

The CEYLON FORESTER

Vol. V, No. 3 (New Series)

January-June, 1962



Published by the Forest Department, Ceylon

PRINTED AT THE GOVERNMENT PRESS, CEYLON

Price : Rs. 3

OUR CONTRIBUTORS

L. C. A. Wijesinghe—Junior Assistant Conservator of Forests, Division of Forest Education.

A. S. A. Packeer—Acting Warden, Department of Wild Life.

W. R. H. Perera—Assistant Conservator of Forests, Division of Forest Research.

G. Sidorov—Geographer, U. S. S. R.

D. S. Wimaladasa—Forest Guard.

THE CEYLON FORESTER

The Ceylon Forester is published biannually by the Forest Department, Ceylon.

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

The Hony. Editor,
The Ceylon Forester,
Forest Department,
9, Kew Road,
Colombo 2.

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Subscriptions—

	Rs.	c.
Annual	5	00
Single copies	3	00

(Special concession rates applicable to Ceylon Forest Department staff will be notified through D. F. O.)

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Hony. Editor .. W. R. H. PERERA
Editorial Office .. FOREST DEPARTMENT
9, KEW ROAD
COLOMBO 2

"The forest is a peculiar organism of unlimited kindness and benevolence that makes no demands 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.

EDITORIAL

THE MERGING OF FORESTRY AND AGRICULTURE

FORESTRY has often been referred to as the 'Foster Mother' of Agriculture. Man's first 'forestry practice' was the 'harvesting' of trees. Only when he realised the value of forests, did he pay heed to the conservation and tending of natural forests, and the growing of trees. Primitive man subsisted by gathering fruits, leaves, and grains in prairies for food. However, once agriculture even in its most primitive form was practised, man started with some sort of rearing of crops—often with disastrous after-effects on the land on which these crops were raised.

Early 'Forestry practices'—or more correctly lack of Forestry practices—which consisted of the haphazard harvesting of timber—resulted in the denudation of many forests and the creation of waste lands. Similarly, primitive forms of agriculture, lack of any form of management of catchment areas serving agricultural land, agriculture on the wrong type of land, has resulted in fertile lands with a luxurious cover of vegetation being turned into deserts or semi-deserts.

As stated earlier, in the early stages of civilisation there was no science of forestry except the 'harvesting' of timber. Forests were destroyed for the practice of a primitive form of agriculture. However, the end result was usually the same—deserts or infertile lands. As man progressed from harvesting to rearing in forestry; one could say that forestry did assume the role of being Foster mother to agriculture during this stage. The main aims of Forestry were conservation, tending and regeneration of forests, and lumbering, commensurate with the demands of conservation. Sound forestry practices did have a tremendous beneficial effect on agriculture and agricultural land which was served directly or indirectly by forested lands.

Early Foresters therefore realised the importance of all aspects of conservation ; which was the foundation or the basic principle on which the science of rational Forestry was built on. However, agriculture as it was practised in its earlier forms did not pay much heed to any principles of conservation. Nor were these principles applied in the practice of agriculture. For instance the primitive form of shifting cultivation as it was and is practised is not concerned about the retention of soil fertility, soil erosion, or the conservation of water.

One could also cite the case of plantation crops where no water or soil conservation principles were applied in practice. One can remember seeing rubber trees, tea bushes, cinnamon, and coconut trees ; 'beautifully aligned' up and down the slopes of hills. Eroded plantations were a common sight. Techniques for natural increase or maintenance of soil fertility were not adopted.

This illustrates that the science of forestry and agriculture had nothing in common in respect of all aspects of conservation in the not too distant past. This picture has changed dramatically in the last few decades. A rubber plantation with contour drains, ridges, and terraces throughout the area, with trees planted along the contour, its dense an unbroken top canopy, its cover—crop carpet—this is 'a rubber forest' which would gladden the heart of any Forester. One could pause to wonder whether the run off is less from this 'rubber forest' than a forest that is being exploited ; with all its extraction paths, and disturbance of soil. What would the comparable balance sheet be as regards soil fertility between such a plantation and a forest ; especially when one considers that in addition to the natural maintenance of soil fertility, artificial fertilisers are poured into these plantations ! How does the conservation practices—and the end result as far as soil fertility is concerned compare between a present day agricultural plantation and a Forest Plantation ?

Today, in an agricultural plantation diverse conservation methods are adopted along with the application of artificial fertilisers. While in a forest plantation, especially those on marginal lands, apart from the application of conservation measures, artificial fertilisers are also often used as in the case of agricultural plantations. Furthermore while irrigation was once solely used by agriculture, irrigated forest plantations are fast becoming a common practice in many countries.

These are examples which illustrate that agriculture has adopted the principles of conservation with the result that the application of these principles (of conservation) have merged in the practice of Forestry and agriculture ;—similarly Forestry has adopted the principles of the application of artificial fertilisers and irrigation in the practice of sound economic forestry.

The application to forestry of certain scientific principles and practices which a few decades ago were solely applied to agriculture has been phenomenal. In some cases while the agricultural practices were advanced, the corresponding forestry practice could have been termed as primitive. Comparing corresponding nursery techniques one finds that permanent agricultural nurseries adopting advanced nursery techniques were in vogue, while forestry still resorted to temporary nurseries without any application of fertilisers, and adopting corresponding primitive forms of pest control and watering. Today the techniques adopted in a permanent

forest and agricultural nursery are the same, all the specialised techniques formerly practised only in agricultural nurseries being adopted in forest nurseries.

The application of the principles of genetics had no comparable practices of any practical consequence before the early thirties. While the breeding of superior strains and species were of paramount importance in agriculture ; these same principles were adopted and practised in forestry only after the nineteen thirties. However, within a short period of thirty years the principle of plant breeding as practised in agriculture has been adopted in forestry—and forest tree breeding—though a long-term project—does not in any way differ from crop breeding in its essentials.

There may be certain branches of forestry in which certain practices would not have any corresponding agricultural practices and vice versa—such as the methods adopted to obtain data for yield calculation in the two sciences. But even this diversity—apparent when one has lumber in mind—disappears when the comparison is between the so-called minor forest products, and agricultural products. However, as far as the main principles of agriculture and forestry are concerned, one sees that while the two sciences had different aims and practices in the past—these practices—have gradually been adopted by each other, till they finally merge with each other.

Could we therefore say that the Forestry and Agriculture are gradually merging with each other into a science of Agro-Forestry ?

SOME ASPECTS OF LAND USE IN THE DRY MONTANE GRASSLANDS

L. C. A. Wijesinghe

THE montane grasslands (*patanas*), which cover an area of about 250 square miles, are of two distinct types, the Dry Montane Grasslands (dry *patanas*) and the Wet Montane Grasslands (wet *patanas*). The dry type is the more widespread occupying nine-tenths of the area. Most of the dry *patanas* fall within the region called the Uva Basin. The rest occur as scattered blocks in the Western Basin: and relatively small extents are also found in the Deniyaya-Rakwana hills and in the Knuckles range (Holmes, 1951). The dry *patanas* are situated at an altitudinal range of 2,000 to 5,000 feet, and unlike the wet *patanas*, they receive rain during one monsoon only.

During recent years development of the dry *patanas*, particularly those of the Uva Basin, has been so rapid that it is no longer correct to speak of the availability of large extents of unused *patana*. This applies only to areas which are suitable for development, and excludes excessively steep and rocky sections for which no suitable form of land use could be found. The *patanas* have been used for (a) agriculture, (b) forestry, and (c) "colonization" and village expansion. As the availability of *patana* land for future development is limited it is essential that planned and improved systems of land use be adopted to ensure optimum utilization of the available land.

The object of this paper is two fold. (1) To study the results of an experiment in improved land use in the dry *patanas*, and (2) To assess the role of afforestation in the development of these areas.

EXPERIMENT IN IMPROVED LAND USE—PASTURE CUM SHELTERBELT SCHEME

Background

Afforestation of the dry *patanas* serves several useful functions. During the period of the south-west monsoon these areas are subject to strong dry winds, and this has effectively retarded their development in the past. Afforestation, both in the form of shelterbelts, and as large compact blocks has resulted in the amelioration of the climatic conditions of the surrounding areas, the forest plantations serving as effective windbreaks. Another useful function of these plantations is to provide timber and fuel for the growing population. Because of these beneficial effects, following on afforestation, there has been a phenomenal increase in the population of these areas resulting in the expansion of towns and villagers. The rapid development of Erabadde and Palugama during the past few years can be attributed almost entirely to the protective effects of the forest plantations which have been established in these areas.

With the increase in population, there arose a demand for pasture land for the villagers to graze their *patanas* regularly, and graze the cattle on the fresh flush which comes up with the rains, as it is only the tender shoots of the indigenous grasses that are palatable to the cattle. It is therefore obvious that this grazing practice is wasteful of land, the grazing potential of *patana* being extremely low. This form of grazing is undesirable also because repeated firing results in soil erosion, which both reduces the fertility of the soil and causes silting of reservoirs and water-courses.

It was against this background that the Pasture *cum* Shelterbelt experiment was conceived. The experiment was an attempt to introduce a good pasture grass into the dry *patanas* in co-ordination with a system of shelterbelts.

Experiment

The Forest Department under the guidance of Mr. Letourneux, an F. A. O. expert, set up model Pasture *cum* Shelterbelt experiments at Harasbadde and Palugama. The former has not been a success where the pasture is concerned. This was due to lack of co-operation from the villagers who repeatedly damaged the fence and let cattle in before the planted grass could get established. The experiment at Palugama, on the other hand, has been a complete success, and the description which follows is that of this experiment.

An area, about forty acres in extent, was selected at Palugama in Wilson's Plains, about five miles from Welimada on the road to Nuwara Eliya. The area is rather unusual, in that it consists of only very gently undulating land with no sharp relief. Consequently the area is ideal for the establishment of a system of shelterbelts based on the standard pattern, namely the primary belts to be at right angles to the wind direction and the secondary belts at right angles to the primary ones.

The climatic and soil conditions of the area are typical of the Uva Basin in which it is situated. The annual rainfall is from 60 to 90 inches, most of which is received during the north-east monsoon, from October to January. The period, May to August, is very dry and the south-west monsoon winds sweep over the area. The soil is a lateritic loam of fair depth, and there is hardly any humus on the surface. The proportion of clay is fairly high resulting in the soil caking hard when it dries during the drought period.

During the north-east monsoon rains of 1954 the area was ploughed to a depth of 8 to 12 inches, using a farmall tractor with "tine" attachments. The shelterbelts were then planted. These belts were intended to serve as breaks to the south-west monsoon winds: The primary belts were therefore placed at right angles to the wind direction and the secondary belts at right angles to the primary ones, forming a lattice pattern. As the actual wind direction in an area is modified by topography, it would generally be necessary to study the prevailing wind direction before laying out the shelterbelts, without being guided solely by the general direction of the monsoonal winds. In the experimental site, topography was found to have very little effect on the wind direction because of the plateau-like nature of the area.

The primary shelterbelts were 60 feet in width and the secondary ones half this. The belts consisted of an outer row of *Acacia mollissima* (on either side) followed by alternating rows of Cypress (*Cupressus macrocarpa*) and *Eucalyptus saligna*. The *Eucalyptus* and Cypress were planted at an espacement of 6 feet in quincunx, while the *Acacia* was sown to form a continuous hedge. In addition to the shelterbelts, four other blocks were planted in the surrounding area. The species used for these plantations were *Acacia mollissima* and *Eucalyptus saligna* in mixture.

The areas between the shelterbelts were to form the grass plots, and it was intended that these areas should be planted at the same time as the shelterbelts. Due to unforeseen circumstances, however, the grass could not be planted the same year. With the rains of 1955, the areas between the shelterbelts were reploughed and planted with cuttings of the pasture

grass, *Brachiaria brizantha*, obtained from the Agriculture Department farm at Undugoda. This species which is an introduction from Uganda, is a vigorous, loosely tufted, perennial grass, with erect stems. It is very tolerant of varying soil and climatic conditions, and is drought resistant.

The grass cuttings were planted in furrows along the contours at a 3 feet espacement. This spacing was decided on as it was thought that the grass would spread out and eventually form an even cover. A closer spacing would have resulted in greater expenditure, both in obtaining the extra cuttings needed, and in the cost of labour for planting. However, even after three years growth it was found that the grass had not spread out, but instead had formed dense clumps, in between which, indigenous grasses (mainly *Arudinella villosa* Arn.) got established. (Plate I).

In 1958 one grass plot was reploughed. It was divided into three sections, and these were planted with *Brachiaria* at espacements of 6 inches, 1 foot and 1 foot 6 inches, respectively. Between these sections two half-chain strips were marked out and planted with the legume *Stylocanthes gracilis* (Queensland lucerne) instead of the grass. *Brachiaria* cuttings were obtained from the old grass plots, and this effected a considerable saving in the cost of the operation. After one year's growth it was observed that in the two sections planted at espacements of 6 inches and 1 foot the grass had formed a perfectly even cover completely eliminating the indigenous grasses (Plate II), while in the remaining sections clumps had formed once more, though not so pronounced as before. A spacing of 1 foot is therefore the optimum, bearing in mind the cost of planting. Where grass planting is to be done on a large scale it is recommended that grass nurseries first be established in proximity to the area to supply the cuttings for planting out.

Now, 6 years after planting, the grass in all the plots shows prolific growth. It suffers no ill-effect during the dry months, May to August, and although the aerial parts get somewhat parched during this period, they quickly recover with the onset of the rains. This area is now a regular source of pasture for the government cattle farm at Ambawela. The grass is cropped regularly and cattle dung and artificial N. P. K. mixtures applied as manure. The grass was cut for the first time in June-December, 1960, and a yield of 75 tons of cut grass was obtained. During the period, February-April, 1961, there was a further yield of 60 tons, and in June-August of the same year a third crop of 65 tons was obtained. At each cropping manure was applied to the area: 75 lorry loads of cattle manure, 30 hundredweights of N. P. K. mixture and 48 lorry loads of cattle manure, respectively, on the three occasions. In January, 1961, the plots which showed uneven growth were weeded. This has resulted in the *Brachiaria* spreading out and eliminating a high proportion of the indigenous grasses.

The shelterbelts also have come up quite well, except for the Cypress which appears stunted due probably to it being unsuited to the dry conditions of the area. The *Eucalyptus* has shown very good growth, and has reached an average height of 25 feet in seven years. When the species were originally selected it was expected that because of their different growth rates the shelterbelts would acquire the ideal triangular profile. However due to failure of the Cypress the ideal structure was not formed, but the belts, though more open than expected, have not suffered much in their effectiveness as windbreaks.

This experiment has demonstrated that a much better form of pasturing than is now adopted by the villagers is possible in the dry *patanas*. By introducing a good pasture grass in co-ordination with a system of shelterbelts where necessary it will be possible to increase the grazing potential

of the dry *patanas*, thereby obviating the need for setting apart extensive areas for pasture purposes. This will also eliminate the need for repeated firing of the grass cover with its attendant deleterious effects on the soil and stream flow. The grazing potential of dry *patana* is as low as 5 to 10 acres per animal, and that too for the local breeds of cattle which are of the poorest quality. It is postulated that by introducing *Brachiaria* two acres would be sufficient for one animal of good breed. This can be improved further if some form of irrigation is practised as pasture would then be available throughout the year.

The writer suggests that the results of the Pasture *cum* Shelterbelt experiment be applied on a wider scale. Improvement of pasture land in this way could be undertaken by the Agriculture Department. Alternatively, villagers could be encouraged to do it and some financial assistance given them. As for the shelterbelts, the Forest Department is going ahead with an intensive programme of *patana* afforestation. This work is reviewed in the next part of the paper.

PATANA AFFORESTATION

The Forest Department carries out the afforestation of 500 to 1,000 acres of dry *patana* annually. In selecting land for afforestation, those areas which are windswept, erodible or liable to landslip are given priority. Although in the model Pasture *cum* Shelterbelt experiment afforestation was carried out in the form of standard shelterbelts it is neither possible nor necessary to do so in most places. Generally the relief is such that, for the plantations to be effective as windbreaks they should be raised on the ridges and hill-tops, in the form of compact blocks. It is in such areas and in others which for one reason or another are either unsuitable or marginal for other forms of land use that afforestation is usually carried out.

The results of afforestation carried out so far have been encouraging and, sometimes, even spectacular. At nearly every centre where plantations have been raised either new colonization schemes have been established on the leeward side of the forest blocks or existing schemes have been extended. Palugama, as its name indicates, was a barren windswept area prior to the planting of the shelterbelts in the Pasture *cum* Shelterbelt experiment. No sooner had the plantations come up than the area was transformed into a prospering town. Figures of wind velocity before and after the establishment of the shelterbelts are not available, but the changes observed in the area indicate that there has been a marked reduction in the wind velocity. In other areas too the results have been equally successful. The reader is referred to a paper by De Rosayro (1957) for an account of the afforestation of the Erabadde and Bopatalawa areas. Some of the more recent afforestation works carried out by the Forest Department are described below.

Harasbadde Plantations

Harasbadde is the site of one of the Pasture *cum* Shelterbelt experiments. The pasture, as stated earlier, had failed, but the shelterbelts have come up quite well and serve as effective windbreaks. A colonization scheme has been established at *Galkada Patana* on the leeward side of the shelterbelts. Further extents, on the slopes of the Mahakudugala range, and

almost overlooking the Harasbadde bazaar, have been taken up for afforestation. (Figure III). The soil of this area is unstable and liable to slip. The new plantations will stabilize the soil and afford protection from the winds to Harasbadde and the neighbouring areas, particularly to the two colonization schemes immediately adjoining it at *Diyanilla* and *Ratnayaka Patanas*. Figure III also shows the areas proposed for planting in the next few years. The large proposed area on the opposite side of the road to the existing plantations is called *Wahugala Patana*. As seen in the sketch it is situated on the crest of a hill, and its afforestation will give protection from the winds to Rupaha and other villages in the valley below.

In the afforestation of dry *patanas*, the areas are hand-weeded before planting. A few years back this practice was replaced by ploughing and contour ridging with a tractor. However, as most of the areas now being selected for planting are too steep for tractor-ploughing has been restored. Although ploughing has the effect of promoting initial growth, it has been observed, that in any but the very infertile soils, hand-weeding gives as good results. Strips 3 feet in width and running contourwise, are clean-weeded. The strips are 10 feet apart (from the middle of one strip to the middle of the next). Planting is done in quincunx at an espacement of 10 feet. Formerly the espacement was 6 feet, but the wider spacing is now used for two reasons. (1) There is a saving in the cost of planting operations as there will be less plants per acre. (2) The first thinning is postponed to a stage when useful class I poles could be obtained instead of class II or class III ones.

The species used at Harasbadde were *Eucalyptus saligna*, *Acacia mollissima* and Cypress for the shelterbelts, and *Eucalyptus saligna*, and *E. microcorys* for the other plantations. The latter two species are the ones most commonly used for *patana* planting because of their adaptability to the conditions in these areas and also because of their relatively high timber value.

Dixon's Corner Plantation

This plantation is situated adjoining the Ragala-Udapussellawa road, about four miles from Ragala. Afforestation at this centre commenced in 1954. During the first year, the sections with only a slight gradient were selected and planted after tractor-ploughing. From the following year onwards about 75 acres were taken annually, hand-weeded, and planted. Afforestation at this centre was completed in 1961, and the full block has an extent of about 400 acres. (Figure II). The plantation shelters the adjoining village of Karandagolla and the new colonization scheme at Kumbalwella.

Ettalapitiya Plantation

This plantation is situated close to Bandarawela. As at Dixon's Corner, work commenced in 1954, and the first year's area was planted after tractor-ploughing. Fresh areas were taken up in subsequent years, and the whole block (about 400 acres in extent) was completed in 1960. Protection from wind is afforded to the adjoining government farm and to the small villages and colonization schemes in the valleys between the different sections of the plantation.

Other Plantations

At Harangala, near Nawalapitiya, two areas—*Huriella* and *Wewalhinna patanas*—were afforested in 1961. These two patanas were selected for planting in order to check the soil erosion which was taking place in the area. In the same year two large blocks of 150 each were planted at Ohiya-Raikarawa, a few miles from Boralanda. These plantations are situated at an elevation of about 5,000 feet, and they will eventually form wind barriers protecting the villages round about Boralanda.

A series of shelterbelts were planted at Hunnasgiriya in 1958. The species used were *Eucalyptus saligna* and *E. microcorys*. Unfortunately, due to extensive termite attack there was nearly 100 per cent mortality within an year of planting. The soil in this area is extremely shallow, and there is slab rock a few inches from the surface. This, it was thought, would have been primarily responsible for retarding the growth of the plants and making them susceptible to termite attack. A fresh trial was made in 1959 in two small areas where there was a fair depth of soil. In this case the casualty rate was much lower than previously, but the growth of the plants was poor, and it was concluded that the species tried (*E. saligna* and *E. microcorys*) were unsuited to the locality. In the next two years 25 acres were planted annually, and a number of species were used, namely, *Eucalyptus robusta* (Red Gum), *E. citridora*, *Callitris calca rata* (Rock Cypress), *Dalbergia sissoo*, *M. chelia champaca* (Sinhalese-Sapu), *Mangifera zeylanica* (Sinhalese-Etamba), *Felicium ddcipiens* (Sinhalese-Pihimbiya) and Mahogany. It is still too early to judge the results of this work, but if success is achieved with at least one or two species it is hoped to afforest the entire stretch of Crown land above the main road between the 23rd and 25th mile posts. Hunnasgiriya is one of the most windswept places in the island, and it is only by extensive afforestation that the living conditions in the area could be improved.

Discussion

The importance of afforestation in the development of the dry *patanas* cannot be over-estimated. The functions served by forest plantations in these areas are as follows :—

1. Amelioration of the climate.
2. Stabilization of the soil.
3. Provision of timber and fuel.
4. Provision of employment to the villagers.

The role of forest plantations in ameliorating the climate has already been pointed out. It has often been claimed that forests have various beneficial effects on climate such as increasing the rainfall, but the chief effect as far as the dry *patanas* are concerned is the reduction in the wind velocity. Afforestation is a prerequisite for the development of those areas which are subject to strong winds. The raising of forest plantations have always acted as an impetus to colonization and village expansion. Because of the protection given by the forest cover agricultural enterprises such as vegetable growing, the cultivation of fruit trees (like *Jak*, mango, pears, apples, etc.) and the rearing of cattle become possible, and everywhere one sees evidence of newly settled people taking up to these agricultural occupations on the land allocated to them.

Afforestation also serves to stabilize the soil and prevent erosion. In many instances areas have been specially selected for afforestation in order to conserve the soil and prevent land slips. Soil erosion is a serious problem in the dry *patanas*. It is mainly brought about by repeated firing of the grass cover which exposes the soil, and by vegetable cultivation on steep slopes by sporadic encroachers, without proper soil conservation measures being adopted. Soil erosion is particularly dangerous in the up-country areas as it is here that the rivers originate, and siltage of the water-courses can therefore have serious repercussions. As a general rule it is best if severely eroded areas and catchment areas of reservoirs are placed under a forest cover.

The dry *patanas* are almost completely devoid of any natural forests. The forest plantations are the only easily accessible source of timber and fuel for the people of these areas. The greater demand is for fuel. Firewood depots have been opened up by the Forest Department in a number of places to serve the needs of the public, and these depots are supplied mainly from the plantations. At one time there was no demand at all for *Eucalyptus* timber, but latterly it has been found possible to market this timber, and the demand for it is now steadily rising. A considerable amount of firewood is being supplied to tea factories to be used in the firing of tea. It has been estimated that by using firewood instead of liquid fuel there is a saving of $1\frac{1}{2}$ cents per pound in the cost of manufacture (Administration Report of the Conservator of Forests, 1957). A further benefit is the saving in foreign exchange if the locally available firewood is used.

The various operations connected with afforestation require labour. The work is done mainly on 'check roll', employing casual labour from the locality. When afforestation starts in a particular centre, an extent of about 50 to 100 acres is taken up annually until the programme in that centre is completed. Planting operations include surveying of the area, fencing, holing, weeding and the actual planting. For three years after planting, the area has to be weeded and vacancies planted. By the time planting operations in a centre are over thinnings in the older areas would have generally begun. This means that there is continual employment for the villagers of the area.

For the proper development of the dry *patanas* it is essential that land use should be well planned, and careful thought given to the allocation of land for agriculture (cultivation, pasture, etc.), habitation (colonization and village expansion) and forestry (shelterbelts and other plantations). The present system of land mapping out, though not entirely adequate as it stands, would be a useful basis on which a more comprehensive scheme can be formulated. The dry *patanas* have now been mostly mapped out. The mapping out results however, could be varied in accordance with new proposals for the better utilization of these areas.

It has often been said that forestry should be confined to the worst land. On this basis, rocky and almost sterile land has sometimes been set apart for afforestation. Such areas will not support any form of forest cover. Apart from these areas, generally speaking, only land which is unsuitable for other purposes that is taken up for forestry. Exceptions have sometimes to be made, as for example, when land with good soil and suitable for agriculture has to be afforested in order to protect the neighbouring areas from wind. On the other hand, there have been a few instances when good agricultural land has, for no apparent reason, been afforested. This could be avoided by better land use planning.

There is a common misconception in the public mind that afforestation should always be carried out in remote areas. This view cannot be maintained when one considers the benefits (mentioned above) accruing to the community from afforestation. For *patana* afforestation to be properly effective, particularly with regard to the points 1, 2 and 4 mentioned above, it is essential that it be carried out close to centres of development. However, where it is proposed to settle people in a remote area where adequate *patana* land is available, then afforestation will have to play an important part in the development of such an area. It is therefore clear that forestry cannot be divorced from other forms of land use; afforestation should be incorporated into any scheme for land use planning in the dry *patanas*.

One of the reasons for the general view that afforestation should not be carried out close to centres of development is the high demand for this land for other forms of land use. In this connection the Forest Department has shown how the land required for pasture can be considerably reduced by introducing a good pasture grass into the *patanas*. In this way the pressure on the available land can be reduced.

In conclusion it must be stated that considerable headway could be made for better utilization of *patana* if the officers of the Land, Agriculture and Forest Departments get together at the District level and draw up schemes for the development of these areas.

ACKNOWLEDGMENT

The writer wishes to thank Mr. C. Dissanayake, Forester, for supplying him with most of the information on the Pasture *cum* Shelterbelt experiment, and for the many fruitful discussions he has had with him on the topic of *patana* afforestation.

SUMMARY

The dry *patanas*, particularly those of the Uva Basin, are fast developing, with land being used for agriculture, colonization and forestry. For optimum utilization of these areas, proper land use planning is essential.

Forestry plays a large part in the development of the dry *patanas*. The strong dry winds prevailing in these areas was the main cause for retarded development in the past. Afforestation, by reducing the wind velocity, has improved living conditions, making it possible for colonization and village expansion schemes to be established in what were earlier barren windswept areas. Afforestation also provides timber and fuel, stabilizes the soil, prevents erosion, and provides work in the plantations for the villagers.

Ironically, though essential for development, there is some antagonism to afforestation being carried out near centres of development. This is due to the pressure on the land from other forms of land use. This could be relieved to a great extent by introducing a good pasture grass into selected areas of the dry *patanas* and to improving its grazing potential, thereby obviating the need for setting apart large areas for pasture. Besides

improving the grazing potential of *patana* it will also render it unnecessary to carry on the present practice of firing the grass cover to obtain a regrowth of tender shoots to feed the cattle. That such an improved pasture scheme is possible has been shown by the Forest Department by the 'Pasture cum Shelterbelt' experiment which is fully described.

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FIG. II. DIXON'S CORNER

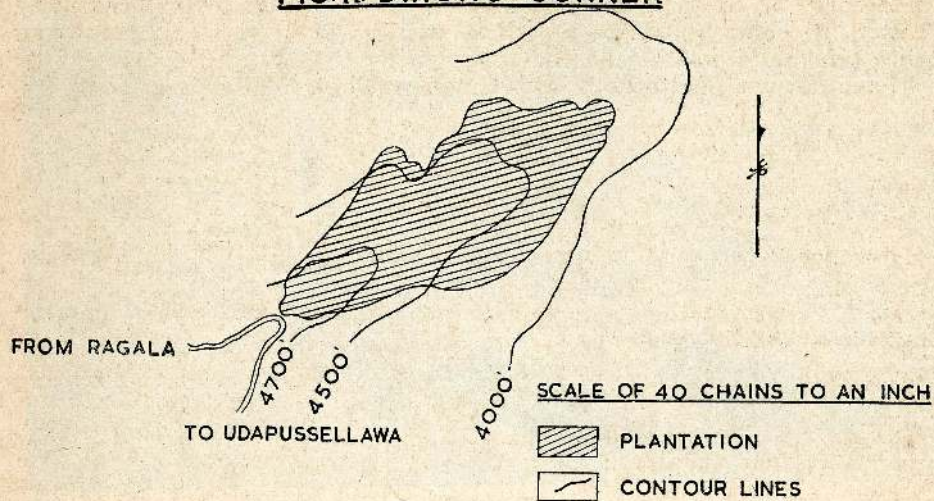
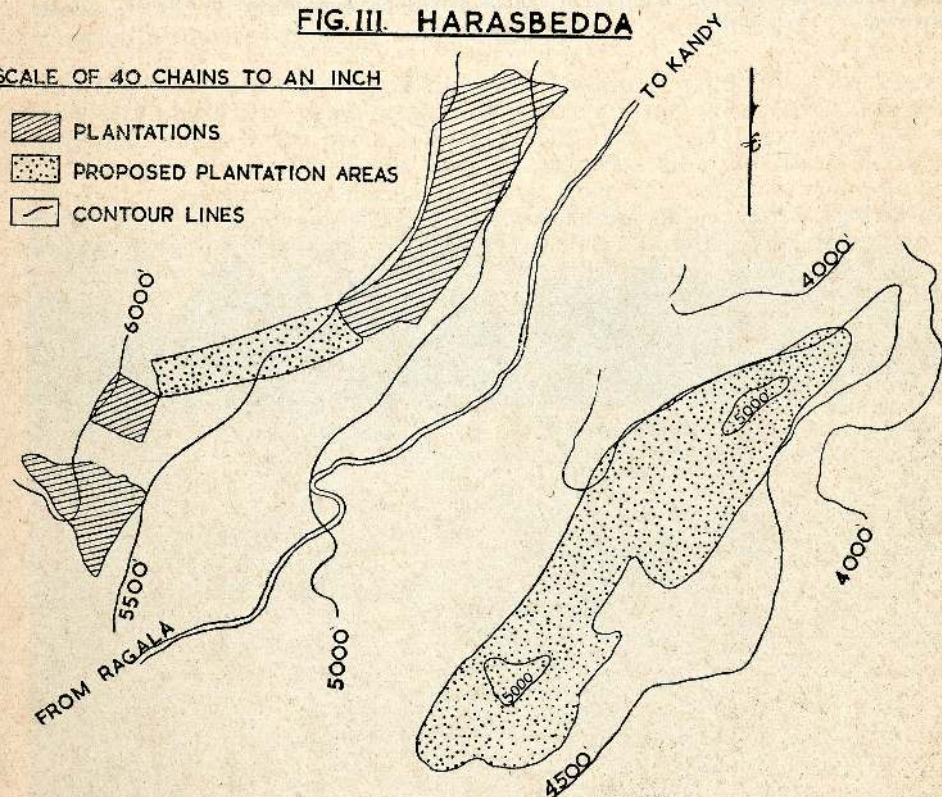


FIG. III. HARASBEDDA

SCALE OF 40 CHAINS TO AN INCH

-  PLANTATIONS
-  PROPOSED PLANTATION AREAS
-  CONTOUR LINES



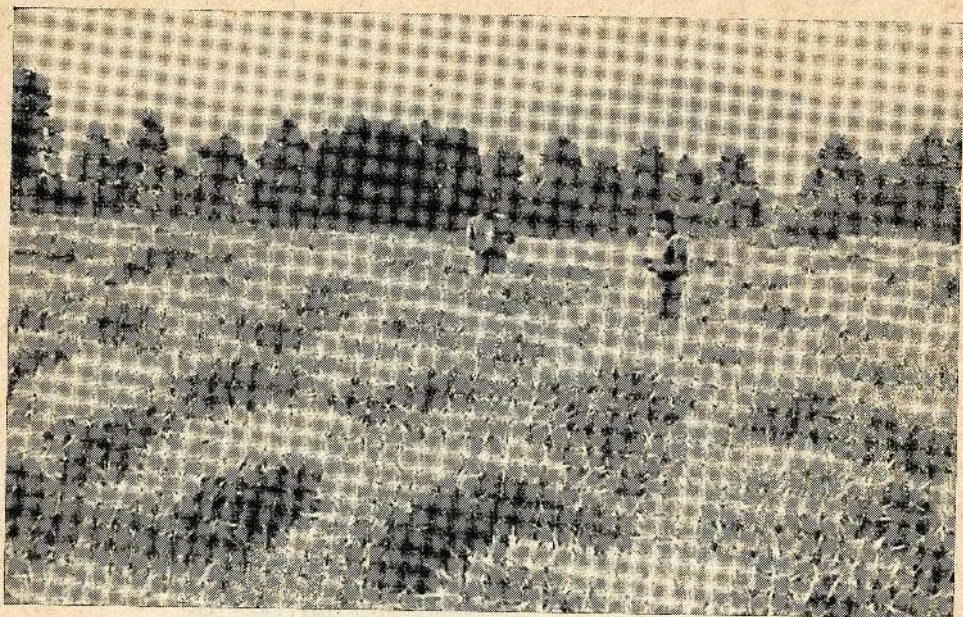


Plate 1. Plot of *Brachiaria brizantha* where the cuttings were planted at an espacement of 3 ft. The grass has grown in the form of clumps, with indigenous grasses in-between. In the background is a shelterbelt.



Plate 2. Plot of *Brachiaria brizantha* planted at an espacement of 1 foot. The grass has formed a uniform cover.

WILD LIFE RESOURCES OF CEYLON

A. S. A. Packeer

TODAY, one often speaks of the spiralling growth of the earth's population which has increased by 500,000,000 persons since the beginning of the present century. But this and the concomitant demands of modern civilization for more food and for more space have meant that the few untouched natural areas of the earth where animal herds can still roam freely are being steadily encroached upon. They are rapidly shrinking in size and their wild life threatened into extinction and that is why National Parks and nature reserves which now exist in every civilized country are considered of greater importance than ever before. Wild Life and its natural habits are a scientific and cultural heritage of all mankind.

But nature conservation is not merely a matter of protecting species and environments and constituting in the form of National Parks a series of 'standard' natural habitats through which it becomes possible to appraise the good or bad effects of the transformations imposed by man on nature. It must also be deliberately dynamic for progress in ecology making it possible to give mankind effective help in its fight against hunger and to contribute towards better living conditions.

In Ceylon, ideas concerning the preservation of wild life, have changed within the past fifty years or so. The public are now aware that unless our birds and animals are protected, they will also cease to exist. It is a well established rule that it is our duty to preserve the wild life of today for the benefit of future generations. Ever since the country was colonized, there has been a steady decline in the number of our birds and animals. Part of this decrease has been brought about by cutting down forests and the draining and cultivation of land. The works of Samuel Baker and other writers of the nineteenth century would convey an idea of the vast animal population which then existed and the immense and easy toll taken by European hunters.

Ceylon, in proportion to its size, possesses a rich and varied collection of wild life to exhibit to the visitor. Fortunately, unlike in other countries there is no wild animal as such on the verge of extinction, except for the wild elephant.

Protection to our wild fauna is given mainly in National Reserves and Sanctuaries. The national reserves first proclaimed in 1938, are now 1,123 square miles and consists of—

- (a) 4 *Strict Natural Reserves*. In these areas the fauna and flora are left completely undisturbed and into these areas admission is prohibited except for research.
- (b) 3 *National Parks*. 401 square miles, being areas into which the public are freely admitted on permits and are areas in which they can study and observe the fauna and flora.
- (c) 6 *Intermediate Zones*, 487 square miles, in which shooting is permitted during the open season. During the close season, the zones are open for photography. All national reserves are state forests.

The largest strict Natural Reserves are 111.6 and 112.5 square miles in extent. The remaining two, which are smaller areas, 5.5 and 4 square miles, are essentially flora reserves, one possessing the characteristic flora of the highest mountain zone and the other a mixed and unusual flora of a mountain in the arid zone. A strict natural reserve should primarily be a localised area extending over the habitat of a species in danger of extinction or requiring special protection and which needs to be completely isolated from and undisturbed by man in order to enable it to rehabilitate and survive.

NATIONAL PARKS

There are two National Parks, Wilpattu National Park, 212 square miles and Yala National Park consisting of two blocks—91 square miles. Topographically the Ruhuna and Wilpattu National Parks are strikingly different but equally picturesque and attractive. The Ruhuna park is bounded by the sea; the coast line being broken by the sea. Interspersed between stretches of forest, scrub, and large extents of park country are picturesque rocky hills rich in ancient ruins. By contrast, the Wilpattu Park has few rock outcrops and hills; its characteristic feature is sand but in it there are 26 natural lakes of varying size and beauty—two salt and the rest fresh. In Wilpattu elephants are fewer than in Ruhuna but bears are much more numerous. Walking within the Park is prohibited. Experience in the National Parks of Ceylon has confirmed the experience in Kruger and other National Parks that many animals soon cease to exhibit alarm at the passage of motor vehicles because no harm can come to them from vehicles or passengers inside them. Peafowl appear to be most tame, deer graze or move a short distance only to resume their grazing. Lone bull buffaloes which wallow in water-holes sometimes do not even raise their heads to look and elephants are liable to behave in an unconcerned way to great alarm of visitors. But this picture of peaceful content changes when one of the occupants alight from the vehicles and is recognized by the animals as a man on foot. The animals are instantly alerted and begin to move into cover and concealment. Other animals found are Sambur, Wild boar, leopard, porcupine, crocodile, hare, etc. Junglefowl are also common. Birds of varied plumage and description are also found in rich profusion; of these the more fascinating are the Painted Storks. Many opportunities are available for the observation of animal behaviour, enumeration of animals and ecological studies over a wide field. Animals, like elephants and buffalo, are likely to make hostile demonstrations. Bears, liable to be more dangerous than elephants and buffaloes, generally run away as soon as they see an approaching vehicle or a man on foot. Leopard present a very remote danger.

INTERMEDIATE ZONES

There are six intermediate zones.

SANCTUARIES

Sanctuaries can include private lands and have been established (a) to prevent killing in religious places; (b) to be bird sanctuaries and (c) to be buffer or protective zones.

PROTECTED ANIMALS AND PLANTS

The list of birds, beasts and reptiles which are absolutely protected at all times include 6 families, 22 species of birds, 5 beasts and one reptile. 6 of the birds are migrants which visit Ceylon from September to April. Absolute protection is given to certain trees which have historical associations and also to some orchids. Poaching occurs mostly during drought in jungles close to villages and along banks of perennial rivers such as the Kalu Oya along the Wilpattu boundary, the Kirinda Oya from Wellawaya to Tissamaharama and sections of the Yan Oya, Deduru Oya and the Amban Ganga in the Dry Zone. The usual form of poaching is by sitting up at night over water holes, Kamas, Walas, etc., either in hiding on the ground (Kotuwas) or more commonly in stages on trees (messas or serembis). The poacher accounts for a greater part of the elimination of game in most regions. Still worse is the market hunter because he kills birds and animals for commercial purposes. Commercialization of all forms of wild life is prohibited. In Ceylon the Hog deer is almost extinct like the Quagga and the White tailed Gnu of Africa. The wild elephant here would suffer similar fate if more effective remedial measures are not taken immediately to arrest this condition. The elephant is persecuted so much and killed in alleged defence of crops.

Conservation of wild life would be most effective if it operated on an ecological basis. It is a science of interrelations and studies the balance to be achieved in a system of interacting factors. Some ecological systems are in stable equilibrium, for instance climax communities in nature, such as undisturbed rain forest. But in others the equilibrium may be upset either by natural causes or by human interference—accidental or deliberate. The wild life of Ceylon is a resource of unique value. It must be preserved both as an object of study and as a necessary basis for proper land use policies and as an increasing number of people from all over the world are finding unique satisfaction and interest in it as a spectacle.

THE DEVELOPMENT OF FOREST PLANTATIONS IN CEYLON SINCE THE SEVENTEENTH CENTURY

W. R. H. Perera

INTRODUCTION

FOREST trees, have been planted in Ceylon in some form or other throughout the centuries. In fact, probably the oldest historically recorded tree still in existence, the *Ficus religiosa* tree at Anuradhapura in the Dry Zone, was brought from India and planted in 288 B. C.

The present policy of the Forest Department involves a large scale plantation programme which mainly uses exotics such as teak, various eucalypts and mahogany. Of these, teak, which might be considered the most valuable and important exotic forest tree in Ceylon, was also the first to be introduced into Ceylon—in 1680, by a Dutchman named Van Rhede. It is interesting therefore to trace the development of forest plantations in Ceylon from the first introduction of teak in the latter part of the seventeenth century up to the present time.

After a short summary of climate and topography, this development of plantations will be considered in three stages. Firstly, the historical period up to 1890, when some planting was done haphazardly; most of the plantations made in this period have subsequently been lost sight of. Secondly, the period from 1890 to 1953, which may be termed the 'Embryonic Period' of forest plantations in Ceylon; in this stage various species were tried and attempts made to establish concentrated stands of valuable plantations. Finally the period 1953 onwards; in this stage intensive forestation projects, including mechanised planting, has been planned and executed in co-ordination with other land utilization projects.

Climate and Topography

Ceylon situated between 5° 55' and 9° 55' North latitude, and 79° 42' and 80° 55' East longitude has an area of 25,352 square miles. The greater part of the land forms the lowlands which rise from the coast to an elevation of about 1,500 feet; the rest about 20% of the whole is mountainous and situated centrally towards the South of the island.

The central massif which plays an important part in determining the climatic conditions, is essentially composed of two ridges, the larger of which runs from North to South, while the lesser more or less from East to West, so that together they give the appearance of an anchor. In addition there are other small groups of mountains. The highest point on this mountain massif is 8,292 feet.

The type of rainfall are monsoonal, instability or convectional rain, and cyclonic rain. There are two monsoon periods, the North-East monsoon from October to February, and the South-West monsoon from May to September. The distribution of these monsoon rains is greatly affected

No

by the central mountain range ; but the topography does not appear to have any influence on the distribution of the inter-monsoonal convectonal and cyclonic rains.

The island can be divided into a number of climatic zones dependent on the topography and the amount of rainfall. But throughout this article reference will be made to five main climatic and topographic zones.

1. *The Dry Zone*.—This zone, consisting mostly of undulating land with a few isolated hills (e.g., Ritigala 2,314 ft. and Westminster Abbey 1,831 ft.) has a rainfall between 50" to 75" and covers about 2/5ths. of the island. Records at selected stations in this zone show that the monthly rainfall is less than two inches in only two or three months of the year.

Station	Total Rainfall	Less than Two inches per Month		
		June	July	August
Anuradhapura ..	57.84 "	80"	1.25"	1.98"
Mihintale ..	58.94"	80"	1.10"	—*
Periyaaru ..	79.4"	1.92"	—	—
Valaichcheni ..	73.6"	40"	1.32"	1.40"
Vavuniya ..	61.4"	90"	88"	—
Mankulam ..	61.2"	1.00"	1.08"	1.69"

(*Rainfall over 2")

2. *Arid Zone*. This is a part of the Dry Zone where the mean annual rainfall is less than 50". Moreover in this zone the monthly rainfall is less than 2" for at least six months of the year. Thus while the distribution of rain is satisfactory in the Dry Zone, it is very poor in the small Arid Zone area.

3. *The Lowland Wet Zone*. This zone consists of both coastal areas in the West and South of the island, and hilly terrain towards the interior up to an elevation of about 1,500 feet. The rainfall varies from 75" to 150" and even more. Distribution of the rainfall throughout the year is also very good, with heavy precipitation during the South-West and North-East Monsoon periods.

4. *Intermediate Zone*. Between the wet and dry zones there is an intermediate zone which is composed mostly of undulating land with some hilly tracts. The zone has a rainfall between 75" to 100" which is well distributed throughout the year.

5. *The Montane Zone*. This hilly area between about 2,000' and 8,200 feet has a high rainfall which varies from 80" to over 200" in different parts of this zone. The rain is very well distributed throughout the year with the main precipitation during the two monsoonal periods. Exceptionally, however, in a small area of this zone, namely a valley lying between two mountain ranges—one of which gets the full blast of the South-West Monsoon and the other that of the North-East Monsoon—the rainfall is only 60"–80".

Historical Period 1680-1890

The first teak was introduced to Ceylon in 1680 by Van Rhede. Apart from the fact that this was planted in the Matale area, no records are available as to the exact location or the number of trees planted. More

teak was planted during this period near the coast, but most of these plantations have now been cut, sold or lost sight of. During this initial stage of teak planting teak was declared a Crown tree, so that any tree even on private land was the property of the Crown. This regulation was bound to prevent planting of teak on private lands, which might otherwise have resulted in private teak estates.

Of these earlier plantations no record appears to have been maintained, but a census taken in 1880 revealed the presence of 17 plantations totalling 50 acres in the Wet Zone in the Southern and Western Provinces. About this time 30 acres were planted at Kekanadure and 37 acres at Hali-Ella in the Matara district—also in the Wet Zone. One old plantation referred to in the records of this period is the Akuresa plantation, which had been leased out on an annual rental of Rs. 2.50 for cultivating the ground underneath the teak, while the branches were lopped to manure the ground. Even today the effects of this lopping are noticeable in the few trees still left in the present Akuresa resthouse premises.

Another record of interest is that in 1881, 110 teak trees were sold at Hanwella—also in the Wet Zone—for Rs. 1,281.

The earliest record of any plantation 'technique' is for the plantation established near Puttalam in the Dry Zone in 1880 and 1881. In all, eight acres were planted, with a 12' spacing in the first year and 6' in the second year. It cost Rs. 30 per acre to clear the land; this was met by the Forester from savings during four years from his transport allowance. The establishment of a nursery and planting was done by the Foresters depot and baggage labourers with the assistance of prisoners and poll tax defaulters.

By about 1870 attempts were made to raise forest plantations by taungya on Chena land—land on which shifting cultivation is practised. This is particularly interesting as taungya methods, or co-operative afforestation as it is called in Ceylon, was not used in forest reserves by the Forest Department until a few years later.

In 1876 teak seed was sown along with the Indian Corn crop—no manioc or plantain being allowed—near Pulkanawa tank in the Dry Zone; the work being supervised by the Forester. Though the exact fate of this particular planting is not known, subsequent teak plantations raised in this area have been very successful.

In the Wet Zone, with the intention of raising railway fuel forests, land was given out on short lease for cultivation. The cultivator paid the then existing dry grain tax of 1/4th the crop. Additionally he had to plant 450 trees (*Artocarpus heterophyllus*, *Melia dubia*, *Cassia siamea*, etc.) to the acre. A fine of Re. 1 was imposed for every tree short. These plantations were a total failure.

Towards the close of this period, in 1888, *Eucalyptus saligna*, was first planted at Nuwara E'iya in the Montane Zone. The planting was done departmentally but no records are available of the area planted or spacing of plants. Four years later some of these trees were 40 feet in height and 17 inches in girth.

The first experimental planting of the now famous Sundavola plantation in the Kurunegala district was done in 1889. The species planted were jak, teak, satin and honduras mahogany (*Swietenia macrophylla*).

Planting was continued after 1890—and strip planting was first introduced on the direction of the Conservator Mr. Broune in 1891. Planting was continued, using various species and methods and at present this plantation consists of 373 acres.

These early plantations were not a great success, a contributory cause for their failure being that every officer selected a new site; when he left the area the plantations were lost sight of. There were 906 acres of plantations in 1890, of which 712 acres were teak.

The Period 1890 to 1953

Attempts to establish concentrated stands of forest plantations, not only on land with degraded and poor quality forests, but also on the unproductive Patana (grass) lands of the Montane Zone, commenced during this period. However, policy as regards plantations and choice of species did vary from time to time. Species with differing Silvicultural characteristics were often intimately mixed in the same plantation, or planted in small units, resulting in a 'mosaic of age classes and species'.

Before further description of the progress of forest plantations, an interesting though perhaps irrelevant occurrence may be mentioned. In 1890, 15 acres of land were planted by the Forest Department with rubber (later to become a very important agricultural crop); but this plantation was a failure chiefly due to silting the plantation in an area liable to flooding.

Well organised taungya plantations in forest reserves were started in 1890, first in the Intermediate zone forests where jak (*Artocarpus heterophyllus*) was planted 5' to 6' apart, the present plant spacing being 10' by 10', mahogany being underplanted in the Jak stand at the end of the third year. In the Dry Zone indigenous species such as satin (*Chloroxylon swietenia*), halmilla (*Berrya cordifolia*), ebony and margosa were also planted under this scheme; subsequently teak was the chief species used with stumps as planting material, and a spacing of 6' by 6' (presently 10' by 10'). The system followed was—and it is essentially the same today—to conclude a Co-operative reforestation agreement with a suitable lessee for a three year period. After the Forest Department has exploited the utilisable timber, the lessee clears the area, burns it and fences the area with barbed wire provided by the department. Plants, stumps or seeds are supplied by the department. The lessee is paid a reward after completion of planting; a second reward is paid during the second year if the area is well tended and stocked, and a final reward on leaving the area at the end of the third year if the plants are well established.

In the Montane Zone departmental planting of both the degraded natural forests and Patana grasslands was gradually increased. At first *Eucalyptus robusta* was generally used but later *E. saligna*, *E. microcorys*, and *E. pilularis* were also extensively planted, as well as *Cupressus macrocarpa*. Some of the other species tried were *Callitris*, *Tristania conferta*, *Cedrella serrata*, *Acacia decurrens* and *Acacia mollissima*. Some Pines such as *Pinus khasia* and *P. caribaea* were also tried but the main species planted were various eucalypts. In the Montane grasslands planting of eucalypts was and is done on weeded strips contourwise.

The spacing was 5' apart, presently 10' apart; the plants being in planting baskets. In addition estate fuel blocks to meet the needs of tea estates were planted, chiefly with *E. robusta*.

In addition to the main plantation schemes enumerated above, small scattered plantations of indigenous species such as nedun (*Pericopsis mooniana*) were opened up in the wet zone. In the Dry Zone indigenous species were planted in cleared gaps and strips; while *Casuarina equisetifolia* was planted on sand dune areas in the dry and arid zones.

This was the general set-up of plantation work when the planting of teak suffered a severe set-back and was practically abandoned after 1921. P. M. Lushington a forestry adviser, in his report to the government stated, "Ceylon is not suited to the growth of teak as a large timber tree. Teak plantations if they are continued in Ceylon should be the exception and not the rule". R. M. White's memorandum on the report further aggravated matters, he stated, "The teak plantations are likely to prove a great financial success for the supply of telegraph poles". The result was the substitution of very slow grown hardwoods for teak, and co-operative reforestation was also considerably reduced; but the supply of telegraph poles was increased and by 1927, 27,500 teak trees, the best in the stands, were cut down for telegraph poles leaving the unwanted and inferior trees. Champion (now Sir Harry Champion) in 1935 aptly called this calamity "an unjustifiable misinterpretation of his remarks". The overall results of the findings of the adviser were that the previous attitude of the department towards regular plantations was considerably upset, enthusiasm dampened, and plantation work reduced. By 1926 when plantation work was languishing the total acreage of plantations which was 1,405 acres at the turn of the century had increased to about 15,000 acres.

However some sort of planting continued until in 1939 Patana reforestation was intensified, while in 1949 the spacing of plants in these montane plantations was increased from 6' by 6' to 10' by 10', with a resultant saving of nearly 50 per cent in the costs of planting.

By 1950 the planting of jak and mahogany in the Intermediate Zone was also increased; papain derived from papaw, which is the main crop planted by lessees in this zone fetching attractive prices in the world markets about this time. Teak was also being gradually planted again in the Dry Zone on a larger scale. Thus after the setback of the twenties, planting was to some extent intensified again by about 1939; while at the end of this 1890-1953 period there were about 26,000 acres of established forest plantations, an insignificant acreage compared to the three million odd acres of forest land under Forest Department management.

The Period Since 1953

It was realised that even the valuable forests of the wet evergreen type in the Lowland Wet Zone, had been overfelled and had deteriorated badly in some areas. The intrinsically poor type of forests in the Dry Zone which formed the bulk of the island's forests, though mostly secondary forests about four to seven hundred years old, had produced the major portion of the country's requirements of hardwoods for nearly a century and were now badly depleted. Moreover a considerable proportion of these forests in the Dry Zone were being cleared yearly to

restore the ancient net work of irrigation tanks in connection with developmental schemes. The remaining forests were the stunted natural vegetation of the Montane Wet Evergreen forests and about 150,000 acres of Patana grasslands in the Montane Zone.

Under these circumstances it was imperative that a determined effort should be made to achieve a large and intensive forestation programme. The forest department accordingly planned a comprehensive afforestation scheme which coordinated with other land utilization and development schemes, employed modern techniques of planting. The scheme, launched in 1953 with advice given under the Technical Assistance Scheme of the F. A. O., was further intensified in 1957-1958 and 1960-61 and is now being implemented. The main projects undertaken under this afforestation scheme are :—

1. Establishment of new nurseries and improved nursery practices.
2. Afforestation schemes in the Wet and Dry Patanas in the Montane Zone.
3. Reforestation of degraded Montane Wet Evergreen Forests.
4. The wind break and improved pasture scheme in the Dry Patanas.
5. Cooperative (taungya) and departmental reforestation in the Dry and Intermediate Zones with teak and, jak and mahogany.
6. Enrichment planting in the Wet Zone.
7. Reforestation of sandy and Arid tracts of land.
8. Tree Planting Campaign.

Nurseries

All existing nurseries were enlarged and additional nurseries established. The first large central nursery was established near Anuradhapura in the Dry Zone for raising teak plants for stumping. Clearing of the 17 acre site and ploughing of the area preparatory to bed construction was done by tractors. Living quarters for the staff have been constructed at the site. The nursery is watered from the nearby river by a 6 H. P. diesel pump and Pioggia Perrot automatic irrigators.

Among the other nurseries established was one in the drier part of the Wet Zone at Kamburupitiya. At this site a stream was dammed at two points at the top and bottom of the nursery, which is on a slightly sloping ground, and from the reservoirs thus constructed water is pumped to overhead tanks for watering the nursery beds. This nursery was stocked mainly with mahogany and nedun; it is also intended to raise teak plants. Large nurseries have also been established at Monkey Bridge and Tanamalvella. The nurseries at Kankaniyamulla and Kumbalpolla have been extended.

Afforestation of Wet and Dry Patanas

Mechanisation of planting operations was started in 1953. Mechanised planting was however abandoned in a few years as it was found to be uneconomical in the tract involved which is extremely hilly.

In the wet Patanas a Caterpillar D—2 tractor was employed to plough the soil with a disc harrow to a depth of 9" to one foot; this exposed the moist, often water logged wet patana soil and made it friable. To reduce

the soil to a fine tilth and remove any remnants of grass and weeds, a further working of soil by rotavator was necessary before planting was done. *Pinus caribea* and various eucalypts, in baskets, were planted at a spacing of 10'; each species being planted in separate blocks. *Acacia decurrens* seed was sown in between as a filler species; a mechanised seed drill to be used for this purpose was found to be unsatisfactory and manual labour used. The D-2 tractor was able to work up to a gradient of 30 degrees, and was also used for road construction and nursery work.

Originally in the Dry Patanas French motor planters were used for holing, while the weeding of contour strips was done by hand. Later a Farmall tractor with a cultivator with tines was used to plough the soil to a depth of 6" to 8" in two operations, ploughing along the contour and obliquely. On slopes too steep for mechanised work all work was done manually. The main species used were and are eucalypts, *Pinus caribea* and *Acacia decurrens*; the last named being dibbled at 2' intervals. When it was subsequently found that motor planters were not economically satisfactory, manual labour was used for this purpose. The area consists of a large number of small hills. Due to this topography of the area, mechanised planting was found to be uneconomical, and was abandoned in favour of manual planting.

Windbreak and Improved Pasture Scheme in Dry Patanas

This scheme drawn up in 1954 by specialists of the Forest and Agricultural Departments envisaged the improvement of pasture land and simultaneous protection of swept and eroded land from wind. The areas selected were ploughed by Farmall tractors. The main wind belt, at right angles to the prevailing winds and 66' wide, is planted with individual rows of *Eucalyptus saligna* and *Cupressus macrocarpa*, while *Acacia mollissima* is sown along the edges on either side to form a pyramidal wind break. Subsidiary belts 33' wide are laid out crosswise. In between the wind breakes, which are 375' apart, *Brachiaria brizantha* (Signal grass from Kenya) is planted out by cuttings. The protection afforded by this scheme and other Patana afforestation schemes has made possible the use of wind swept land for both habitation and agricultural development.

Co-operative and Departmental Planting in Dry and Intermediate Zones

Co-operative planting in the Dry and Intermediate Zones mainly with teak and jak respectively was intensified; the system adopted being the same as that which has been described earlier, except that in the intermediate zone some groups of villagers were given areas to plant. Since it has not been possible to get Co-operative lessees in sufficient numbers to plant the yearly acreage, departmental planting by which all planting and tending operations are done by the forest department is also resorted to.

In the Eastern Province teak plantations, fire results in the ingress of *Imperata cylindrica* (illuk) a noxious grass which is a further source of inflammable material. In 1953, with a view to eradicate this grass the affected areas were ploughed with tractors and boga seed (*Tephrosia candida*) sown. However, during the unprecedented drought of 1956 the boga itself caught fire; hence it is as yet too early to have conclusions.

Enrichment Planting in the Wet Zone

Large extents of degraded and poor quality forests in this zone are enriched by the planting of mahogany striplings and nedun plants in cleared strips. Cleared strips 8 ft. to 12 ft. wide are opened half chain apart in the forest, and the above species planted at intervals of 10 ft. in each strip. Any trees that overhang the strips or in any way interfere with the growth of the young plants are poisoned.

Reforestation of Sandy and Arid Tracts of Land in the Dry and Arid Zones

In the Pallai area of the Dry Zone there are large sandy tracts of land. The natural vegetation of this land consists of isolated patches of low scrub. The water table of this area is fairly high, being between 15 feet to 24 feet from ground level.

This area is being reforested with *Casuarina equisetifolia* and *Eucalyptus camaldulensis*. Both species are raised in nurseries. In the case of *Casuarina equisetifolia* about nine month old plain plants are used for planting while the eucalypts are planted in polythene or cane planting baskets. In these sandy and dry areas, polythene tubes are far superior to planting baskets. Planting is done during the North East Monsoon.

The area to be planted is cleared of all scrub and burnt. Shallow wells—from 15 ft.-25 ft. deep and about 15 ft. in diameter are dug throughout the planting area. Planting is done at an espacement of 10 feet—and the plants watered for 2-3 months after planting. About half a gallon of water is used per plant. It is possible to establish *Eucalyptus camaldulensis* even without watering—but growth is far superior when watering is resorted to. Watering is done only in the dry weather.

In the Mannar and Hambantota areas of the arid zone there are large tracts of low thorny scrub. *Prosopis juliflora* is used to reforest these areas. The seed of this species is sown in cleared patches. The patches are about 20 feet in diameter.

Small scale experimental planting, using the "Methode Steppique" has also been initiated in these areas in 1961. The species being tried out are *Eucalyptus camaldulensis*, *Eucalyptus gomphocephala*, and *Gmelina arborea*. In the case of the eucalypts tubed (polythene) plants are used; while *Gmelina arborea* is planted out as stump plants. *Acacia cyanaphylla* seeds has also been sown in these areas. It is too early to conclude on the success of this project.

Tree Planting Campaign

In spite of its heavy planting programme the Forest Department has been able to give much advice and supply on the average 250,000 plants per year to schools, various societies and estate owners for the tree planting programme launched in 1953.

The schemes enumerated above are the main plantation projects undertaken. In addition many minor schemes have also been undertaken. One such scheme is the afforestation both of the Ceylon University Catchment area (a neglected tea and rubber estate) and of other specific catchment or badly eroded areas. By the end of 1960 nearly 67,000 acres were under forest plantations of which over 11,000 acres were teak. The

present minimum target for annual afforestation work is about 7,000 acres, which it is hoped to increase till all unproductive, degraded and poor quality forests are all planted or enriched.

Summary and Conclusions

An attempt has been made to trace the development of forest plantations from the first recorded planting of presently planted exotic species, to the present large scale and planned forestation projects. Teak was first planted in the latter part of the seventeenth century, though no detailed records are available. This was followed by the plantation of other exotic species as well as indigenous ones. Large scale, or more correctly comparatively large scale planting began towards the turn of the nineteenth century. This was continued with one or two setbacks, but otherwise with a gathering momentum until the crystallisation of a clear cut and intensive forestation plan in 1953.

The area of forest plantations which amounted to merely 1,405 acres in 1900, increased to about 26,000 acres by the end of 1952, while today this figure has doubled. This progress indicates the intensity of the forestation programme since 1953. The full impact of the further intensification of the planting programme in 1957 and 1960 will only be apparent in a few years time.

Various factors have contributed towards artificial methods of regeneration playing an increasingly important role in Ceylon Forestry. These include the slow growth of the majority of the naturally regenerated indigenous species, the difficulty in establishing natural regeneration, and the comparatively poor proportion of preferred species in a naturally regenerated stand. However, economic considerations including the high cost of natural regeneration techniques is the most important factor that has to be considered. Plantations should continue to play an increasingly major role in forestry in Ceylon. It is the writers personal opinion that in the not too distant future, artificial regeneration or natural regeneration in artificially established plantations, will be the main lines on which Ceylon's future silviculture will develop.

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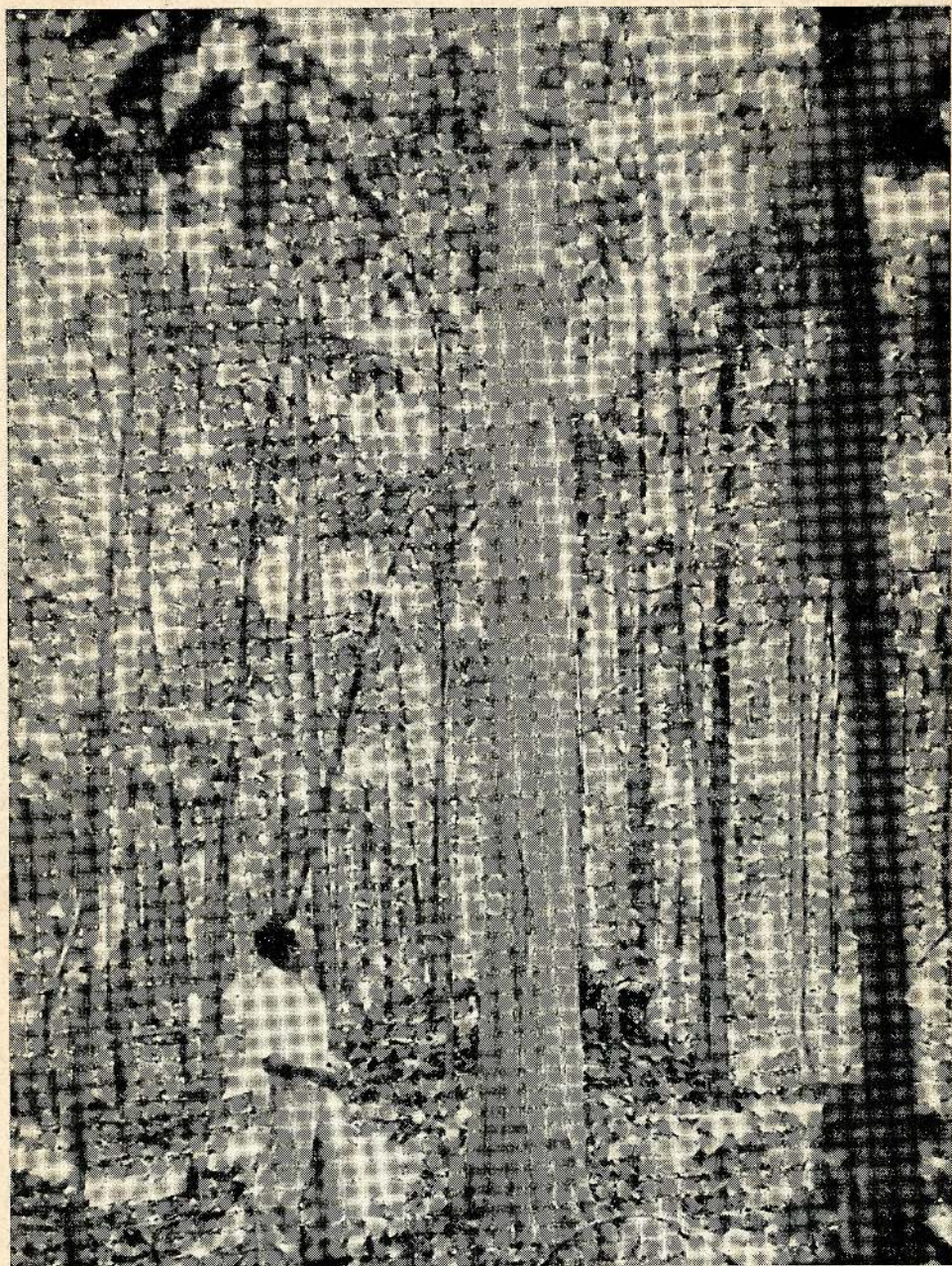
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Experimental planting of *Cedrella mexicana* at Mudunpita in the intermediate zone—Age one year.



Sundapola today—profuse regeneration of mahogany under second generation teak.



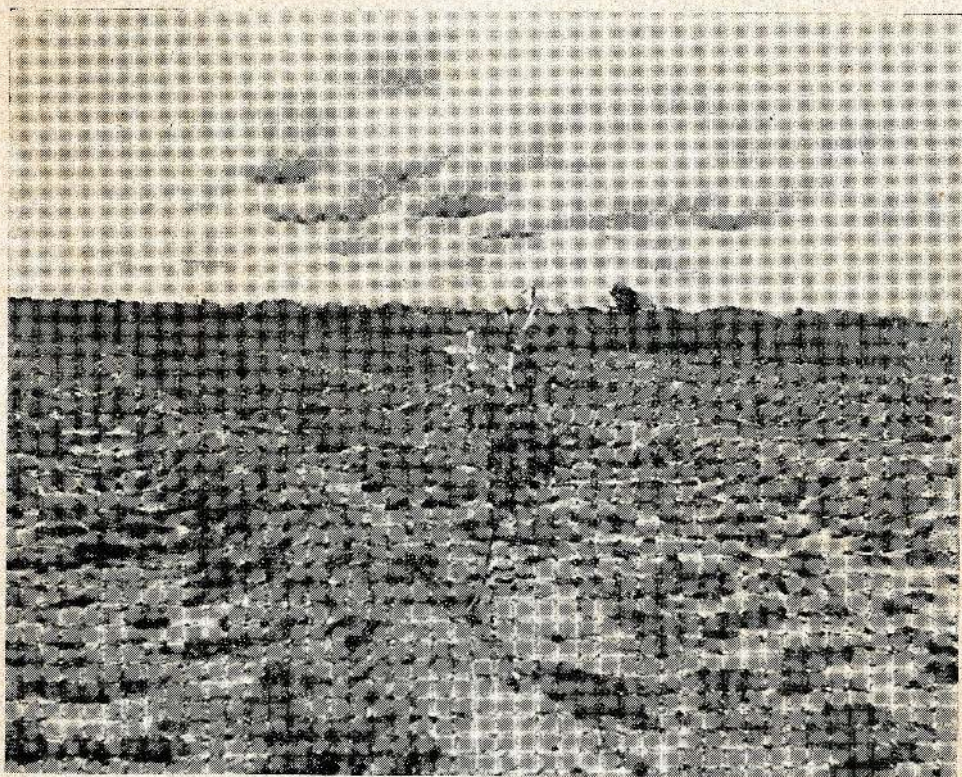
Enrichment planting with Mahogany—Oliyagankelle—4 years old.



Seven-year old et-demata, *Gmelina arborea* with Wa—*Cussia siamea* in the foreground. Experimental planting in the intermediate zone at Ridiyamulle.



Two-year old experimental plantation of *Eucalyptus camaldulensis* on sandy tracts at Pallai in the dry zone. Natural vegetation of land in the foreground.



Experimental planting of *Eucalyptus camaldulensis* at Nya-arü in the Arid Zone
—5 months old.



Pinus caribaea at Errebedde in Montane Zone—7 years old.

FORESTS PROTECT FIELDS

G. Sidorov.

WE are crossing the expanses of the southern Russian steppe that stretches out in the Volga-Don interflow in the Voronezh region. The wide plain is cut with deep gullies. The sun is parching mercilessly. A dry wind is blowing, that comes here from the sandy deserts of the East. The sky is smoky whitish from the dust, with no traces of its eye-pleasing blue colour. It is difficult to breathe. The eye is bored at the monotonous sight of this scorched hardened earth. Not without reason is it called the Stony Steppe.

But then against the tawny empty steppe a dark green mass slowly comes into view. Can it really be a forest? Yes, it is a forest! It is emerging before us like a vision.

But wherefrom comes this green "outlier" in the steppe, with a narrow world of its own, with a new geographical environment, quiet, cool and alive with the singing of birds?

GREEN BARRIERS

At the turn of this century when Russian science sounded alarm about a marked drying of the steppes which led often to poor crops and starvation among peasants, a convincing voice was raised by Professor Dokuchayev, a noted soil scientist, who urged planting forest shelter belts to combat drought. Later in the Stony Steppe Dokuchayev initiated scientifically based practices of steppe afforestation.

These practices taken up by Soviet scientists proved to be entirely correct. Now we see here fields of the Dokuchayev Agricultural Institute founded by Soviet state, set in a man-made landscape. Protected by forests, the soil has improved its water characteristics, dry winds ceased blowing, and fields produce now better crops. The experience gained allowed formulation of a theory, stemmed from practice, of steppe afforestation. Basing themselves on its achievements, Soviet scientists and practical workers carry out land and forest improvement on drought-afflicted lands.

In the post-war years the dry areas of the USSR saw a particularly wide scope of forest planting work, including eight large state shelter belts. In conjunction with local land protecting plantations that are established on the fields of collective and state farms, the national shelter belts are radically improving the climate of arid areas.

Let us carry ourselves mentally to the banks of the Ural river which forms a conventional border-line between Europe and Asia. At present the largest of the eight state shelter belts runs parallel to the river. It is stretching almost along the meridian from one of the southern spurs of the Urals—Vishnevaya Mountain—to the Caspian Sea. The length of this state weather belt is 1,080 kilometres. Like a green barrier it stands here to be the first to meet the impact of winds blowing from the deserts.

At first many could not believe that this land scorched by arid winds could produce forest stands. But forests have grown. And in this forest experts were aided by science.

The Vishnevaya Mountain-Caspian Sea state shelter belt passes through areas widely different in climate and soil conditions. All these features had to be taken into account by forest growers. Together with scientists they tested and selected wood species best suited for each locality. Thus, for instance, the lengthy and arduous search for trees and brushes to be planted on salty soils crowned finally with success. No less persistent were efforts to establish the best width, density and form of forest plantations.

FORESTS AND CROPS

Even the younger-age shelter belt protects fields from dry winds and ensures an appreciable gain in harvest averaging not less than a centner of grain per hectare. At the age of 12 to 15 the effects of a shelter belt become even more pronounced. It provides for an additional increase of 2 to 3 centners of grain per hectare. All this was brought to light by scientists following a survey of the fields in the south-eastern areas of the country.

In 1960 the fields of Northern Caucasus and the Ukrainian South were swept by devastating dusty storms. The elements did no damage where adequate shelter belts had been planted. Thus, for example, in the steppe "Gigant" state farm of the Rostov region a green barrier saved from demolition 50 thousand hectares of crops. In the neighbouring state farm with no protective belts the hurricane carried away the upper soil layer together with seeds sown in it. True, the collective farm quickly recultivated and sown the fields, aided by powerful machinery. But still the damage done was considerable.

"Forests save grain," the steppe farmers would say now. The truth of the statement dawns upon you with especial force during a tour of the fields of the "Dominsky" collective farm which is situated near Volgograd in a steppe whose climate resembles more that of a sandy waste. Some 30 to 40 years ago owing to frequent droughts part of the collective farm lands was considered "good-for-nothing." Shelter belts brought fertility to them. With the dry wind failure to reach these parts, collective farmers annually harvest 20 to 25 centners of grain per hectare now.

The network of shelter belts protecting the fields of the USSR is expanding with each year. The next 20 years will see a large scope of steppe afforestation work as envisaged in the new Programme of the Communist Party of the Soviet Union. Green forests—farmer's friend—will aid him in harnessing the elements and making fields more fertile.

ලංකාවේ වන සම්පත

ඩී. ඇස්. විමලදාස.

හෙළදිව, සොබාසිරියෙන් ඔප් නන්වන, සොදුරු බවෙහි නිමන් කරවන, දශීන යෙන් දේශානුරාගය ජනනය කරවමින් ලක් පොළොව රසයෙන් පොහොසිත කරවන, සිහිල් කරවන, එක් සම්පතෙකි; වන සම්පත.

එනිසා ම ලංකාවේ ජාතික වනෝද්‍යානයන්හි අගය මෙතෙකැයි නොගිණිය, නො මිනිය නොහේ. දෙශ දේශාන්තරයෙන් ලංකාවේ සුන්දරත්වයෙන් සැනහිමට එන ගවේශකයෝ වන සිරියෙන් අසීමිත ආශවාදයක් ලබති. හේතුව, වන ගහනයන්ගේ පිහිටීම, වැවෙන වෘක්‍ෂලතා, පිපෙන වනමල් හා සවභාවයෙන් එහි රැඳී ඇති කළුන්මක භාවයන් ය.

මේ වන ගහනයන්හි සුන්දර බව සියදහස් ගුණයෙන් වැඩි වන්නේ ඒවායේ වෙසෙන ඇත්, ගෝන, මුව, දිවි, වලස් ආදී වන සතුන් නිසාය. උහු වන බිම් නිජබිම් කොට වෙසෙති. වන සිරි වඩවති. ප්‍රභාපවත් භාවයෙන් හා අභිමානයෙන් වන රජ දහනෙහි ආධිපත්‍යය හා ආරක්ෂාවද උහු සදාකල්නිම අපෙක්‍ෂා කෙරෙති.

මහ වන මැදින් රුරා හැලෙන දිය ඇලි තුරු සෙවනෙහි නිසලව පිටි ඇති පස් පියුම් පිරිවිල්, උණ, බට පදුරු අතුරෙහි ගල්තලා, සුදු වැලි පිටි තැනිතලා, මල්ගොමු, සපු, දුනුකෝ, දෙපසින් පිරිවරා ගත් දිය කඩිති, යන මෙතැන්හි ලංකාවේ කමණියත්වය හා දශීණියත්වය පිළිබිඹු වී ඇත්තේය. සුන්දරත්වය එසේ රැක ගනිමින් රටේ පස සමූහ කිරීම හා සෝදා පාලුව නැති කිරීමද වනගහනයන්ගෙන් සිදුවන ඉමහත් ප්‍රයෝජනයෝයි. සිත් පිත් නැති වෘක්‍ෂලතාවෝ එක සණව වැඩෙමින් මහා වන ගහනයන් බවට පත්ව, පෘථිවි රසය රකිමින් පෘථිවියේ ස්පිරිතාවය සලකති. එහෙත්, "අවිචාරවත් මනුෂ්‍යයන් දැන් දැන් එහි කෘතගුණය නොසලකා කටයුතු කරන්නාහයි කිව යුතුව ඇත".

වන ගහනයන් යම්තාක් කල් පවතීද, ඒ තාක් කල් සෞම්‍ය දෙශගුණයක්ද පවතී. මක්නිසාද යත්, "වියළි සිඳි නොයන දිය කඩිති වනාන්තර තුල ආරක්ෂා වෙමින් පවත්නා බැවිනි." රසවත් පෘථිවි ඔජාවෙන් යුතු බැවින්, ගොවිතැනට ද මහත් සෙතකි. අගනා මැණික්ද මේ වන ගහන ආකර කොටගෙන රැකෙමින් පවතී. කරුවල, බුරුත, මිල්ල, කොස්, කැල, හොර ආදී අගනා වෘක්‍ෂයෝ ලංකාවේ වනගහනවල සරුවට වැඩෙති. මේ නිසා රටේ ජාතික ධනය රැකෙමින් පවත්නා හෙයින් ඒවායේ ආරක්‍ෂාව සැලසීමට රජයද වෙහෙසෙනු පෙනේ. ඇතැම් ආත්මාර්ථකාමී ව්‍යාපාරිකයෝ ඒ වන ගහනතුල ඇති වටිනා දෑව රහසින් කපා උහු නුන්ගේ මඩි තරකර ගනිති. ඇතමෙක් බලහත්කාරයෙන් අක්කර ගණන් කපා, කොටා, පුළුස්සා තාවකාලික ගොවිතැන් කොට අතහරිති. තවෙකෙක් ඒවා බලයෙන් අත්කර ගැනීමට වෙහෙසෙති. මින් සිදු වන්නේ රටට මහත් ව්‍යසනයෙකි. දැව හොරෙන් කපා මුදල්කර ගන්නෝ ජාතියට වංචනික ලෝභියෝය. පොදු අයිතිය පැහැර ගන්නෝය. ආත්මාර්ථකාමී නිවටයෝය. අපරික්ෂාකාරී ලෙස දැව කැපීමෙන් පස සෝදායාම පමණක් නොව, වටිනා කුඩා ගස් රාශියක්ද විනාශ වෙයි. සෝදා පාලුව ඉන් දෙගුණ තෙගුණ වී පස නිරස වෙයි. ඒ ප්‍රදේශය පාලු සවභාවයකට පත් වන නිසා සුන්දරත්වයෙන් ඇත්වෙයි. දිය කඩිති වියලී යාම නිසා දේශගුණය විපරිත වෙයි. වන සත්වයෝ අකල් ව්‍යසනයට පත්වෙති. මේ අසාධාරණ ක්‍රියාවෙන් එතෙක් කල් පැවති වන ශෝභාව කෙළවර වනු පමණක් නොව රට ආර්ථික දුෂ්කරතාවයට ද පත්වෙයි.

ලංකාවේ ජාතික ධනය රැකගන්නා මෙබඳු වන ගහනයන් දැන් දැන් ආත්මාර්ථ කෘමීන්ගේ පොරෝ පහරට ගොදුරු වෙමින් කණගාටුදායක ඉරණමකට පත් වී ඇති වග කරුණු සහිතව පෙන්විය හැකිව තිබේ. මේ වන ගහනයන්හි වැඩෙන වටිනා දෑව ක්‍රමානුකූලව පසට හෝ සුන්දරත්වයට හානියක් සිදු නොවන හැටියට කපාගෙන ඒවායින් අගනා කර්මාන්ත කළහැකිය. දැව කර්මාන්තයෙන් මේ රටට විශාල ධනයක් රැස්කරගත හැකිය. ඉන් රටේ රැකිරක්ෂා හිඟයද බොහෝ දුරට මගහරවා ගත හැකි වේ. එසේම දැව කපාගත් බිම්වල ශ්‍රී ලත් වටිනා ගස් රෝපණය කළ යුතු වෙයි. මිනිස් වාසයට නුසුදුසු බිම් පෙදෙස් සොයා ඒවායේද ගස් වැවිය යුතුය. “ලංකාවේ වන සම්පත” සවිභාවයෙන් ලත් දායාදයකි. එය රැක ගැනීම දෙශානුරාගී රට වැසියාගේ පරම යුතුකම වේ.

ඉහත කී ක්‍රමයෙන් වන ගහනයන්ගෙන් ප්‍රයෝජන ගැනෙන්නම් ඉන් සුන්දරත්වයටද දෙශ ගුණයටද, වන සතුනට හා සාරවත් පසටද කිසිත් හානියක් සිදු නොවනු ඇත.

කුට ව්‍යාපාරිකයන්ගේ අසාධාරණ පොරෝ පහරට මේ ජාතික වනෝද්‍යානයන් බිල්ලට නො තබා රැකගෙන ඉන් ජාතියේ යහපත තකා ධනය උපදවීමට නම්, දැනට වඩා දැඩි පියවරක් ගත යුතුව තිබේ. මේ ජාතිඥ්‍ය, නින්දනීය සාපරාධී ක්‍රියාවන් කරන නිවටයන්ගේ අත් අඩංගුවෙන්, ලංකාවේ සුන්දරත්වය හැකි වන සතුනට රැකවරන දුන් පෘථිවියේ ස්ථිර තාවය සලසන වනගහනයන් මුදවා ගැනීමට රට වැසියාගේ නොවක් සහයෝගයද රජයට ලැබිය යුතුය.

මිනිසාට මෙන්ම ගත කොළටද නීතියේ සාධාරණත්වය තිබිය යුතුය. එය නො සලකන කුටෝපක්‍රමිකයන් අල්ලා ඔවුන් ජාති ඥාතියන් ලෙස හංවඩු ගසා, නීතියේ රැහැනට හසුකර ලීම වන ආරක්ෂක නිලධාරීන්ගෙන් සිදුවන, සිදුවිය යුතු ජාතික සේවයක් ලෙස රටවැසියා විසින් අදහස් කෙරේ. මෙසේ ස්ථිර පිළිවෙතක් උඩ, ජාති මමත්වයෙන් යුතුව රට වැසියා කටයුතු කළොත් අපේ ජාතික ධනය පෙන්වන සෞභාග්‍ය මුද්‍රිතමත් කරවන, සොදුරුබව දන්වන ලක් පොළොව සාරවත් කරවන, එහි ස්ථිර භාවය රකින, අප අභිමානයෙන් ප්‍රාණවත් කරවන සුන්දර වනෝද්‍යානයන් රැකගත හැකි වෙනැයි කල්පනා කළහැකි.

SOME GROWTH AND INCREMENT STUDIES FOR SPECIES GROWN IN THE UP-COUNTRY FOREST PLANTATIONS

W. R. H. Perera.

THE extent of land so far reforested under the Up-Country Plantations Scheme is over 16,000 acres.

The main plantation blocks are situated at Pattipola—Meepilimana—Ohiya—Conical Hill—Errabedda—Diyatalawa—Kinigama—Kandapola—Mahakudugala—Dickson's Corner—Madulsima—Ettalapitiya and Uduhawa.

Diameter/Volumes curves

Diameter/Volume curves have been prepared for species grown in the following blocks—

Pattipola

Ohiya

Conical Hill

Errabedde

Kandapola

Mahakudugala

In each block trees covering the range of diameters of the respective species were felled, measured, and the volumes calculated. By graphical interpretation the volumes corresponding to the mid-diameter of each four inch diameter class were determined.

This data was used to prepare diameter/volume curves for the different species by Forest blocks—graphs 1-6.

Comparative Increments Rates

With the aid of data collected from sample plots situated throughout the plantations; the girth increments of the chief species in these plantations were determined. Increment data was collected up to an age of 30 years. By extrapolation of Age/Increment graphs, increment up to 40 years was estimated. Comparative girth increment curves for the different species were drawn, up to 40 years—which is the rotation age for these plantations—Graph 7.

These studies are meant purely for use by local Forest Officers in plantation work and in their day to day Forest Mensuration work.

Species

Eucalypts—*E. saligna*; *E. microcorys*; *E. pilularis*; *E. robusta*; *E. globulus*.

Cypress—*cupressus macrocarpa*—*Accacia melanoxylon*.

Rainfall Statistics

Average annual rainfall over a 30 year period—

	Station	Elevation	Rainfall
Conical Hill	..	5600'	114.2 inches
Mahakudugala (7 year period)	..	5500'	114.0 "
Ambawella (Pattipola Plantation)	..	6200'	105.8 "
Kandapola	..	6500'	94.0 "
Ohiya	..	5820'	90.6 "
Errabedde	..	4100'	69.2 "

MONTHLY DISTRIBUTION OF RAINFALL DURING THREE DIFFERENT YEARS

1. Conical Hill

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
9.63..	5.58..	5.08..	8.15..	11.78..	22.09..	8.10..	9.08..	8.32..	7.47..	6.35..	1.50..	104.3
13.90..	4.14..	1.97..	10.58..	15.16..	32.17..	15.19..	4.55..	16.39..	11.80..	12.34..	6.59..	138.78
5.10..	1.79..	10.17..	9.10..	8.09..	16.34..	6.71..	10.62..	4.20..	15.46..	9.86..	3.87..	95.31

2. Mahakudugala

31.95..	14.61..	7.98..	13.68..	2.43..	4.46..	.50..	7.79..	11.27..	5.11..	7.51..	10.13..	117.32
10.47..	11.72..	1.89..	5.03..	9.23..	3.51..	6.41..	1.23..	2.47..	8.28..	24.34..	64.94..	149.32
8.19..	2.52..	6.60..	5.06..	1.05..	9.43..	2.47..	.69..	.57..	6.83..	22.90..	21.39..	87.70

3. Ambawella

(Pattipola Plantation)

7.25..	14.61..	1.26..	12.46..	7.22..	5.58..	10.19..	7.18..	16.17..	10.76..	10.47..	2.71..	105.87
6.60..	5.85..	5.59..	11.22..	14.08..	7.59..	7.25..	11.17..	8.02..	6.69..	10.57..	8.15..	109.78
4.78..	3.97..	1.34..	13.13..	7.25..	15.15..	10.42..	5.10..	6.44..	8.88..	10.99..	6.16..	93.61

4. Kandapola

20.09..	10.66..	6.69..	10.09..	5.62..	3.51..	.49..	3.67..	11.96..	5.20..	4.93..	6.83..	89.84
7.58..	8.62..	.62..	6.85..	10.18..	3.78..	3.70..	1.36..	1.74..	9.12..	18.27..	42.82..	114.64
4.63..	5.39..	1.21..	13.99..	4.26..	6.58..	4.30..	2.17..	5.92..	6.39..	14.39..	10.04..	79.29

5. Ohiya

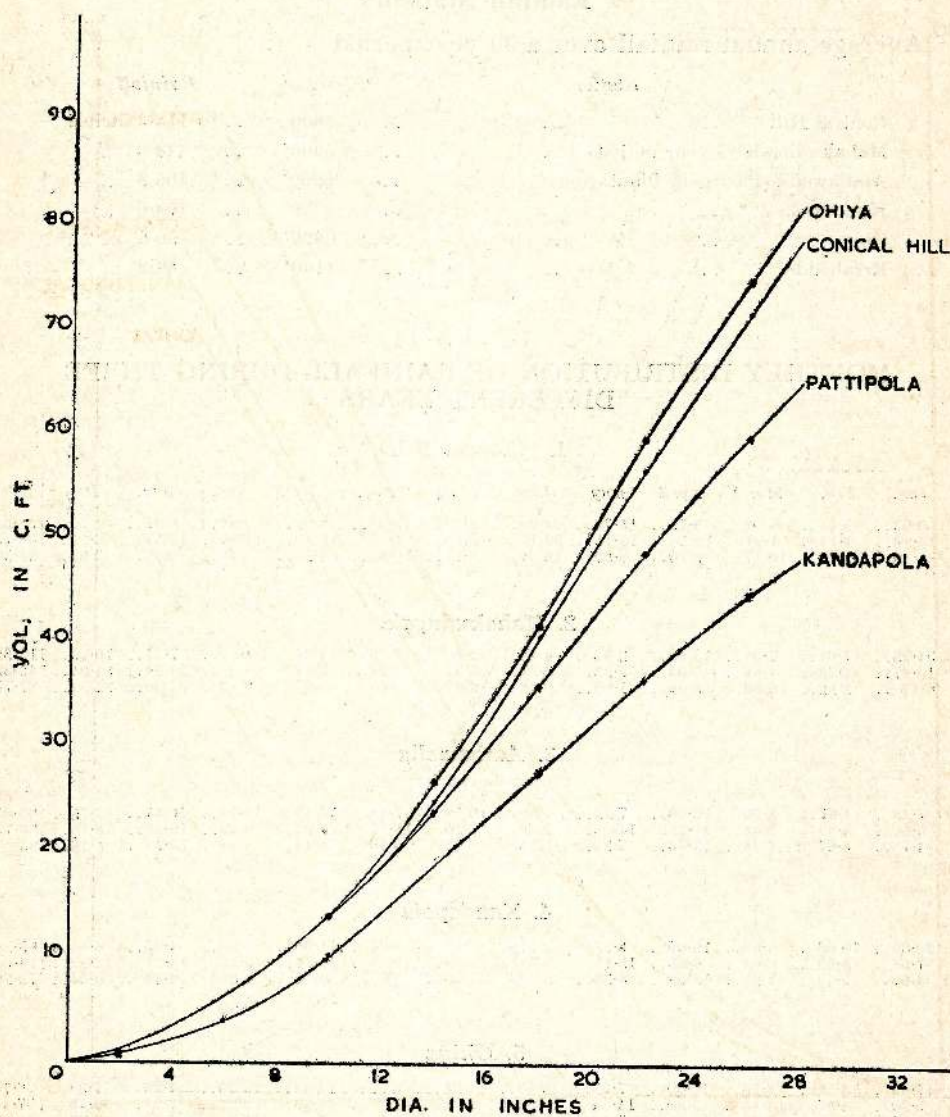
17.49..	8.51..	8.15..	10.50..	7.51..	3.53..	1.22..	6.55..	12.34..	9.30..	4.26..	7.38..	96.76
5.30..	4.67..	3.44..	13.00..	14.79..	1.92..	2.72..	1.10..	1.90..	12.22..	17.27..	30.18..	107.44
3.57..	3.73..	2.02..	10.21..	7.42..	5.78..	3.20..	1.11..	2.50..	11.45..	11.34..	9.22..	71.59

6. Errabedda

15.54..	6.10..	5.56..	9.05..	1.97..	1.17..	.80..	3.27..	9.27..	8.96..	4.86..	3.56..	70.1
4.17..	3.14..	1.27..	7.82..	5.65..	1.30..	1.72..	0.09..	1.58..	12.81..	12.54..	28.14..	80.13
6.48..	1.34..	6.11..	5.03..	5.53..	0.97..	1.50..	3.67..	3.36..	10.84..	7.53..	4.96..	57.32

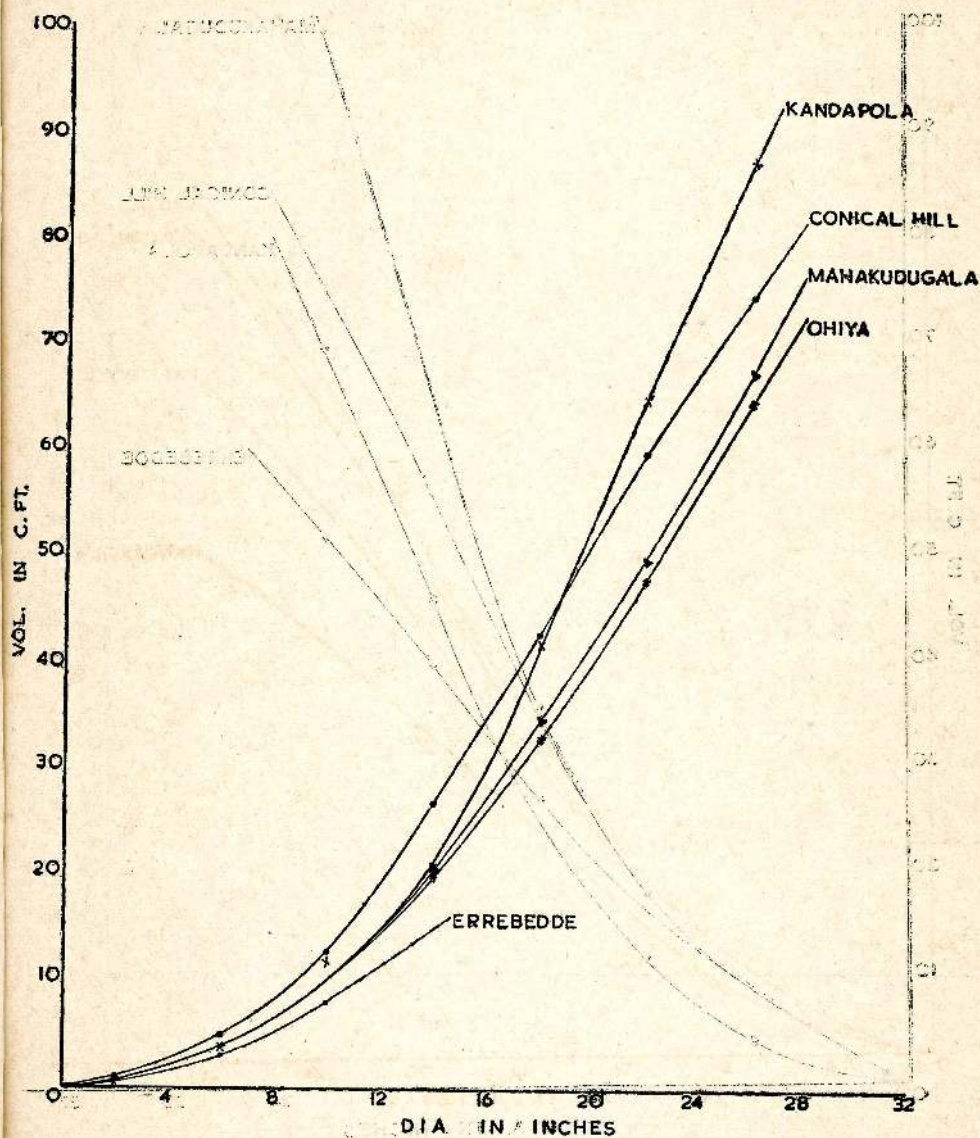
GRAPH 1

DIA./VOL. CURVES - UP COUNTRY PLANTATIONS
CYPRESS



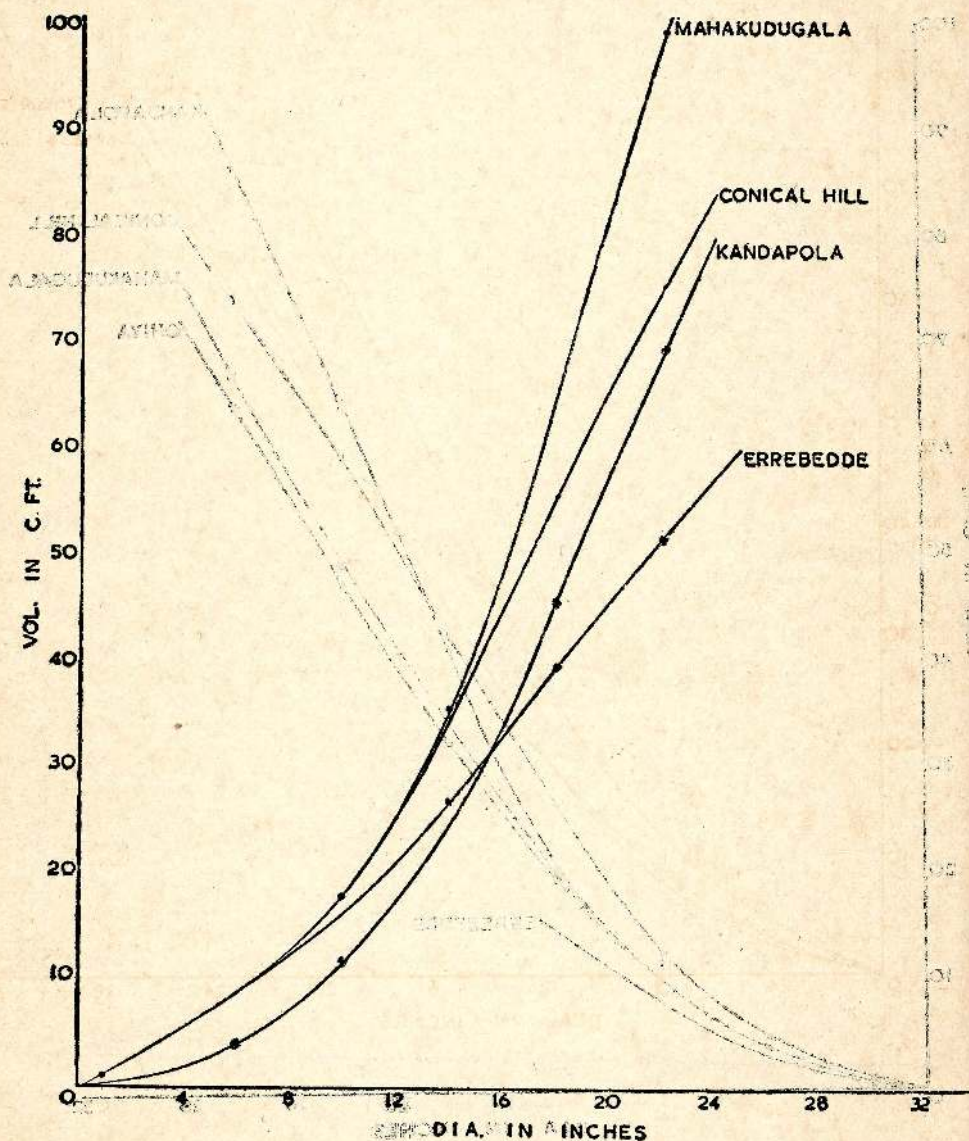
GRAPH 2

DIA / VOL CURVES - UP COUNTRY PLANTATIONS
EUCALYPTUS MICROCORYS



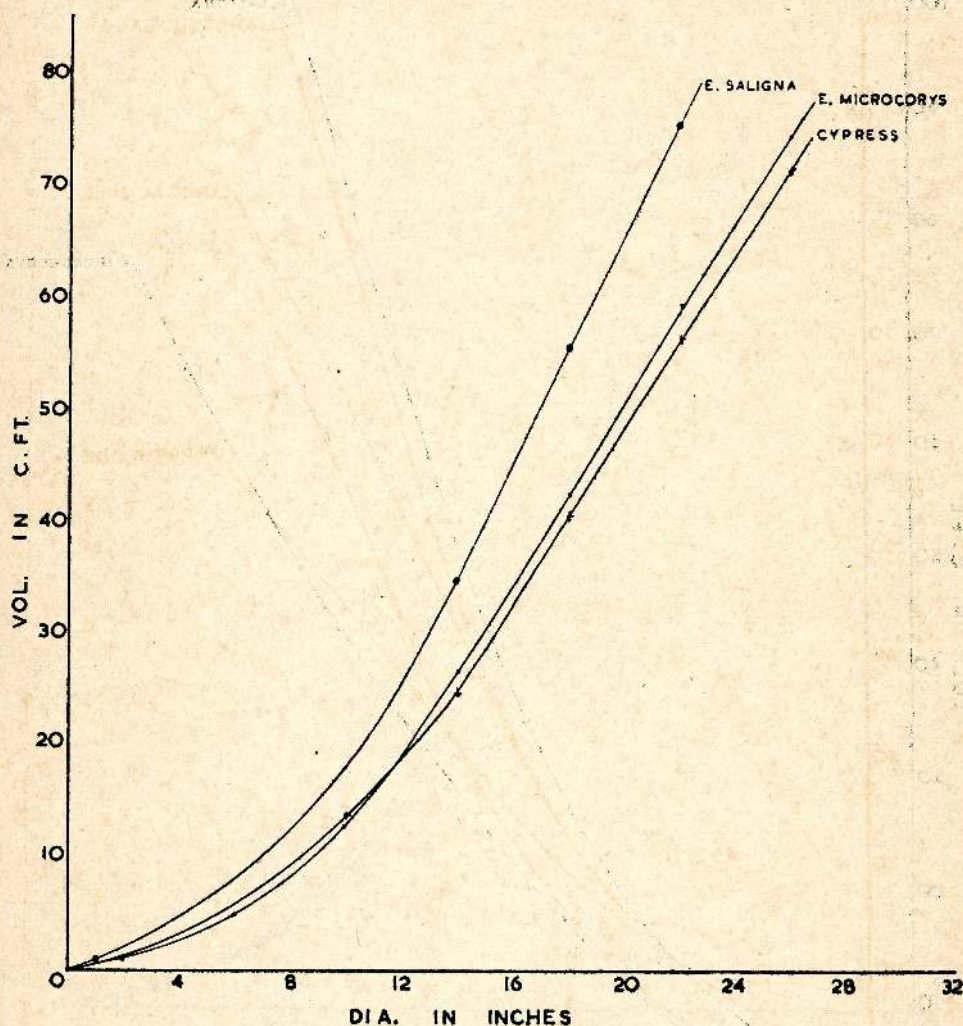
GRAPH 3

DIA./VOL. CURVES - UP COUNTRY PLANTATIONS
EUCALYPTUS SALIGNA



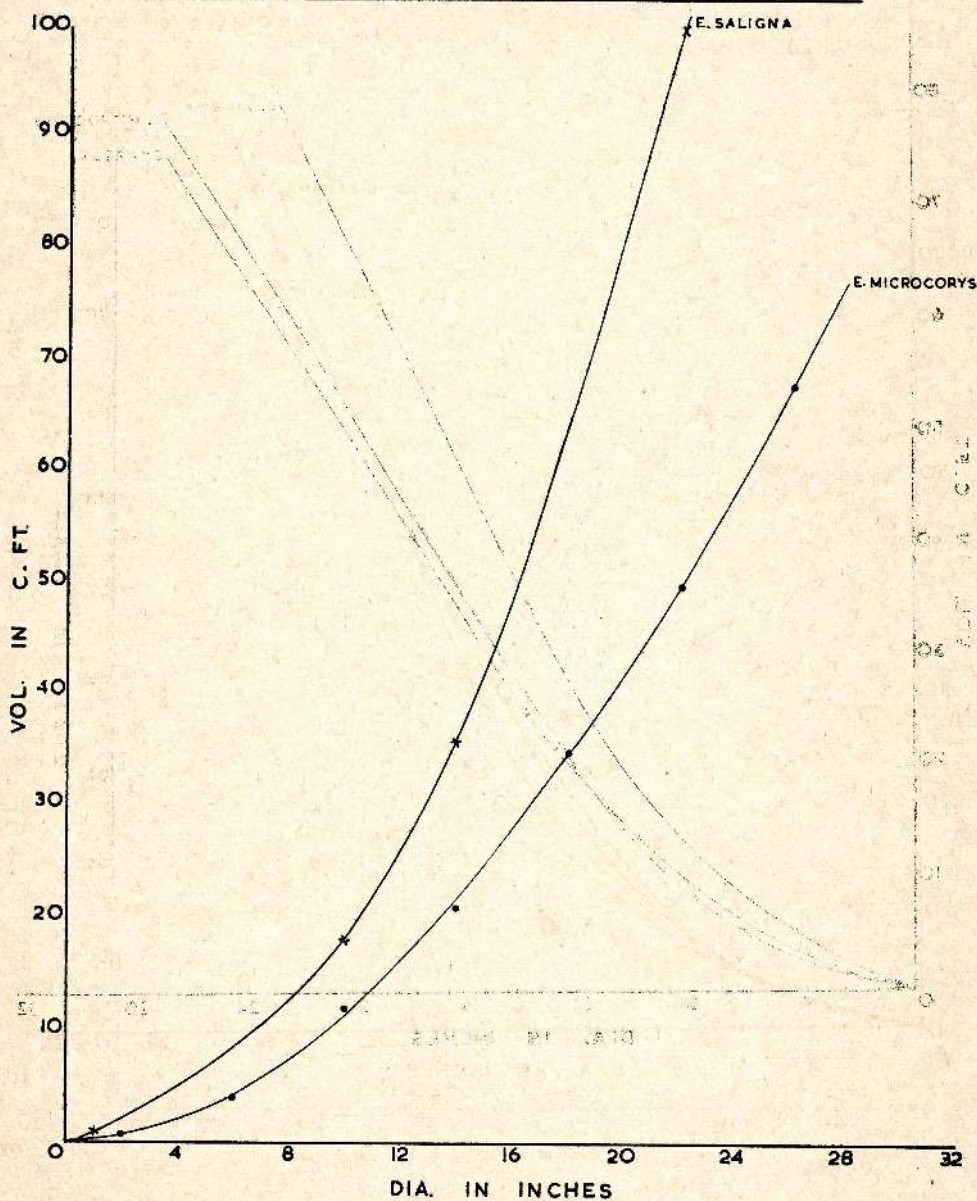
GRAPH 4

CONICAL HILL
DIAMETER / VOLUME CURVES



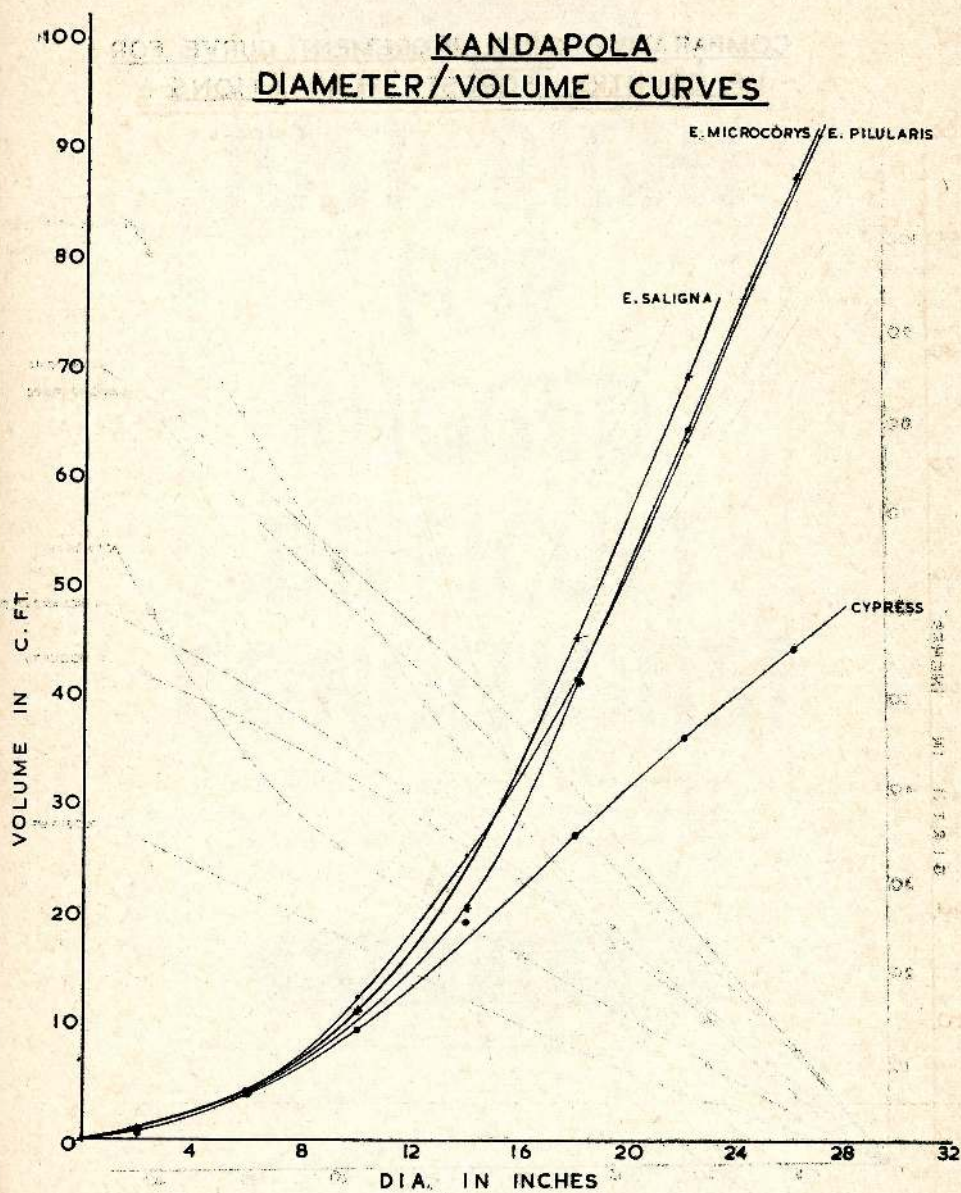
GRAPH 5

MAHAKUDUGALA DIAMETER / VOLUME CURVES



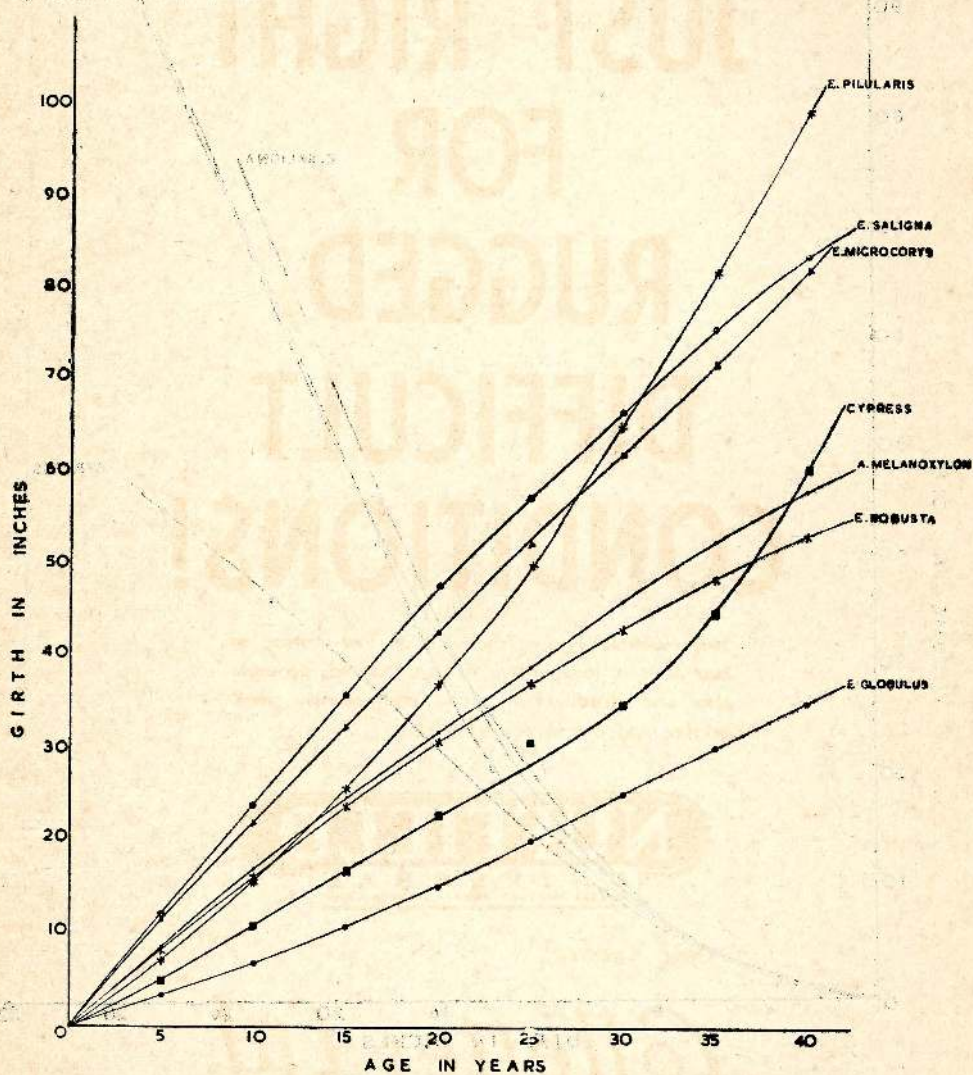
GRAPH 6

KANDAPOLA
DIAMETER/VOLUME CURVES



GRAPH 7

COMPARATIVE GIRTH INCREMENT CURVE FOR
UP-COUNTRY FOREST PLANTATIONS





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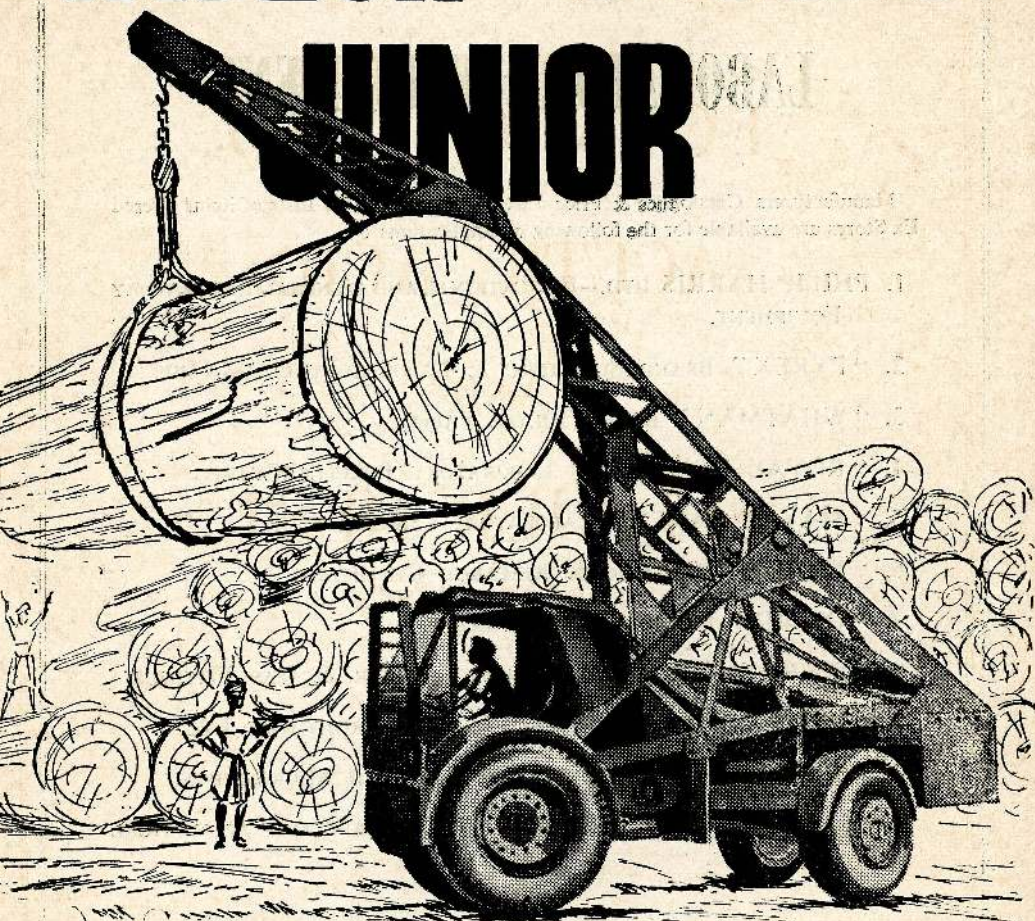
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