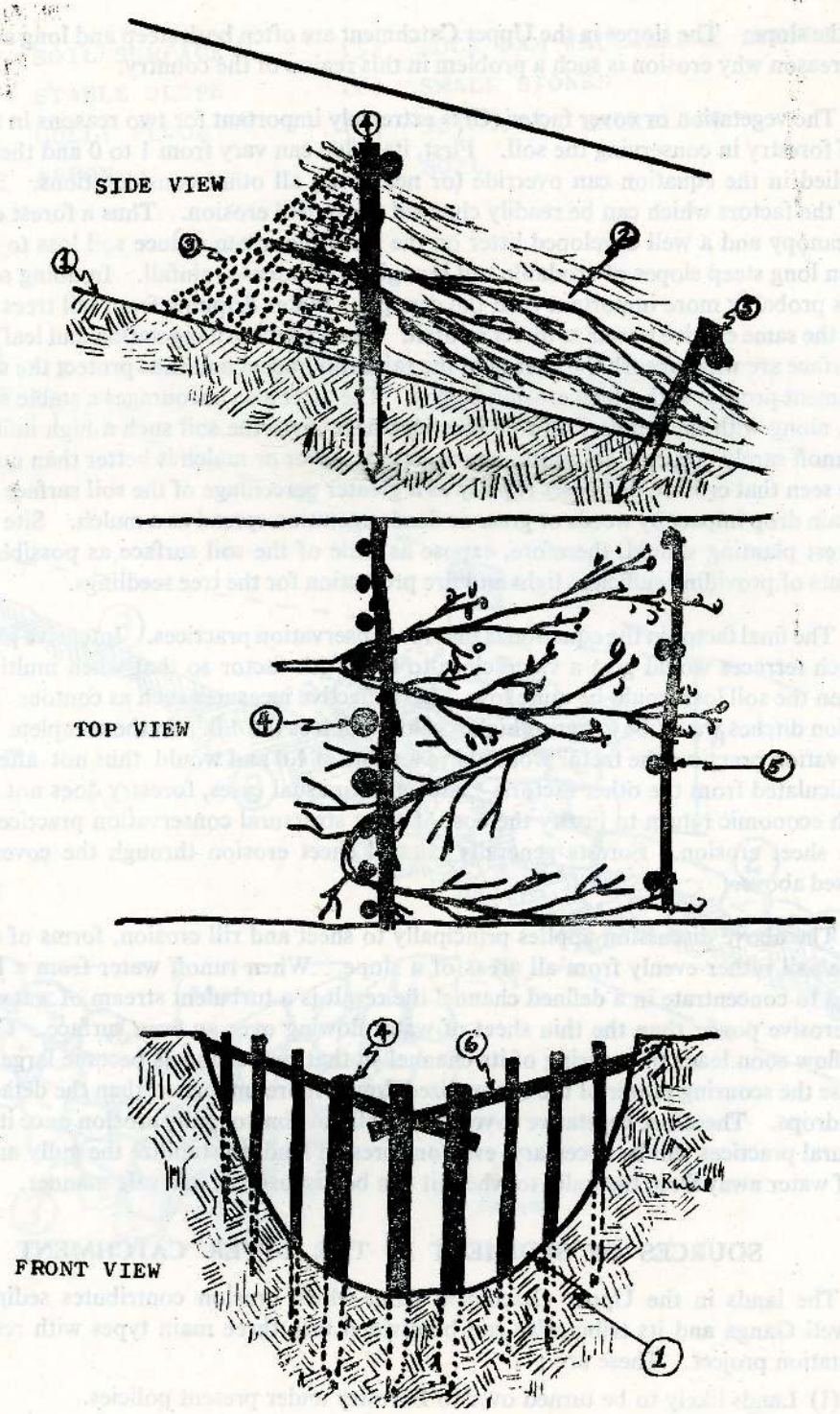


FIGURE 3. SINGLE ROW BRUSH CHECK DAM

My discussions with Forest Department personnel indicate that only lands in certain classes of use are likely to be turned over to the Forest Department immediately for tree planting under the watershed management program. These land classes include :

(1) Most of the mountain-top patana areas (with the exception of Horton Plains which is upper montane grassland and is to be preserved as such).

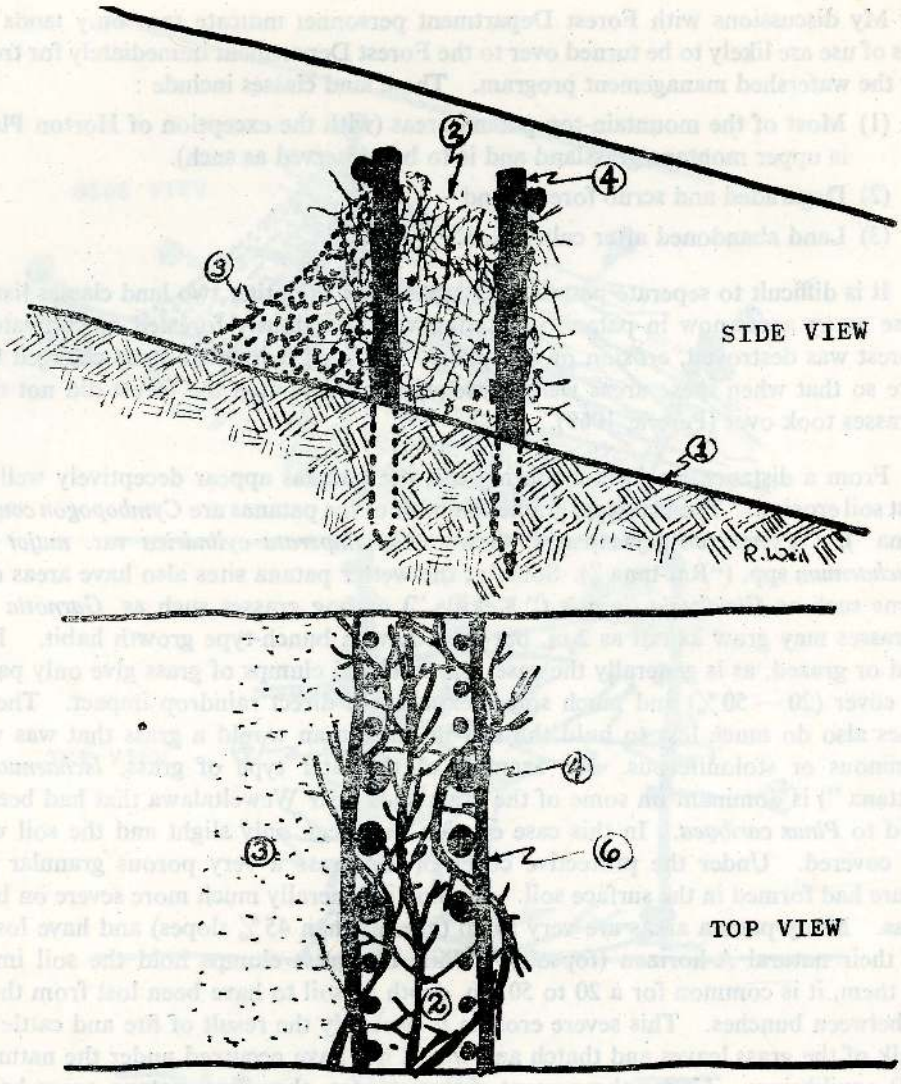
(2) Degaraded and scrub forests, and

(3) Land abandoned after cultivation,

It is difficult to seperate patana grasslands from the other two land classes listed above, because many areas now in patana vegetation were previously forested or cultivated. After the forest was destroyed, erosion on the poorly managed cultivated areas changed the micro-climate so that when these areas were subsequently abandoned the forest did not regenerate, but grasses took over (Perera, 1969).

From a distance, as from a touring car, the patanas appear deceptively well protected against soil erosion. The principal grasses on most of the patanas are *Cymbopogon confertiflorus*) (" mana "), *Chrysopogon zeylanicus* (" Gawara "), *Imperata cylindrica* var. *major* (" Illuk ") and *Ischaemum* spp. ("Rat-tana "). Some of the wetter patana sites also have areas dominated by ferns such as *Gleichenia linearis* (" Kekilla ") or bog grasses such as *Garnotia tectorum.* The grasses may grow as tall as 2 m. but most have a bunch-type growth habit. If they are burned or grazed, as is generally the case, the scattered clumps of grass give only partial vegetative cover (20 — 50%) and much soil is exposed to direct raindrop impact. The scattered bunches also do much less to hold the soil in place than would a grass that was vigorously rhizominous or stoloniferous. An example of the later type of grass, *Ischaemum indicum* (" Rattana ") is dominant on some of the grasslands near Weweltalawa that had been recently planted to *Pinus caribgea.* In this case erosion had been only slight and the soil was nearly 100% covered. Under the protective cover of the grass a very porous granular or crumb structure had formed in the surface soil. Erosion is generally much more severe on bunch-type patanas. Many patana areas are very steep (greater than 45% slopes) and have lost most or all of their natural A-horizon (topsoil). While the grass clumps hold the soil immediately under them, it is common for a 20 to 50 cm. depth of soil to have been lost from the exposed areas between bunches. This severe erosion is probably the result of fire and cattle removing the bulk of the grass leaves and thatch and would not have occurred under the natural (undisturbed) equilibrium. Under the present circumstances, therefore, patana areas have only a moderate resistance to erosion and will make a significant contribution to sedimentation unless converted to forest and/or protected from cattle and fire.

The TAMS Environmental Assessment (1980) identified 32,300 hectares of forest lands in the Upper Catchment. Of this amount they classified 27,100 hectares as having little or no commercial value. Much of this is " degraded forest " in need of replanting or at least improvement planting. Most of the large trees have been removed for fuel or timber and the protective forest floor has disappeared. Between the remaining trees the soil may be bare and severely eroded or more commonly it is sparsely covered with patana grasses and shrubs. In the vicinity of Nuwara Eliya and also around the Knuckles range, considerable areas still remain where the natural forest cover is quite good and the soil is well protected from erosion. Even in these areas, however,the fringes accessible from roads and settled areas are being rapidly degraded and require conservation treatment. In the tea growing areas only the most rocky ridges and drainage ways on the mountaintops remain in forest. Illicit felling of trees is accelerating in



(1) GULLY FLOOR
(2) DENSELY PACKED BRUSH
(3) BACK SLOPE OF SOIL OR GRAVEL
(4) MAIN UPRIGHT SUPPORT
(5) PEG AND CROSS BAR TO HOLD DOWN BRUSH
(6) CROSS BARS LASHED TO FORM V-SHAPED SPILLWAY

FIGURE 4. DOUBLE ROW BRUSH CHECK DAM

all areas. I hardly visited a forested site where I didn't see or hear the felling of trees. Where only scattered individual trees are taken the damage to the forest stand is extensive, but the soil erosion damages are minimal. However, much more serious erosion is caused where the felling of trees is concentrated to clear land for chena farming or where the felling is intensive and continual and the logs are dragged repeatedly over the same trails. The latter situation is common on the forested slopes above tea estates where there is a concentrated demand for cooking fuel. I have seen many examples of " skid trails " turning into active gullies more than 8 m. wide, 6 m. deep and 100 m. long. The major " skid trails " and the subsidiary ones leading to them are an important source of sediment from otherwise forest-protected areas.

The third category of land generally made available for forest planting is land where agricultural cultivations have been abandoned. These lands are among the poorest forest planting sites. Abandonment usually has come only after the soil has been so eroded and its fertility so depleted that further attempts at cultivation were hopeless. Left to succession, most of these sites have a scrub forest — thornbush cover or else are dominated by grasses and small shrubs in a patana — like community. In fact it is quite easy to mistake such abandoned cropland for natural patana from a distance. But on close-up inspection it is seen that these lands generally have a much more sparce vegetative cover than true patana. The percent cover is often only 25%, and rarely above 60%. In many cases the soil has lost all of its A horizon and most of its B horizon as well. What is left is quartz gravel and weathered gneiss fragments mixed with a continuously diminishing amount of clayey soil material. Some sites have eroded down to bare bedrock.

There are three general types of abandoned cultivations common in the Upper Catchment, These are abandoned tea, old Chena or grazing lands, and worn out upland fields that had been continuously cultivated for tobbacco or garden crops. The abandoned tea land usually can be recognized by a few scattered tea bushes and the remnants of stone terraces, drains and access roads. The main vegetation is generally patana grasses with scattered small scrubs such as *Psidium guajava* (" Ambul Pera "). The tea estate's conservation structures generally were allowed to fall into disrepair even before the crop was abandoned and thus have little or no value in erosion control at present. The terraces have crumbled and the diversion channels have filled with sediment. Gullies are common and usually actively eroding. The abandoned chena lands usually have more soil remaining and potentially erodable. This is because the period of cultivation is not prolonged by the use of fertilizers in chena farming. Usually the soil would be cultivated for only 2 or 3 years and then left to natural regeneration. Chena lands are typically covered by thorny and often leguminous scrubs and young trees. Most of the abandoned agricultural lands tend to have a surface layer of quartz gravel which was left behind when the finer soil fractions were washed away. This and the fact that these soils are no longer mechanically disturbed and loosened by cultivation should make them less susceptable to sheet erosion than areas continuing to be cultivated without conservation treatment. However, in order to improve watershed management and obtain some economic production from the abandoned croplands, there can be no doubt that they rightly are major targets of the reforestation program.

At the same time it is also clear that the erosion and sedimentation situation in the Upper Catchment will not be appreciably improved without substantial improvements in conservation on the other two sources of erosion, namely currently cultivated land and construction sites. My observations suggest that the TAMS Environmental Assessment has grossly underestimated this

aspects of the problem. While it is true that well managed tea land is subject to very little erosion on slopes of 40% or less, I believe the TAMS report (section C) was much too optimistic about the proportion of tea estates that fall into this category. Of the 76,200 hectares of land devoted to tea in the Upper Catchment, TAMS cites only 300 hectares as occupying slopes greater than 40%. Having personally measured tea slopes with abeny level readings of 40% to 75% on as least 3 times that area, I have to be sceptical of the TAMS method of estimating slopes which was based on counting the density of contour lines on 1 inch to 1 mile topomaps. I would also call into question the TAMS figures which purport that only 3,400 hectares of tea lands are poorly managed with "a sparse crown cover of tea bushes and a pronounced breakdown in the terracing system". This represents less than 5% of the total area in tea, none of it, according to TAMS, having steeper than 40% slops. My own estimate based on ground observation is that 60 to 80% of the tea in the mid elevation is poorly managed and susceptible to erosion. In the high elevation areas (where the tea commands a better price) this figure is probably only 20 to 30%. On these mismanaged tea landsthe tea conopy is so sparse that 30 to 90% of the soil surface is exposed. These slopes are generally scrape-weeded one or two times per year, making the soil especially susceptable to erosion. Within a month of being disturbed by scrape weeding the surface layer of clean quartz gravel has reappeared, indicating a soil loss of about 5 mm or 50 tons /hectare. In addition, gullies and slips are left untreated to erode and drains are clogged with sediment. Based on measurements of the difference between the present soil surface and the level of the root crowns on mature tea bushes, I estimate an annual rate of soil loss of 75 to 125 tons/hectare from poorly manged tea with 40% slope and sandy clay soil of the Red-Yellow Podzolic great soil group.

A similar situation exists with respect to other continuously cultivated land which the TAMS report classifies as "permanent dry cropping". This land is used to produce clean-cultivated rain-fed crops such as grains, vegetables and tobacco.

Production of the latter has greatly expanded in recent years. Because the soil is physically disturbed by tillage and weeding every year and the annual crops cover the soil for only a few months of the year, this type of land use is perhaps the most inviting for erosion. The TAMS report identifies 32,800 hectares of this type of land use, but estimates that less than 50 (*sic*) are steeper than 40% slopes. My observations are that most of this land has slopes between 30 and 40%, but at least several thousand hectares are steeper than 45%. To make matters worse, much of this land use is on Immature Brown Loams, soils whose relatively sandy A horizons are very susceptible to erosion and which are quite shallow to begin with. For land steeper than 40% only bench terraces could adequately protect the soil, but these are rarely, if ever, installed. The best conservation measures that I have seen on these lands are rock retaining walls and diversions which are placed so far apart (over 30 m) and at such a steep gradients (10 to 20%) that they are of questionable value. To be effective on these unstable, shallow soils such diversion terraces would have to be built only 3 or 4m apart and adeuqate provision made for the safe disposal of the channeled runoff water. In the Victoria catchment the ineffectiveness of the current practices is seen by the truncated soil profiles, exposed rock, gullies and valley sediments.

Finally, the sediments eroded from soil disturbed by house and road construction may far overshadow that from neglected lands in certain localized water sheds and around the major towns such as kandy. The Galata area settlement scheme south of Gampola is a striking example of the impact of construction activities on a watershed. Perhaps no soil is so susceptible to

erosion as is freshly excavated material, especially when it is dumped in steep piles. Nowhere, whether on private or government sponsored construction sites, did I see any effective measures being taken to minimize erosion from these activities.

Watershed management must extend to all classes of land use in a catchment or the desired benefit cannot be realized.

RECOMMENDED PRACTICES TO CONTROL SHEET EROSION

Site preparation and planting must be carefully performed. Otherwise afforestation may, in the short run at least, increase rather than decrease soil loss. It should be realized that just because trees have been planted on a slope, that slope is not instantly forested and erosion does not cease. From observing plantations of various ages, I would estimate that it takes from 8 to 12 years for *Pinus caribaea* to establish enough of a canopy and litter layer to effectively stem erosion on Upper Catchment sites. Closer tree spacing will hasten cnaopy closure and litter development. Thus on slopes steeper than 40% the 6ft. $\times$6ft. is preferable to 8ft. $\times$8ft. spacing. The Forest Department personnel currently are doing a good job of achieving spacings on this order. Fire, cattle, drought etc., make re-supplying trees desireable on many sites.

The more fertile and better water holding capacity sites encourage more rapid development of protective cover. On the most degraded, infertile sites fertilization at planting time or even after establishment may give worthwhile results. The need for fertilizer should be based on soil tests, but field fertility experiments also need to be conducted to determine at what soil test levels a significant growth response to fertilizer is likely by the species being planted. In the meantime the following *tentative guidelines* could be applied.

Sites where erosion has been severe and where the natural vegetation is sparse should be sampled for soil testing. One composite sample composed about 15 small subsamples well mixed together should suffice to represent 20 to 30 hectares of relatively uniform land. Soil tested at the Central Agriculture Research Institute and found to contain less then 0.09% total nitrogen and/or less than 3.0 p pm "Olsen" phosphorous could be given 30 kg/ha of N and/or 12 kg/ha of P, respectively. This could be applied as about 22g (3/4 oz.) of Urea and/or 40g ($1\frac{1}{2}$ oz) of single super phosphate in each planting hole if trees are planted 1.8m $\times$ 1.8m. (6 feet) apart. Good mycorrhizal infection should obviate the need for phosphorous fertilizer on pines. *Albizia* may respond to small additions of lime or potash where soil test values (in m.e./100g) are below 1.0, 0.5 and 0.1 for Ca, Mg and K, respectively. This should also be investigated.

On sites with only a sparse cover of natural vegetation, consideration should be given to establishing a tempory ground cover of creeping legumes which would protect the soil and enrich it in nitrogen. This is similar to the practise used in establishing rubber plantations. It should be considered for forest plantations only where the existing vegetation covers less then 50% of the soil surface. If the soil is extremely low in phosphorous (less than 3.0 p pm. by the Olsen test), the legume seeds should be coated with super hosphate after inoculation with the appropriate rhizobia. Some possible species for trial as groundcovers are : *Centrosema pubescens Calapagonium muconoides, Stylosanthus gracilis* and *Pueraria phaseoloides*. These can usually be established simply by broadcasting the seed on moist soil. The establishment of groundcover is probably justified on fewer than 10% of the likely forest planting sites in the Upper Catchment.

Some planting sites on abandoned agricultural land near Victoria Falls and Lakadagala and the steeper slopes near Yakadagoda would be good areas for this special treatement.

To minimize soil loss during site preparation and planting every effort should be made to disturb as little of the soil surface as possible. Even on the more stable soils, if the slope is over 40% no more than 5% of the soil surface should be disturbed. On a 30% slope disturbance of upto 20% of the surface could be tolerated. Greater soil disturbance will result in a major increase in soil loss during the first few rainstorms after site preporztion is carried out. Strip weeding as sometimes practiced in Upper Catchment forest plantings exposures more soil than is desirable. With trees spaced at 8 ft. × 8 ft. and a 3 ft. wide strip cleared of weeds, the result is disturbance of nearly 40% of the surface. This is alright for a 20% slope, but not on a 45% slope. An alternative is the patch weeding technique with only a circle 3ft. in diameter around each tree being freed of weeds. With 8 ft. × 8 ft. spacing this would disturb 10% of the surface. With 6 ft. × 6 ft. spacing it would be 20%. Using a 2 ft. diameter patch the corresponding figures would be 5% and 9% of the surface disturbed. On slopes steeper than 45% and spacings closer than 8 ft. × 8 ft., a 2 ft. diameter patch size should be favoured. In some cases I have seen more than half of the entire slope surface cleared of vegetation during site preparation. In such cases the Forest Department generally piles the cleared vegetation, mostly grass, into windrows placed along the contours. While these windrows may have a slight effect on lowing down runoff, it would be more desirable from a soil conservation viewpoint to spread this dead vegetation evenly around the trees as a mulch.

Because protecting the soil from raindrop impact is so central to watershed management, the focus in reforestation site treatment must be on maintaining as complete a cover as possible. Removal of vegetation and mechanical disturbance of the soil should be kept to the absolute minimum necessary to successfully establish the tree seedlings. In this regard the use of herbicides has distinct advantages over mechanical weed control. The soil would be undisturbed and the killed vegetation would remain in place to protect the soil. While oposition to the use of herbicides in reforestation programs is often voiced in Sri Lanka on environmental grounds, it should be noted that these chemicals are widely used on tea and paddy lands in the same watersheds. In forestry work, a herbicide such as " Round-Up " which is systemically absorbed by the plants on which it is sprayed, could be used in ultra-low volumes on only the 10% of the land area immediately around each planting hole (applied prior to planting). Under these conditions it is very unlikely that significant runoff of the herbicide would occur.

A final point with respect to maintaining ground cover to control sheet erosion is that absolute protection must be provided against grazing and uncontrolled fires. Grazing not only removes vegetative cover, but it also compacts the soil, thus lowering its infiltration capacity. Cattle paths (and human footpaths) can also channelize runoff and turn into gullies. Fire protection efforts should concentrate on protecting the *perimeter* of a planting area by the establishment of effective fire-breaks. Carefully controlled, fire can even be used as a tool to maintain such fire breaks. The practice currently followed by the Forest Department is the removal of all plant material from around the seedlings to prevent fire damage. As can be seen from this discussion, this is not a good conservation practice. If the soil in a small patch around a seedling must be left bare, the slope should be leveled by constructing a small " patch terrace ". For patches larger than $2\frac{1}{2}$ ft. in diameter and on slopes steeper than 60% some support for the lower edge of the " fill " part of the patch terrace may need to be provided by a few rocks or bundles of brush anchored by stakes (see Figure 1.)

On land that has previously been in tea or other cultivations some terraces, usually constructed of rock, may still exist. Where it would not greatly distort the planting pattern,

an effort should be made to use these terraces and plant as many seedlings as possible on the deeper, more level micro-sites behind such terrace walls.

RECOMMENDATIONS FOR GULLY EROSION CONTROL

The maintenance of a good forest canopy and litter layer along with the elimination of grazing is normally sufficient to prevent the formation of new gullies. Unfortunately, much of the land allocated for reforestation is already scared by gullies and ravines and these must be given conservation treatment or else they will go on eroding and enlarging despite reforestation.

There are two main principles to gully control and where possible both should be acted upon simultaneously (Gil, 1979). The first principle is to reduce, as much as possible, the amount of water that flows through the gully during a storm. The second is to stabilize the gully itself and trap as much of the sediment as possible.

DIVERSION DITCHES

Gullies tend to begin on the lower part of a steep slope and gradually work their way upslope as they deepen and lengthen. This is because more runoff collects in a channel and the flow increases in volume, velocity and turbulence as it proceeds downhill. Long slopes are therefore more susceptable to gullying than short slopes. As water rushes through the gully it undercuts the gully walls causing soil to slough off and the gully to widen. At the same time the torrent scours the soil from the gully floor causing it to deepen. There is usually an abrupt drop at the gully head where runoff water cascades into the gully under-cutting the upper edge and causing it to eat further uphill. These processes can only be stopped by divrting the flow of runoff water away from the gully. The diverted water must be carefully disposed of or it may cause new gullies to form. If no natural drainageway is present it can be gradually spread over a large well vegetated area. Alternatively, it may be encouraged to infiltrate in lock and spill type contour drains.

For a large gully, a diversion ditch of the lock and spill type should be constructed about 3 m. above the gully head and run off to either side at no more than 3% slope. The drain should be dug 40 cm. deep and 50 cm. wide, soil conditions permitting. The excavated material is piled downslope from the drain. Every 4 or 5 m. along the length of this drain a block of soil 30 cm. high (70 cm. below the surface) and 40 cm. thick should be left intact to act as a micro-check dam to trap sediment and give the water more time to infiltrate. This type of structure is safe, however, only on relatively stable soils (generally the reddish or yellowish clays).

In addition, for large gullies, a series of small diversion channels should be constructed in a herringbone pattern along the length of the gully to lead runoff away from the gully walls.

STRUCTURES IN THE GULLY

If a gully is very small or if it is on a relatively gentle slope (less than 15 to 20%) it may be possible to simply fill the gully in or reshape it into a gentle deprssion which can then be seeded and fertilized to form a grassed waterway. Once a thick cover of sod-forming grass is established such a waterway can safely conduct runoff downhill-provided the slope is not too steep. On most of the Upper Catchment forest planting sites the slope are too steep and structures must be built in the gully instead.

These structures are mainly series of small check dams with drop structures that arrest the flow of water, trap sediment, and protect the gully floor from scouring. The number of dams, their dimensions and the distance between them will depend on conditions of soil stability, slope size of gully and size of the catchment leading to the gully. This report will provide generalized guidelines for construction of gully check dams. but these may need to be modified according to conditions. If structures appreciably larger than that described below are needed or if gullies larger than 4 m across at their widest point are encountered, the services of a soil conservation engineer should be obtained to assit the Forest Department personnel. *Large structures can be ineffective and even dangerous if improperly constructed,* It should also be noted that structural treatment of gullies should always be accompained by vegetative treatment to stabilize the gully walls and floor.

Gully control check dams can be constructed according to a wide range of techniques and using many materials. To be appropriate for use in the Upper Catchment reforestation program the construction techniques should be smiple and the materials primarily available on the site. Two such types of check dams are :—

(1) loose rock check dams and

(2) brush check dams.

Where rocks are available on site, type (1) is the method of choice for gullies wider than 1m. The check dam with drop structure should be constructed as shown in Figure 2. Note that large stones should be used to give stability to the structure. The largest stones should be used for the crest of the dam as this is where the full force of flow water will be felt. For a 1.0m high dam these stones should weigh at least 30 to 40 kg (65—90 ld) each. Small stones are used to fill in the voids between larger ones and as a base/backslope for the dam (see Figure 2). The dam wall is not built quite vertical, but leans slightly upslope. Its foundation should extend below the gully floor to a depth about 1/3 of its height, ie. a 1.5m. high dam should have an additional 50cm below the level of the gully floor. The dam is also to be anchored into the guly walls at least 25cm to avoid wash-out around the edges. For the same reason it is also essential that the height of the dam be 50cm lower in the center than at the edges. The spillway so formed should be made of the largest stone available. On the downslope side of the dam an apron or splash pad is constructed of large stones anchored in the gully floor. These will absorb the impact of the cascade of water rushing over the spillway during peak storm runoff. A similar apron should be installed at the gully head to stop undercutting and furhter uphill growth of the gully. The height of the dam can be built up with an additional coarse of large stones after sediment has filled in up to the top of the spillway. The gully walls should be planted to trees and grass (especially *Erogrotis spp.*). Once appreciable sediment has accumulated behind the dams, trees should be planted on this also.

For very minor gullies or where stone is not available on site, brush check dams may be advisable. These can be constructed along the lines illustrated in Figure 3 and 4. Two types of brush dams would be appropriate for project applicaions. These are the single row and double row types. In either case the upright members should be about 0.1 times as thick as they are long. They should be driven to a depth below the gully floor equal to $\frac{1}{3}$ their overall length.

In a single row brush check dam 3 or 4 thick posts are driven vertically baout 20cm apart in the center of the gully. Additional, somewhat thinner posts are driven in at 20cm intervals up to the gully walls, as shown. Brush is then cut, preferably from less useful species, and

hooked around these uprights with the bulk of the material trailing down slope. Successive layers of brush are pressed down firmly by jumping on them. When the brush pile is near the final height care must be taken to make the center of the dam 50 cm lower than the edges. The brush is then tied down to 2 sticks from a V—shapped spillway. Soil or gravel is then piled on the upslope side of the dam to form a backslope.

To build a double row brush check dam, two rows of uprights as described above are driven in across the gully. The space between the two rows should be about 1/3 the height of the dam. Brush is then woven in and out of the uprights and pressed down firmly. Layer upon layer is built up with care taken to form a spillway in the center 50cm lower than the edges.

By making the upright supports out of species whose cuttings will take root, a "living check dam" will result and remain effective even after dead logs would have decayed. Some locally common species for this purpose are *Gliricidia, Bovidia* and *Zizpyrus*.

The proper spacing between successive check dams in a gully can be determined from Table 1. Use the slopes given in the first column for relatively unstable soil and those in the second column for more stable soils. The table is based on the relationship :—

$$D = \frac{H}{S_1 - S_2} \text{ where}$$

D = horizontal distance between check dams (in meters)

H = height of dam at lowest point (m)

S_1 — slope of gully floor (m/m)

S_2 — slope assumed to be stable as a waterway with vegetation.

For "stable soils", S_2 is assumed to be 20%. For "unstable soils" it is 10%. The assumed stable slope can be estimated by observing what is the steepest vegetated slope not showing erosion on a particular type of soil.

Probably only 15% of the Upper Mahaweli reforestation planting sites have gullies, but where they do occur they should be treated. The Forest Department could help justify the additional expense and effort by listing in the Conservator's Annual Report, the number of "check dams constructed", "gullies controlled", or "acres protected with soil conservation measures".

EROSION HAZARDS DURING TIMBER HARVEST

Although not directly affecting this project, erosion hazards during logging should be addressed by the Forest Department in order to preserve the gains made by their protection planting program. The State Timber Corporation and the Forestry Department should co-operate in establishing systems of harvest which will keep soil erosion to a minimum when the time comes to harvest the Upper Catchment plantations. This should include proper design and drainage of logging roads and the use of low impact logging systems such as up-hill cable skidding rather than downhill animal or tractor skidding.

Another area of concern with respect to harvesting is the protection of existing forests. These occur mostly on the steepest lands and often line the natural drainage way. A program for providing sufficient fuelwood to tea estate workers is clearly necessary to halt the illicit cutting by tea workers desperate for cooking fuel. Abundant fuelwood could be produced on tea estates either by interplanting trees with tea more intensively than is done at present or by retiring the steepest and poorest tea fields and devoting them to forestry.

TABLE I

HORIZONTAL DISTANCES BETWEEN SUCCESSIVE CHECK DAMS IN GULLIES OF VARIOUS SLOPES ON STABLE AND UNSTABLE SOILS(1)

Slope (%)		*Distance Between Successive Dams* (*m*)(2)					
Unstable	*Stable*	0.5*m. high dams*		1.0*m. high dams*		1.5*m. high dams*	
15 ..	25 ..	10.0 ..	(10.0) ..	20.0 ..	(20.0) ..	30.0 ..	(30.0)
20 ..	30 ..	5.0 ..	(5.0) ..	10.0 ..	(10.0) ..	15.0 ..	(15.1)
25 ..	35 ..	3.3 ..	(3.3) ..	6.7 ..	(6.8) ..	10.0 ..	(10.1)
30 ..	40 ..	2.5 ..	(2.5) ..	5.0 ..	(5.1) ..	7.5 ..	(7.6)
35 ..	45 ..	2.0 ..	(2.1) ..	4.0 ..	(4.1) ..	6.0 ..	(6.2)
40 ..	50 ..	1.7 ..	(1.8) ..	3.3 ..	(3.4) ..	5.0 ..	(5.2)
45 ..	55 ..	1.4 ..	(1.5) ..	2.8 ..	(3.0) ..	4.3 ..	(4.6)
50 ..	60 ..	1.3 ..	(1.4) ..	2.5 ..	(2.7) ..	3.8 ..	(4.1)
55 ..	65 ..	1.1 ..	(1.2) ..	2.2 ..	(2.4) ..	3.3 ..	(3.6)
60 ..	70 ..	1.0 ..	(1.1) ..	2.0 ..	(2.2) ..	3.0 ..	(3.4)
65 ..	75 ..	0.9 ..	(1.0) ..	1.8 ..	(2.1) ..	2.7 ..	(3.1)
70 ..	80 ..	0.8 ..	(0.9) ..	1.7 ..	(2.0) ..	2.5 ..	(2.9)
75 ..	85 ..	0.8 ..	(0.9) ..	1.5 ..	(1.8) ..	2.3 ..	(2.7)
80 ..	90 ..	0.7 ..	(0.9) ..	1.4 ..	(1.7) ..	2.1 ..	(2.6)

(1) Relatively *stable* soil sin the Upper catchment include most Red — Yellow Podzolic clays and sandy clay loams and most Reddish Latosolic clay and sandy clay loams. The assumed stable slope (S^1) for these soils is 20%. Relatively *unstabpe* soils include Immature Brown Loams and soils sandier than sandy clay loam. Soils less than 50 cm. deep are also included in this group. The assumed stable slope (S^2) for these soils is 10%.

(2) Numbers in parenthesis are meters measured along the gully floor rather than along a horizontal plane

ACKNOWLEDGEMENTS

I am most grateful to the many Forest Department personnel who provided excellent co-operation and assistance during the project. Special gratitutde goes to Mr. A. D. R. Ratnarajah, Deputy Conservator of Forests in charge of the project, Dr. K. Vivekanandan, Research Silviculturalist, and Mr. K. Rajapakse, Assistant Conservator of Forests for the Upper Mahaweli. Invaluable advice and assistance was also provided by Dr. J. S. Gunesekera, Head of the Soil Conservation Division in the Department of Agriculture. Appreciation is also due to USAID for financial assistance on the project.

REFERENCES

GIL, N. (1979) — Watershed Development with Special Reference to Soil and Water Conservation. *F. A. O. Soils Bulletin No.* 44

PERERA, N. P. (1969) — The Ecological Status of the Montane Grasslands (Patanas) of Ceylon. *Ceylon Forester*, 9 (1 and 2) : 27 — 51.

TAMS (1920) — *Environmental Assessment Accelerated Mahaweli Development Program*. Vol. II, Mahaweli Authority, Government of Sri Lanka.

6—A67450

The Sri Lanka Forester Vol. 15 (1 *and* 2) *Jan. - Dec.* 1981

Plant Gum Exudates – An Unexploited Forest Resource of Sri Lanka

SUBADRA JAYASINGHE

(*Research Officer*, Ceylon Institute of Scientific and Industrial Research, Colombo 7)

INTRODUCTION

Forests are considered as the main resource of commodities such as timber, fuelwood, and fodder. Apart from these, there are several minor forest resources which are hitherto unexploited in Sri Lanka. The present paper deals with gum exudates which is a source of foreign exchange.

Plants gum exudates such as gum arabic have been articles of commerce from ancient times. Exudates from plants are of two types : water soluble and water insoluble. The water soluble plant exudates are generally referred to as gums. These water soluble exudates or gums are hydrophilic colloids belonging to the class of chemical compounds known as polysaccharides. Gums are generally exuded when the bark of a tree is damaged ; they harden on exposure. These hardended nodules are soluble either in cold or hot water and have specific and characteristic properties. The specific properties exhibited by the plant gums have created a great demand for them in industries such as food and beverages, pharmaceuticals, cosmetics, textiles, lithography and paints. They are used as additives to improve or control the properties of a product. The demand for these natural gums has paved the way to the development of several synthetic and semisynthetic gums. The market for natural gums has been increasing despite the development of many tailor-made synthetic gums.

Plants yielding vegetable gums grow best under tropical climatic conditions, mostly in the arid regions. They need very little care. Many of the trees yield gum in large quantities under adverse conditions, especially during the dry season. Several tropical countries namely Sudan, Iran, India and some other African countries have organized cultivation, collection and export of vegetable gums. Eventhough Sri Lanka has an ideal climate for cultivation of plants yielding gums, no steps have been taken so far to improve the development of this valuable forest resource. Reafforestation programmes can profitably include cultivation of plants such as *Acacia* and *Sterculia*. In addition to providing a commercial commodity these plants can be utilized as fodder for farm animals and as fuelwood.

PLANTS PRODUCING GUM EXUDATES

The most important gum yielding plants belong to the genera *Acacia, Sterculia, Anogeissus* and *Astragalus* (Table 1). There are several other local plants that yield gums. These gums may however not be of a quality as equal to that from the species mentioned earlier.

Species of Acacia

Gum acacia or gum arabic is the oldest and most versatile of natural gums. The 1961 US Food and Drug Administration classified it as being " generally regarded as safe " (GRAS) for use as a food stabilizer. The pharmacopoeiae describe gum arabic as " the dried gummy

TABLE 1

ORIGIN AND MAJOR APPLICATIONS OF THE COMMERCIALLY VALUABLE PLANT GUM EXUDATES

Type	*Origin*	*Botanical family*	*Major Producing Country*	*Major Applications*
1. Gum arabic or Gum aracia	Several species of the genus—acacia (*e.g. A senegal*)	Leguminosae	Sudan	Beer, confectionery lithography
2. Gum tragacanth	Astragalus gummifer and other Asian species of *Astragalus* (not found locally)	Leguminosae	Iran	Pharmaceuticals, salad dressings, dietetic foods
3. Gum karaya	Species of genus *Sterculia* (*e.g. S. urens*)	Sterculiaceae	India	Denture powders, laxatises, textiles, paper, cosmetics
4. Gum ghatti	*Anogeissus latifolia*	Combretaceae	India	Wax emulsions

TABLE 2

SPECIES OF ACACIA FOUND IN SRI LANKA (TRIMEN 1974)

Species	*Locality*	*Comments* (*Anon* 1959)
A. arabica (Willd.)	Trinco, Jaffna	Babul of India, Best Indian Acacia gum. 2 lb. of gum per year (Max. yield). Used in calico printing dying and sizing
A. caeasia (Willd.)	Low country (Dry zone)	Most common climbing Acacia of Sri Lanka
A. dealbata (Link.)	Montane region	Australian species gum is the best Australian substitute for gum arabic
A. decurrens (Willd.)	Montane region	Australian species yield black wattle planted for green manure and as wind brackes
A. eburnea (Willd.)	Common in Trinco, Hambantota District, Jaffna, whole of west coast upto Puttalam	Common in dry and desert regions
A. farnensiana (Willd.)	Low country	Australian species, flowers are used in Cannes, (France) to yield cannes perfume
A. ferrugienea (DC)	Dry region, Anamaduwa	Yields a reddish brown gum similar to gum arabic
A. leucophloea (Willd.)	Common in dry region	Gum used in India for indigenous medicine. Bark is known on Velam bark, exported to India
A. melanoxylon (Br.)	Common in Nuwara-eliya	Introduced species
A. pennata (Willd.)	Kalutara, Haragama	Woody climber
A. planifrons (W & A)	Mannar	Umbrella Tree of the English. It composes a whole forest in Mannar. Exported to South India for fuelwood
A. sundra (DC.)	Between Mannar and Vavuniya	—
A. tomentosa (Willd.)	Kalpitiya, Jaffna, Mannar	—

exudate obtained from the branches and stems of the plants belonging to the genus *Acacia* of the family-Leguminosae". About 900 species of *Acacia* have been analysed, (Anderson 1977). Analyses have shown that gum from each species differ considerably from that obtained from other species in their chemical and physical properties. Seasonal variations of the physical properties have also been observed within a given species.

Trimen describes fourteen species of the Acacia in Sri Lanka (Table 2).

Gum arabic exported from Sudan comes from the species *Acacia senegal.* The gum from other Acacia species have been observed to be inferior when compared with that of *Acacia senegal.*

Wattle gum gathered in Australia comes from several other species of *Acacia* (Mantell, 1947). Many of these species are found in Sri Lanka (Table 2). Wattle gum is observed to be hard and transparent. Apart from gums, these plants yield tanning materials. Their trunks and branches can be used as timber, firewood or fodder.

Species of Sterculia

Gum karaya is derived from *Sterculis urens* of the family-Sterculiaceae.

Along with *S. urens,* five other Sterculia species are found in Sri Lanka (Table 3). It is reported that *S. foetida,* which is also found locally yields a gum similar to gum karaya.

TABLE 3

SPECIES OF STERCULIA FOUND IN SRI LANKA (TRIMEN 1974)

	Species	*Locality*	*Comments* (*Anon.* 1959)
1.	S. foetida L.	Low country	Common in dry region, yields a gum, which is used in book binding in India
2.	S. urens Roxb.	Uma oya, Bintenna, Haragama	Rather rare
3.	S. guttata	Raitunwella, Ambegamuwa, Eratne Kuruwita Korale	Yields a gum that resembles gum tragacunth
4.	S. balanghas L.	Low country	Common
5.	S. colorata Roxb.	Trincomalee, Nilgala, Kurunegala, Dambulla	Inner bark yields a fine fibre
6.	S. thwaitesii	Dry or intermediate country	Very rare

Although synthetic substitutes have been found for gum acacia and gum tragacanth, no such substitutes have been found for gum karaya.

TABLE 4

PLANTS PRODUCING GUMS OF MINOR IMPORTANCE (TRIMEN 1974)

	Plant	*Family*	*Locality*	*Comments* (*Anon*, 1959)
1.	*Cochlospermum religiosum* (S. kinihiriya or Elaambul)	Bixaceae	Dry districts	Yield katira gum, substitute for gum tragacanth. Exported in India for use in cigar paste and ice cream industry. The plant used in reafforestation, being fire resistant. Has several other uses.
2.	*Butea frondosa* (S. gaskela)	Leguminosae	Common in dry region Jaffna, Batticaloa, Bibile, Bintenne	Benagal kino, Red in colour water soluble. Plant useful for reclamation of saline soils, reafforestation.
3.	*Woodfordia fruiticosa*	Lythraceae	—	Gum collected in Rajasthan, flowers yield a red dye used for textiles.
4.	*Salmalia maiabarica*	Bambacaceae	—	Gum exudes only due to natural causes, not by artificial wounds. Known as simul gum.
5.	*Sesbania grandiflora*	Leguminosae	Very common in home gardens	Yields a red gum similar to bengal Kino, uses as a substitute for gum arabic.
6.	*Lannea coromandelica*	Anacardiaceae	—	Gum tapped in India, small quantities exported for confectionery, found to possess very good flocculating properties. Plant is drought and fire resitant.
7.	*Aegele marmeles* (S. beli)	Rutaceae	Cultivated plant	Gum is similar to gum arabic.
8.	*Anacardium occidentale*	Anacardiaceae	Plantation crop	Gum used in India, for adhesives, pharmaceuticals, etc.
9.	*Terminalia* speetes	Combretaceae	Very common in Sri Lanka	In India several Terminalia species are tapped for gum. These form a major part of East Indian gums.
10.	*Albizia* species	Leguminosae	Very common in Sri Lanka	Yields a yellow to brown hydrophillic gum. Some species presently used in reafforestation.
11.	*Bauhinia* species	Leguminosae	Common	Gum similar to gum arabic. Used in India for sizing cloth and paper.
12.	*Moringa pterygosperma* (S. murunga)	Leguminosae	Cultivated, common in Jaffna area	The gum is reddish brown in colour, swells in water. Used in India for calico printing.
13.	*Azardarichta indica* (S. khomba)	Meliaceae	Common in dry country cultivated	Gum collected in India.
14.	*Feronia elephantum* (S. divul)	Rutaceae	Common in dry country	Trunk and branches yield a gum which is water soluble. In India it is used as a substitute for gum arabic.

Anogeissus latifolia

Anogeissus latifolia is a tropical tree belonging to the family — Combretaceae. Mantell, (1947) reports that this tree is common in India and Sri Lanka. The gum collected from this plant is commonly referred to as gum ghatti for which there is a demand in several countries. Other members of the family Combretaceae are also reported to yield gums. Commercial interest was shown in these gums during the period 1972-1974, when there was a shortage of gum arabic. The chemistry of gums from several species of this family has been studied. The compositions and properties of these gums were observed to differ from gums from other genera (Anderson, 1978). Possible industrial applications could be identified for these Combretaceae gums, if regular supplies of clean gums are available.

Other plants yielding gums

Apart from the commercially important gums yielding plants, there are several other plants that produce gum exudates.

Some of these less important gums are used in India for cottage industries and some minor gums *e.g.* Gum kutira are reported to be exported. Table 4 lists locally available plants that yield these less important gums.

Eventhough Sri Lanka has a variety of sources of plant gums, no steps have so far been taken to improve this valuable resource.

As a part of the research programme at CISIR, a study of the gum from the cashew trees (*Anacardium occidentale*) has been undertaken (Jayasinghe and Perera, 1981). Cashew is cultivated in Sri Lanka for the production of nuts, but so far no steps have been taken to make use of the gum that exudes naturally from cashew trees.

In India cashew gum is used for local pharmaceutical purposes and in book-binding. Mantell, (1947) states that cashew is not a competitor to gum arabic due to its partial solubility in water and its darker colour. Our investigations have shown that chemically and physically cashew gum has a close relationship to gum arabic. The CISIR method of processing of cashew gum has produced a product free from the undesirable qualities mentioned by Mantell (insolubility and dark colour). Cashew gum when purified yields a completely soluble product which is white in colour.

CONCLUSION

It is evident from the earlier statements that Sri Lanka has considerable resources of vegetable gums. Yet this country imports vegetable gums, for domestic use as well as for utilization in industries. It is therefore worthwile considering the introduction of important gum yielding plants such as Acacia and Sterculia in the re-afforestation programmes. Cultivation of Acacia species can lead to improvement of surrounding soil by nitrogen fixation. It has also been observed that species of Acacia can tolerate adverse ecological conditions and hence are ideal candidates for inclusion in the re-afforestation programme of dry and arid zones.

ACKNOWLEDGEMENT

The work on Plant Gum Exudates forms part of the programme of research of the Ceylon Institute of Scientific and Industrial Research. The author expresses her gratitude to the CISIR Governing Board for permission to submit this article for publication.

REFERENCES

ANONYMOUS (1959) — *The Wealth of India, Raw materials*, Council of Sci. and Indus. Res. ; New Delhi.

ANDERSON, D. M. W. (1977) — Water soluble plant Gum Exudates — Part I : Gum Arabic. *Process Biochemistry* 12, (10), 24-29.

ANDERSON, D. M. W. (1978) — Water soluble Plant Gum Exudates — Part 2 : The Combretum Gums. *Process Biochemistry* 13, (7), 4-18.

JAYASINGHE, S. AND PERERA, M. H. — (1981) — Unpublished work.

MANTELL, C. L. (1947) — *The Water soluble Gums*. Reinhold Publishing Corporation, New York.

TRIMEN, H. (1947) — *A Handbook of Flora of Ceylon*. M/s. Bishen Singh Mahendra Pal Singh, Dehra Dun and M/s. Periodical Experts, Delhi.

The Sri Lanka Forester Vol. 15 (1 *and* 2) ; *Jan.* — *Dec.* 1981

Preliminary Investigations on Vegetative Propagation of Madhuca Longifolia

R. SENARATNE

(Department of Agronomy, Faculty of Agriculture, Ruhuna University, Sri Lanka)

H. M. W. HERATH[1] AND S. BALASUBRAMANIAM[2]

(University of Peradeniya, Peradeniya)

SUMMARY

Investigations on the vegetative propagation of *Madhuca longifolia* (L.) Macbr. were carried out by means of grafting and budding on about one year old seedlings of the same species. Methods tried out in grafting viz. Cleft and Wedge grafting showed no significant difference in the rate and percentage of sprouting and both methods gave a final percentage of success of 87.2. In budding, the treatments effected viz. Patch budding, Modified Forket and H — budding also showed no significant difference in the rate and percentage of aprouting and all the treatments recorded a final success of 100%.

INTRODUCTION

Madhuca longifolia (L) Macbr. is a large deciduous tree with a dense spreading canopy belonging to the family sapotaceae. This species is found in South India and Sri Lanka and it produces seeds regularly and profusely. The seed kernel contains as much as 50% oil which is edible (The Wealth of India, 1962 ; Senaratne, 1980) and oil extracted from fresh mature seeds or seeds which have been stored under proper conditions does not posses any offensive odour or disagreeable taste (The Wealth of India, 1962) ; hence it can be used as a substitute for traditional vegetable oils. The oil can also be used in the manufacture of soap (Choudhury and Mukherji, 1954), margarine and confectionaries (The Wealth of India, 1962). The Physico-chemical properties of oil are such, it could be used as an ingredient in chocolate manufacture (Nakayama, 1969). Moreover, *M. longifolia* could yield contructional timber (The Wealth of India, 1962).

In view of its valuable uses, *M. longifolia* shows promise as an agro-industrial crop. In exploitation of this species, it is important to get true-to-type plants with short vegetative period. In this context, vegetative propagation becomes important. However, attempts made to propagate *M. longifolia* by means of cuttings and layering have been unsuccessful (Senaratne, 1980). Under these circumstances, investigations were carried out to ascertain the possibilities of propagating *M. longifolia* by budding and grafting.

---

1 Professor of Agricultural Biology.

2 Associate Professor of Botany.

MATERIALS AND METHODS

Grafting:

A batch of mature seeds of *M. longifolia* were collected from a healthy tree in the Kurunegala District and were sown at the Horticulture Nursery of the Central Agricultural Research Institute at Gannoruwa in October, 1978. When seedlings were about one month old, they were transplanted in the field at a spacing of 45 cm. — 30 cm. Once the seedlings attained a diameter comparable to that of a pencil (which occured about one year after transplanting), two treatments namely whip grafting and cleft grafting were done at rendom in a randomised block design with three replicates. Each treatment comprised of 39 seedlings. Scions (12 cm.) used for grafting were taken from a tree after defoliation so that the apical buds were in a state of dormancy. Once the grafting was complete, each scion was covered with an inverted polythene bag and the open end was tied to the stock to prevent desiccation of the scion (These coverings were removed 21 days after grafting). Number sprouted in respect of each treatment was recorded from the fourteenth day onwards at short intervals to ascertain whether there were any differences in the rate of sprouting between treatments. This experiment was conducted at Gannoruwa from October 1978 to March, 1980 during which experimental blocks were kept weed free and watered whenever necessary.

Budding :

Raising of seedlings in the nursery, transplanting and after-care operations were done as described under grafting. When the seedlings attained approximately pencil thickness (which occured nearly one year after transplanting), three treatments viz. H — budding, Patch budding and Modified — Forket budding were done on plants at random. Each treatment comprised of 15 seedlings was replicated 3 times. Scions (Bub patch, 2 cm.) for the above purpose were obtained from *M. longifolia* branches with semi-hard wood. After budding each bud patch was wrapped on to the stock firmly by means of a polythene tape (30 cm. × 1 cm., 300 guage). Three weeks after budding the tape was untied and wrapped again so as to expose the bud facilitating its growth. Four weeks after budding, the stocks were cut off about 2.5 cm. above the point of union so as to have a cut sloping away from the bud. Number sprouted in respect of each treatment was recorded from the first month onwards at short intervals to ascertain whether there were any differences in the rate and percentage of sprouting between treatments.

This experiment was also carried out at the Horticulture Nursery of the Central Agricultural Research Station at Gannoruwa from October, 1978 to March, 1980.

RESULTS AND DISCUSSION

In the grafting experiment buds of the scions remained dormant for more than two weeks after grafting in respect of both treatments. But buds started sprouting after the 15th day and the numbers sprouted on the 20th day in respect of cleft and whip grafting were 10 and 12 out of 39 grafts with corresponding percentages of 25.6 and 30.8 respectively (Table 1 and 2). However, after the 20th day, the percentage sprouting increased progressively and on the 27th day, it was 66.7 and 82.1 as regards Cleft and Whip grafting respectively. On the 46th day after grafting the numbers sprouted in respect of Cleft and Wedge grafting were 33 and 34 giving rise to percentages of 86.4 and 87.2 respectively. The total number taken in the case of both treatments was 34 out of 39 grafts giving rise to a total percentage success of 87.2. Though there were differences in the percentage of sprouting between treatments on 20th, 27th and 46th day after grafting, they were not statistically significant (Fig. 1). Hence it is evident that scions of

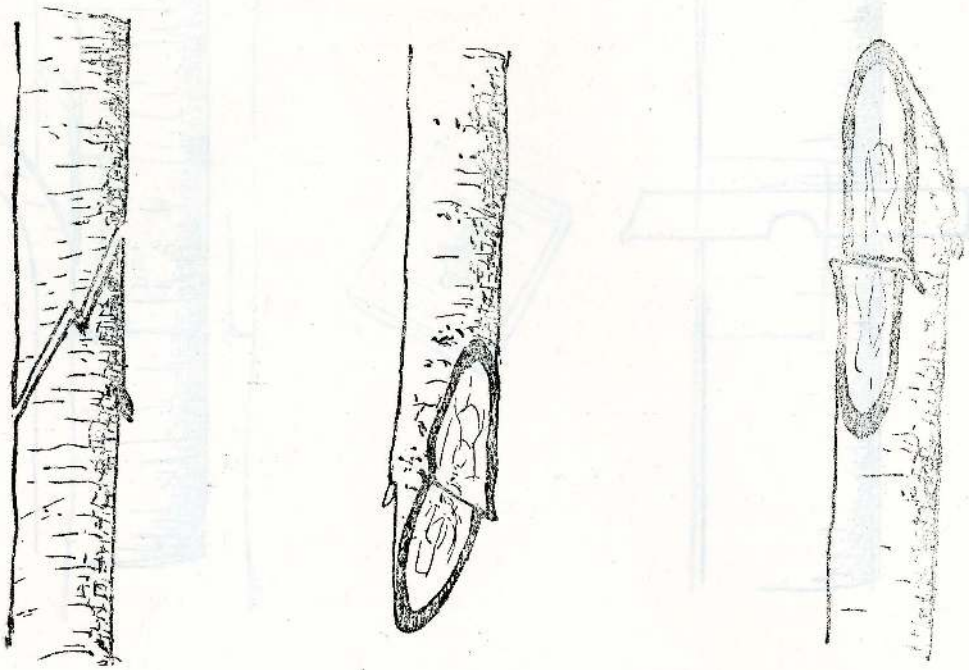


Fig 1—Whip Graft

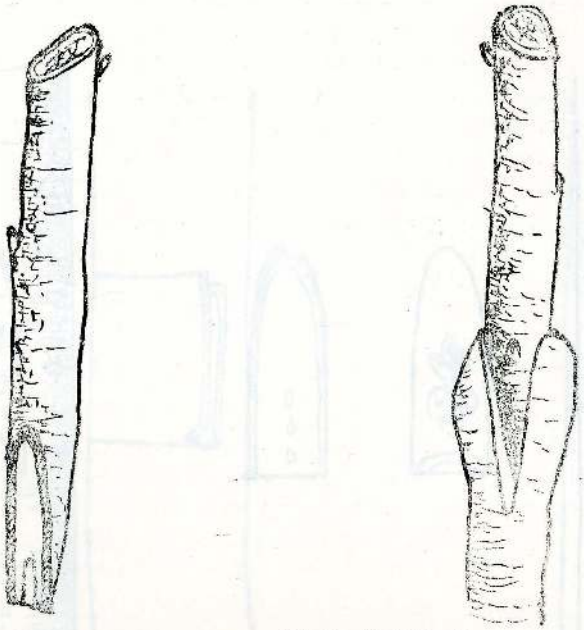


Fig 2 - Cleft Graft

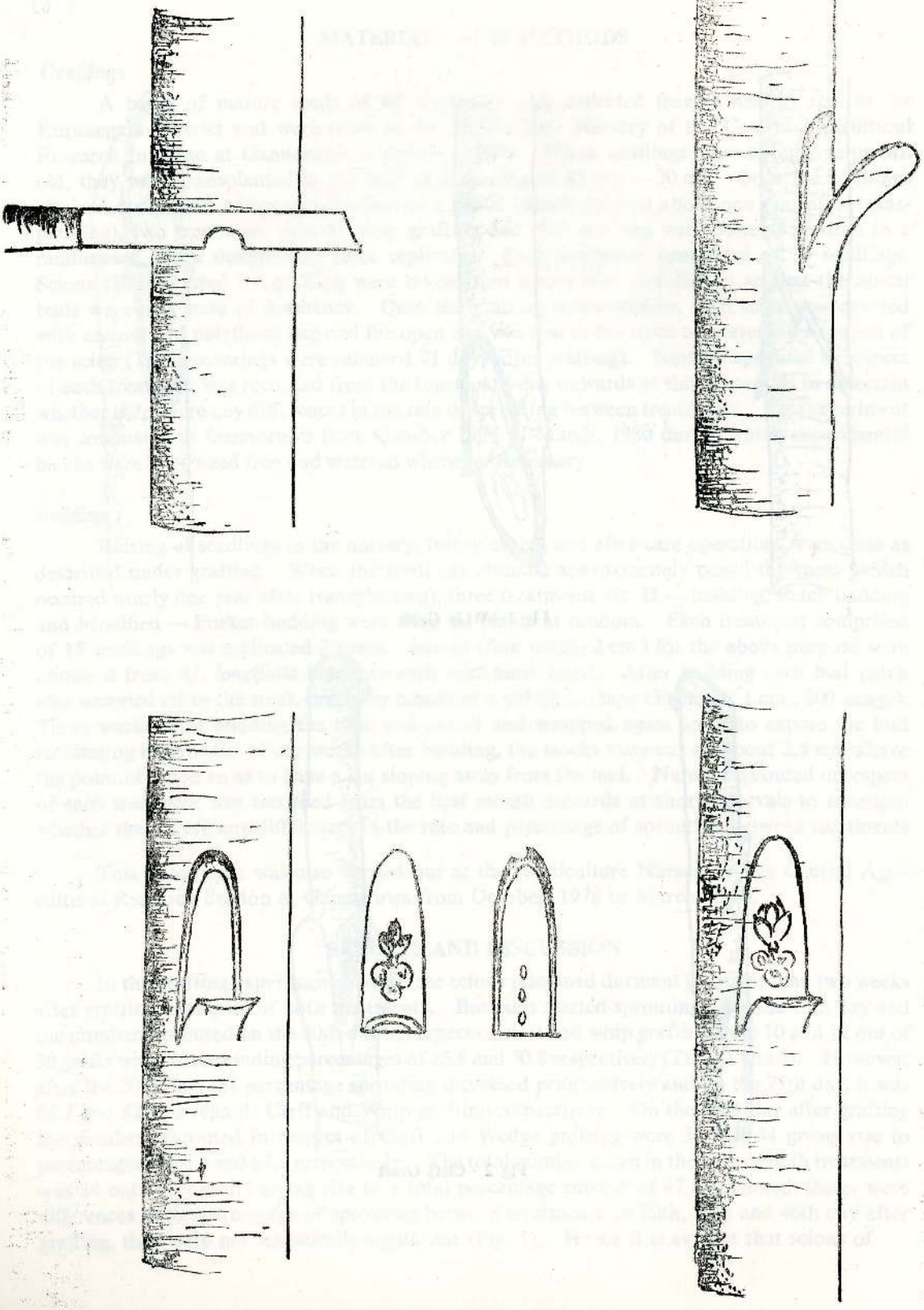
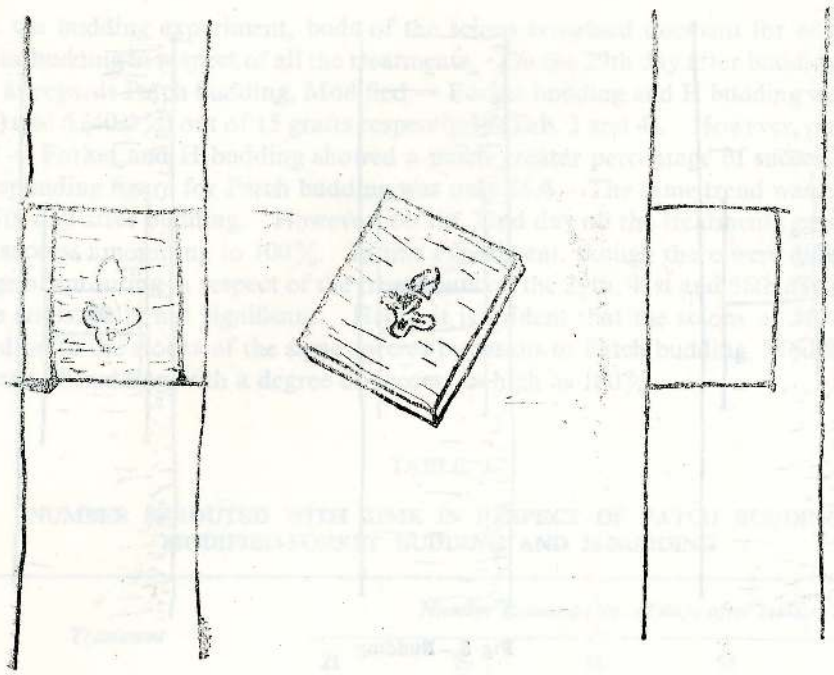


Fig 3—Modified Forket Budding



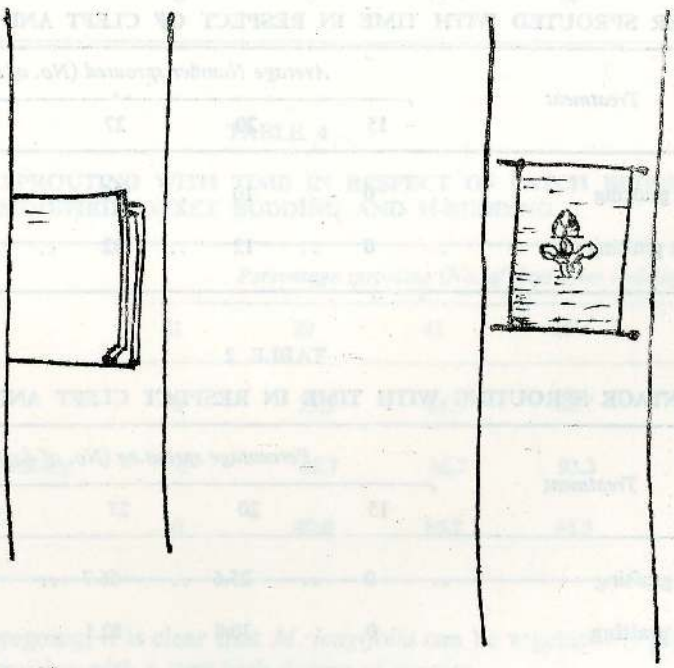


Fig 4—Pat h Budding

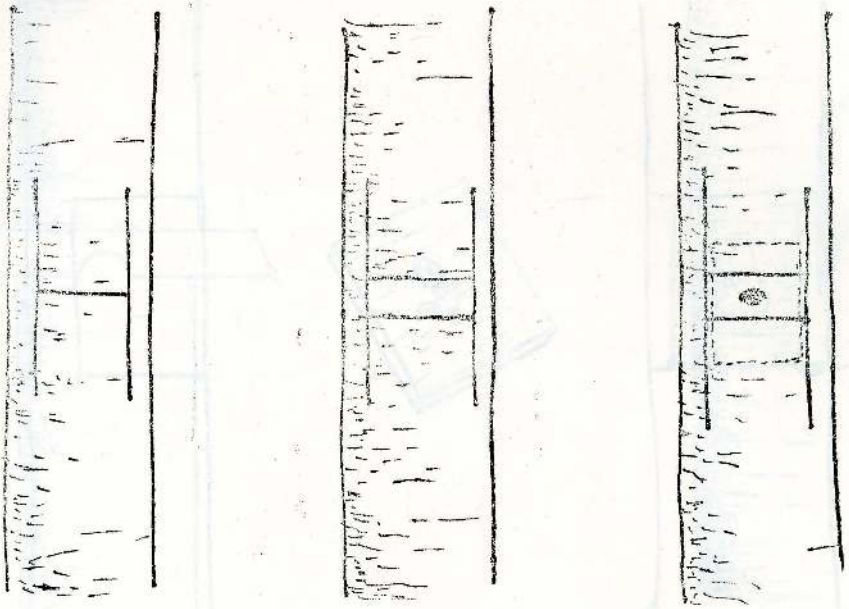


Fig 5—Budding

M. longifolia can be grafted on to the stocks of the same species by means of Cleft and Whip grafting with a degree of success as high as about 87%.

TABLE 1

NUMBER SPROUTED WITH TIME IN RESPECT OF CLEFT AND WHIP GRAFTING

Treatment	Average Number sprouted (No. of days after graft.ng)				
	15	20	27	46	58
Cleft grafting	0	10	26	33	33
Whip grafting	0	12	32	34	34

TABLE 2

PERCENTAGE SPROUTING WITH TIME IN RESPECT CLEFT AND WHIP GRAFTING

Treatment	Percentage sprout.ng (No. of days after graft.ng)				
	15	20	27	46	58
Cleft grafting	0	25.6	66.7	86.4	87.2
Whip grafting	0	30.8	82.1	87.2	87.2

In the budding experiment, buds of the scions remained dormant for more than three weeks after budding in respect of all the treatments. On the 29th day after budding the numbers sprouted as regards Patch budding, Modified — Forket budding and H budding were 5 (33.3%), 7 (46.7%) and 6 (40.0%) out of 15 grafts respectively (Tab. 3 and 4). However, on the 41st day, Modified — Forket and H budding showed a much greater percentage of success (86.7) whilst the corresponding figure for Patch budding was only 66.6 The same trend was observed even on the 55th day after budding. However, on the 72nd day all the treatments gave an identical figure of success amounting to 100%. In this experiment, though there were differences in the percentage of sprouting in respect of the treatments on the 29th, 41st and 55th day after budding they were statistically not significant. Hence it is evident that the scions of *M. longifolia* can be budded on to the stocks of the same species by means of Patch budding, Modified — Forket budding and H budding with a degree of success as high as 100%.

TABLE 3

NUMBER SPROUTED WITH TIME IN RESPECT OF PATCH BUDDING, MODIFIED-FORKET BUDDING AND H-BUDDING

Treatment	*Number sprouted (No. of days after budding)*				
	21	29	41	55	72
Patch budding	0	5	9	13	15
Modfied-Forket budding	0	7	13	14	15
H-budding	0	6	13	14	15

TABLE 4

PERCENTAGE SPROUTING WITH TIME IN RESPECT OF PATCH BUDDING, MODIFIED-FORKET BUDDING AND H-BUDDING

Treatment	*Percentage sprouting (No. of days after budding)*				
	21	29	41	55	72
Patch budding	0	33.3	66.6	86.7	100.0
Modified-Forket budding	0	46.7	86.7	93.3	100.0
H-budding	0	40.0	86.7	93.3	100.0

In view of the foregoing, it is clear that *M. longifolia* can be vegetatively propagated by means of budding and grafting with a very high degree of success.

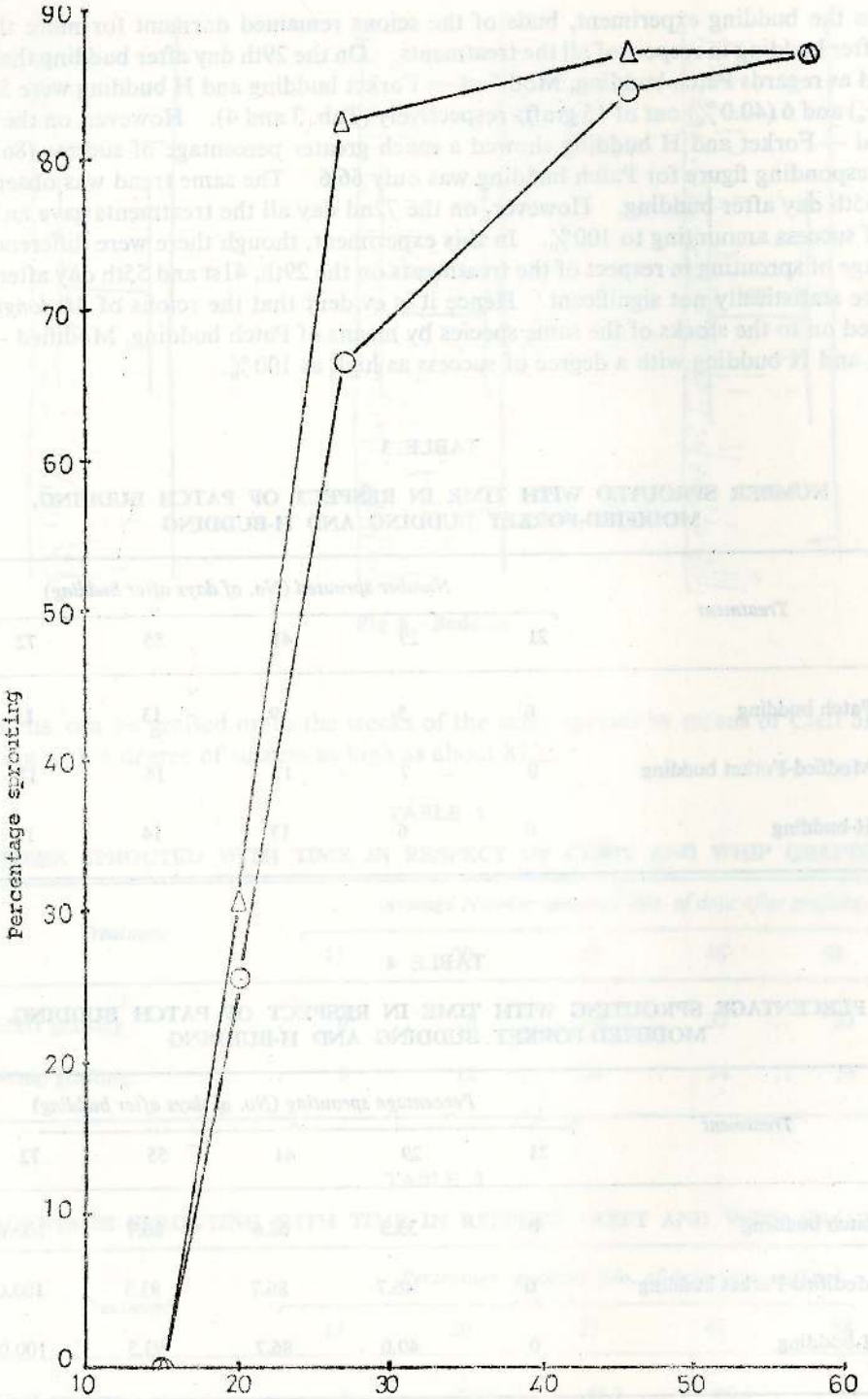


Fig. 6 ! Percentage sprouting with time in grafting experiment 1.
(△—△) whip grafting (○—○) cleft grafting.

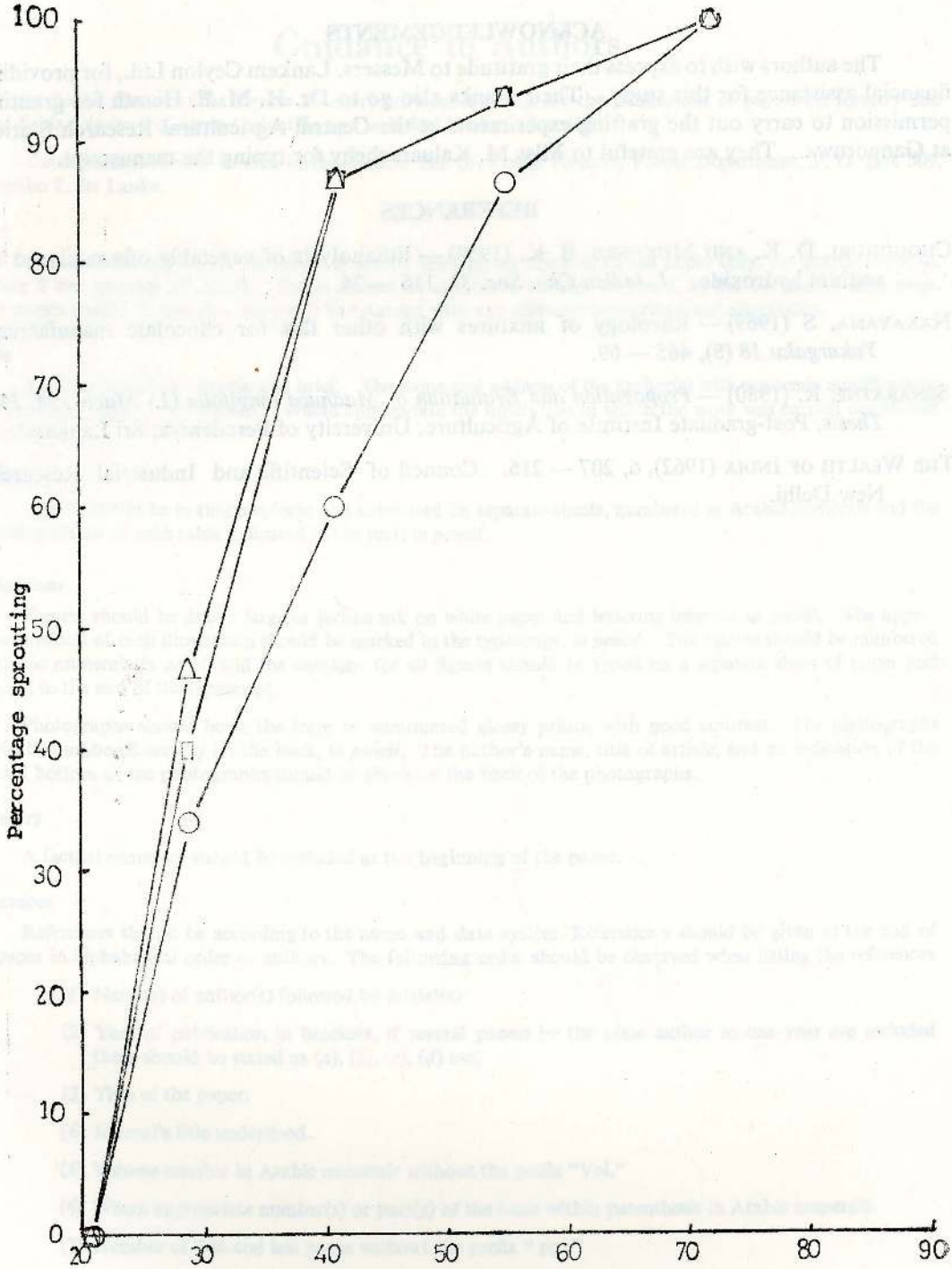


Fig. 7 ! Percentage sprouting with time in budding experiment 2.

(○-○) Modified Forket budding, (△—△) **Patch budding,** (□—□) **budding.**

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Messers. Lankem Ceylon Ltd., for providing financial assistance for this study. Their thanks also go to Dr. H. M. E. Herath for granting permission to carry out the grafting experiments at the Central Agricultural Research Station at Gannoruwa. They are grateful to Miss M. Kaluarachchy for typing the manuscript.

REFERENCES

CHOUDHURI, D. K. AND MUKHERJI, B. K. (1954) — Ethanolysis of vegetable oils catalysed by sodium hydroxide. *J. Indian Che. Soc. 31*, 116 — 24.

NAKAYAMA, S (1969) — Rheology of mixtures with other fats for chocolate manufacture. *Yukargaku 18* (8), 465 — 69.

SENARATNE, R. (1980) — *Propagation and Evaluation of Madhuca longifolia (L) Macb . M. Phil Thesis*, Post-graduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

THE WEALTH OF INDIA (1962), *6*, 207 — 216. Council of Scientific and Industrial Research, New Delhi.

Guidance to Authors

THE Sri Lanka Forester (*The Ceylon Forester*) provides a means for the publication of papers on forestry and allied fields ; reviews of current scientific and technical books and articles.

Contributions should be sent to the Editor, *The Sri Lanka Forester*, Forest Department, P. O. Box 509, Colombo 2, Sri Lanka.

Text

All contributions should be typed in double spacing, on one side of the paper only, on quarto (or A 4), leaving 2 cm. margins all round. Sheets should be numbered serially, *In pencil*, at the bottom of each page. Two copies should be sent in-a copy will be returned with any editorial corrections and alterations.

Title

The title should be specific and brief. The name and address of the author(s) with academic qualifications and position held should be given. Where appropriate the institution in which the work was carried out should be included.

Tables

Tables should be in simplest form and submitted on separate sheets, numbered in Arabic numerals and the desired position of each table indicated in the text, *in pencil*.

Illustrations

Figures should be drawn large in Indian ink on white paper and lettering inserted in pencil. The appropriate position of each illustration should be marked in the typescript, *in pencil*. The figures should be numbered in Arabic numerals *in pencil* and the captions for all figures should be typed on a separate sheet of paper and fastened to the end of the typescript.

Photographs should be in the form of unmounted glossy prints, with good contrast. The photographs should be numbered serially on the back, *in pencil*. The author's name, title of article, and an indication of the top and bottom of the photographs should be given on the back of the photographs.

Summary

A factual summary should be included at the beginning of the paper.

References

References should be according to the name and date system. Reference s should be given at the end of the paper in alphabetical order of authors. The following order should be observed when listing the references

(1) Name(s) of author(s) followed by initial(s)·

(2) Year of publication in brackets, if several papers by the same author in one year are included these should be stated as (*a*), (*b*), (*c*), (*d*) etc.

(3) Title of the paper.

(4) Journal's title underlined.

(5) Volume number in Arabic numerals without the prefix "Vol."

(6) Where appropriate number(s) or part(s) of the issue within parenthesis in Arabic numerals.

(7) Number of first and last pages without the prefix " pp ."

e.g.—VIVEKANANDAN, K. (1979) —Performance of Provenances of Eucalyptus in the dry zune, *Sri Lanka Forester*, 14 (1&2):49 — 57.

The titles of journals should be abbreviated as in *The World List of Scientific Periodicals.* If in doubt leave it to the editor.

When reference is made to a book the title should be underlined, the edition, volume number (wherever appropriate), page(s) (p or pp.), the publisher and the town of origin should be given in the following order :

e.g.—TROUP, R. S., (1921) —*The Silviculture of Indian Trees.* 1st Edn. Vol. 1. p. 30. Clarendon Press, Oxford.

In the text references must be made by giving in brackets the name of the author and year of publication *e.g.* (Troup 1921). When the author's name is part of the sentence it should be given as " ..... Troup (1921) ..... "

ගසක් වවන්න
மரமொன்றை நடுங்கள்
PLANT A TREE