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Report

ON

FORESTRY IN KENYA COLONY

BY

R. S. TROUP, C.I.E.,

Indian Forest Service; Professor of Forestry in the University of Oxford.

PUBLISHED FOR THE GOVERNMENT OF KENYA BY THE CROWN AGENTS FOR THE COLONIES,
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University of
California

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Report

ON

FORESTRY IN KENYA COLONY

By R. S. TROUP, C.I.E.

INTRODUCTION.

This Report is based on a visit to the Forests of Kenya Colony from the 9th September to the 8th October, and from the 1st to the 27th December, 1921, the intervening period being devoted to an inspection of the forests of Uganda. The forests visited were those of Mt. Kenya, the West Aberdares (Kinobop), West Mau, Tinderet, Eldama Ravine (Grogan concession), N. Nakuru, Naivasha, Escarpment, Royi, Lari, Ngong and Karura, as well as the plantations of Lari, Kikuyu, Londiani, and other localities where the reafforestation of areas cleared for railway fuel is in progress. Denuded areas in native reserves were visited near Machakos in the Wakamba reserve and in several parts of the Kikuyu reserve. Want of time prevented an inspection of the forests in the coast region, and it is impossible, therefore, to make recommendations regarding them. I was accompanied for part of the time by Mr. E. Battiscombe, Conservator of Forests, and for the remainder of the time by Mr. H. M. Gardner, Acting Senior Assistant Conservator of Forests; to these officers, as well as to other persons from whom I received assistance, I am much indebted.

1.—FOREST AREAS.

1. The forest area of Kenya Colony has not yet been accurately computed, but the following figures, taken from the Forest Report for 1920-21, may be regarded as approximate :—

	Square miles.
Total area of Colony	245,060
Area of agricultural land... ..	47,170
Area of forest :	
Merchantable (including bamboos), 3,600; unprofitable or inaccessible, 1,500	5,100
Percentage of total land area covered by forest, 2·08 per cent.	
Ratio of merchantable forest to agricultural land, 7·63 per cent.	

Private forests occupy 100 square miles, and State forests 5,000 square miles, of which 2,200 square miles or 44 per cent. are timber forests, and 2,800

square miles or 56 per cent. comprise bamboo areas, open moorlands and unexplored forests. The area of State forest actually administered at present is roughly estimated at 3,207 square miles.

In comparison with that of most countries the ratio of forest area to the total land area is very small, as will be seen from the following pre-war figures :—

Japan (excluding Formosa and the Kurile Islands), 59 per cent.; Canada, 38 per cent.; European Russia (excluding Finland), 36 per cent.; Austria-Hungary, 30 per cent.; U.S.A., 29 per cent.; Germany, 26 per cent.; Norway, 21 per cent.; and France, 18 per cent. In British India State forests alone occupy 23 per cent. of the total area, but of these about half the area consists of "unclassified forests," a portion of which will ultimately disappear.

The relatively small percentage of forest in Kenya Colony might well give cause for alarm when it is considered that countries like France and Germany, with a percentage many times as great and with intensive systems of forest management producing high yields per acre, are unable to supply all their own timber requirements and have to make good the deficiency by imports. These two countries, however, are highly industrialized, and on this account are much larger consumers of timber than an agricultural and pastoral country like Kenya Colony is ever likely to be. Another point to be noted is that more than three-fourths of the area of the Colony consists of arid and sparsely populated tracts, covered largely with thorn bush, where the amount of timber and firewood consumed is negligible. Nevertheless, from the point of view of production alone, irrespective of other considerations, the forest area of the Colony has already been reduced to the utmost limit of safety. It is true that there is some prospect of building up an export trade owing to an estimated excess of production over home consumption (see paragraph 27). This excess, however, is to a great extent fictitious, and is due largely to the heavy over-exploitation of a considerable tract of valuable and accessible forest under the terms of a timber lease, which does not expire till 1958. This lease allows felling in such a manner as not only to exploit the legitimate increment of the forest, but also to make serious inroads on the forest capital; on its expiry, therefore, there may be a serious drop in out-turn unless this is compensated by (1) the building up of the forest capital throughout the Colony by systematic management, and (2) the opening up to regular working of forest tracts at present inaccessible. After 1958, therefore, with an increased demand for timber as a result of the extension of railway and other communications, and with the normal development of the country, the position may become one of considerable anxiety; local scarcity of fuel and small timber is likely to be felt even sooner, as is indeed already the case in some localities. The solution of the difficulty lies in the strict conservation and protection of all existing forests, the preparation of working plans, the introduction of more intensive systems of management and improved methods of exploitation, and the afforestation of denuded areas, where necessary, to supply local demands.

2.—DISTRIBUTION OF FORESTS.

ADMINISTRATIVE AND EXECUTIVE CHARGES.

2. The administrative head of the Forest Department is the Conservator of Forests, with headquarters at Nairobi. The distribution of the forests, and their allotment to divisional charges under Assistant Conservators of

Forests, are shown in the map accompanying this Report, and in the following statement:—

ALLOTMENT OF FOREST AREAS TO DIVISIONAL CHARGES.

Division	Headquarters.	Name of Forest.	Approx. area. sq. miles.	Remarks.
Coast	Mombasa	Shimbu Hills, Jombo, etc. Arabuko Mwachi Witu Mangrove creeks Total Coast Division	20 132 9½ 4½ 150 316	Very rough estimate.
Nairobi	Nairobi	*Karura Kamiti } Kyambu } *Ngong Capell } *Dagoreti } *Kikuyu } *Lari *Escarpment Royi *Kinobop Naivasha Total Nairobi Division	3 2 12 23 50 80 63 180 10 423	
Nyeri	Nyeri	*S. Aberdares Nyeri *Kenya & N. Kenya Total Nyeri Division	350 6 660 1,016	
Laikipia	Rumuruti	N. Aberdares and Laikipia *N. Nakuru and Olbolossat Total Laikipia Division	303 57 360	
Londiani	Londiani	*W. Mau *Grogan concession (part) Tinderet *S. Mau Nakuru Lake } Molo Total Londiani Division	110 252 170 250 22 804	
Uasin Gishu	Kapsaret (Eldoret P.o.)	Kapsaret Selater Road Grogan concession (part) Elgon Elgeyo Total Uasin Gishu Division	5 90 68 100 25 288	
Grand total administered forests			3,207	square miles.

* Forest station in charge of a European Forester.

Forest tracts amounting to nearly 2,000 square miles have not yet been demarcated or brought under the administration of the Forest Department.

The existing territorial charges are at present adequate, and new forest areas brought under the administration of the department may be conveniently included in one or other of them until such time as it is found convenient to increase the number of divisions.

3.—FOREST TYPES.

3. The forests of Kenya Colony are essentially evergreen, a fact which is due primarily to a well distributed rainfall and the absence of the long dry season which is accountable for the deciduous forests prevailing in the typically monsoon climates of India and Burma.

A complete study of the various forest types and sub-types in the Colony has not yet been made; meanwhile the following rough classification may be taken to include the main types:—

(1) *Mangrove forests*, situated along tidal creeks on flat muddy ground lying between high and low water mark. The prevailing species are those commonly found in the eastern region of the mangroves, and include *Rhizophora mucronata*, *Ceriops Candolleana*, *Bruguiera gym-norhiza*, *Avicennia officinalis*, *Lumnitzera racemosa*, *Sonneratia caseolaris*, and *Heritiera littoralis*. These forests are of considerable economic importance in supplying poles, fuel and tanning bark. Mangrove poles are at present exported more largely than any other form of forest produce, their chief destinations being the ports of the Persian Gulf and South Arabia.

(2) *Coast forests*.—These forests are situated in the tropical coastal belt, rising to an elevation of about 1,200 feet. They contain such trees as *Afzelia cuanzensis* (mbemba kofi), *Trachylobium Hornemannianum* (gum copal, mtandarusi), *Mimusops* sp. (n'gambo), *Combretum Schumanii* (mpera mwitu), *Brachylaena Hutchinsii* (muhuhu), *Erythrophloeum guineense* (mkelekele), *Tamarindus indica* (tamarind) and others.

(3) *Scrub forests*.—Under this term may be included a number of types extending mainly over large arid waterless tracts between the coast and the highlands, and consisting either of impenetrable thorn bush or of acacia scrub of varying density sometimes merging into open savannah types. The most important tree, occurring near the coast, is the African blackwood or ebony, *Dalbergia Melanoxylon*, but it is of small size and is usually crooked. Along rivers and watercourses special types of fringing forest make their appearance, among which may be mentioned the acacia ("fever-thorn") belts along the Athi and other rivers and the poplar (*Populus Denhardtiorum*) belts along the Tana River.

(4) *Savannah forests*.—These are open types of forest in which the trees are scattered over grass-lands. The trees are for the most part evergreen, attain a height of 20-40 feet, and often have rounded crowns. Among the more typical species are *Combretum splendens*, *Erythrina tomentosa*, *Dombeya umbraculifera* and *Bauhinia reticulata*. Special dry savannah types also occur in which species of acacia, often flat-topped, are prominent.

(5) *Plateau forests*.—These forests are situated on red laterite soil on the plains of the highlands at an elevation of 5,000 to 6,500 feet, and are typically represented in the neighbourhood of Nairobi, where the normal rainfall is 40 inches, and the climate is equable and fairly cool.

Essentially evergreen in character, they contain a considerable number of species, including *Brachylaena Hutchinsii* (muhugu), *Croton Elliotanus* (mukinduri), *Olea chrysophylla* (mutamayu, brown olive), *O. Hochstetteri* (musharagi, here at its lower limits and a small tree), *Piptadenia Buchanani* (mukvi, along streams), *Maba abyssinica* (muirosi), *Rawsonia usambarensis* (mutendera), *Markhamia Hildebrandtii* (muho), *Warburgia ugandensis* (muziga), *Calodendron capense* (Cape chestnut), *Strychnos Elliottii* (muteta), *Phyllanthus discoideus* (mukarara), *Teclea* sp. (munderendu), *Schrebera alata* (mutoma), *Gelonium procerum* (munyenye), *Acokanthera Schimperii* (murichu), *A. longiflora* (murichu), *Elaeodendron* sp., *Eugenia* sp. (by streams), *Drypetes Battiscombei* (munyenye), *Ekebergia Ruepelliana* (mununga), and *Chaetacme microcarpa* (maiuyu). Isolated specimens of cedar (*Juniperus procera*) are sometimes met with, but the trees are stunted and are below their usual elevation. There are occasional climbers and epiphytic figs, but these are not so abundant as in moister types of forest. There is a moderate undergrowth of grass, herbs and shrubs, including *Indigofera*, *Abutilon*, *Ardisia*, *Clausena anisata*, various *Compositae* and *Acanthaceae*, and in open places *Dodonaea viscosa*, *Carissa edulis* and bracken fern. The forest varies in quality, being stunted and dry in character where the underlying rock is near the surface. The predominating tree likewise varies, in some places muhugu (*Brachylaena*), in some olive, and in some croton, becoming almost gregarious. Croton regenerates with great freedom, and muhugu regeneration is often plentiful, especially where the soil is exposed and there is no heavy growth of grass. The most important tree of this type of forest is muhugu, remarkable in being a giant composite reaching a height of 100 feet and occasionally more, with a long, clean, but much fluted and irregularly shaped bole; the wood is hard, compact, fragrant, very durable and resistant to termites, and is an excellent fuel.

(6) *Cedar forests*.—These, the most important timber forests in the Colony, are characterised by the presence of the East African pencil cedar, *Juniperus procera*, a large evergreen tree ordinarily attaining a height of 60-70 feet, but under specially favourable conditions reaching a height of 120-150 feet and a girth of 12-18 ft. The true home of the cedar is on the slopes of the mountains at an elevation of 7-9,000 feet, with a rainfall of 40-55 inches, though it occasionally ascends or 9,500 feet or higher, and descends to 6,000 feet or even lower. Within its altitudinal range its distribution is governed largely by rainfall; generally speaking, where the rainfall exceeds 55 inches, the cedar forests give place to moister types of evergreen forest in which the cedar is absent. Cedar forests extend into comparatively dry regions where the rainfall is as low as 25 inches, but here the trees are usually stunted and badly shaped.

The forests are evergreen in character, the chief companions of the cedar being *Podocarpus gracilior*, *P. milanjanus*, *Olea Hochstetteri* (musharagi), *O. chrysophylla* (mutamayu, brown olive), *Warburgia ugandensis* (muziga), *Rapanea rhododendroides* (mugaita), *Dombeya Mastersii* (mukao), *Toddalia nobilis* (munderendu), *Teclea* sp. (munderendu), *Celtis Kraussiana* (murundu), *Weihea africana* (musaizi), *Allophyllus abyssinicus* (mushami), *Eugenia* sp., *Olinia* sp. and other trees. There is a somewhat dense undergrowth of shrubs, chiefly evergreen, and herbaceous plants; among these may be mentioned *Myrsine africana*, *Trichocladus ellipticus* (wych hazel, forming a dense growth in valleys and moist places), *Rubus* spp., *Rhamnus prinoides*, *Plectranthus* spp., *Impatiens* spp., *Acanthus eminens*, *Mimulopsis Thomsonii* (reaching a height of 6-10 feet and forming dense masses in fertile places) and

other Acanthaceae. In damp places ferns are common, and the trees are often festooned with moss and pendulous lichens. Climbers are common, the large climber *Toddalia aculeata* being conspicuous, and epiphytic figs are met with occasionally. In open places grass makes its appearance in quantity, together with many Compositae and Labiatae, bracken fern, *Indigofera*, *Cluytia*, *Dodonaea viscosa*, *Hypericum Schimperianum*, *Crotolaria agatiflora*, and other shrubs and herbaceous plants.

The cedar forests are often much intersected by grassy glades, particularly towards their lower limit; this is well exemplified in the submontane tracts of W. and S.W. Kenya, where the cedar is found in stunted form mixed with dry evergreen bush in clumps and patches of varying extent alternating with grasslands. Among the poorer and drier types of cedar forest towards the lower limit of the species may be mentioned that in which the cedar, which is usually stunted, badly shaped, unsound, and often severely attacked by a loranthaceous parasite, is associated with *Olea chrysophylla* (olive), *Ardisia* sp., and other dry evergreen trees of small size; there is a soil-covering of dry grass and shrubs, among which *Tarconanthus camphoratus* (m'lelishwa) is often abundant, together with *Lippia asperifolia*, an aromatic verbenaceous shrub resembling lantana, and various composite plants. Fire does immense damage in these dry types of forest, but their maintenance and protection is desirable, since they are important sources of supply of fuel, fence-posts and other small material, as well as a certain amount of sawn timber.

No accurate estimate of the area of cedar forests or of the probable future out-turn of cedar has yet been made, nor will this be possible until systematic surveys for working-plans purposes have been carried out. Mr. Battiscombe has estimated that there are 50,000 acres of cedar forest within 20 miles of the Uganda Railway having an average stand of 500 cubic feet per acre, while with improved communications a much larger area will become available for exploitation. On the slopes of Mt. Kenya alone there are estimated to be some 75,000 acres of cedar forest.

The cedar is often badly attacked by a fungus (*Fomes juniperinus*), an account of which is given in paragraph 26.

(7) *Temperate rain forests*.—These forests occur on the eastern and southern slopes of Mt. Kenya and the eastern slopes of the Aberdares, in regions of heavy rainfall. The minimum rainfall necessary to produce this type of forest has not been ascertained, but it is probably about 55 to 60 inches. There is evidence to show that these forests at one time covered a much larger area than they do now, but the extensive destruction of forest by the Kikuyu has greatly curtailed the area, and the lower limit of this type may now be placed at about 7,000 feet, with an upper limit of between 8,000 and 9,000 feet, above which the bamboo zone is reached. The distinguishing characters of this type of forest are a dense luxuriant evergreen vegetation, a high atmospheric humidity, and a great variety of trees, some of which attain very large dimensions. The most important tree, which is not always present, but generally forms a distinct belt at about 7-8,000 feet, is *Ocotea usambarensis* (muzaiti or so-called "camphor"), an immense tree with a buttressed base and a clean cylindrical bole, not uncommonly attaining a height of 120 feet and a girth above the buttresses of over 30 feet. The timber is remarkable for its durability, fallen trees being found in the forest which have lain for decades without the slightest sign of decay or insect attack. Among other trees characteristic of this type of forest may be mentioned

Podocarpus milanjanus (often reaching a large size and regenerating freely under shade), *Albizzia fastigiata* (mukuruwe), *Pygeum africanum* (mueri), *Allophyllus abyssinicus* (mushami), *Weihea africana* (musaizi), *Olea Hochstetteri* (musharagi), *Warburgia ugandensis* (muziga), *Rapanea rhododendroides* (mugaita), *Cornus Volkensii* (mukorombosi), *Vangueria infausta* (mubirungombe), *Ekebergia Ruepelliana* (mununga), *Gelonium procerum* (munyenye), *Dombeya Mastersii* (mukao), *Panax* sp.? (mutati), *Conopharyngia* sp. (mwelele), *Xymalos monospora* (mwagwa), *Garcinia Gerrardii* (munyawa), *Webera* sp. (musigetu), *Vitex keniensis* (moru), *Ochna* sp. (mungarima), and a lofty sapotaceous tree, *Mimusops* sp. (muna), with a buttressed base; in open places two soft-wooded fast-growing euphorbiaceous trees, *Neoboutonia macrocalyx* (mutundu) and *Macaranga* sp. (mukuhakuha), spring up in great abundance.

Where the canopy is unbroken the undergrowth consists of evergreen shrubs and small trees, rubiaceous species being prominent, as well as two species of *Dracaena*; in very moist forest the undergrowth may be dense and impenetrable, but frequently it is possible to walk through it without discomfort. There is often an abundant growth of ferns on the ground, and in moist ravines there is a luxuriant growth of tree ferns, wild banana and giant lobelia (*Lobelia Gibberoa*), which sometimes attains a height of 30 feet or more. Climbers are numerous, some reaching a large size, and epiphytes are well represented, the trees being often festooned with moss and ferns, while large epiphytic figs are in evidence.

Where the canopy is heavily opened out, an entirely different undergrowth makes its appearance, the ground becoming covered with a dense impenetrable mass of shrubby and herbaceous growth, characteristic plants being *Triumfetta*, *Rubus*, and various Labiatae Compositae, Malvaceae, Acanthaceae, Solanaceae, etc., which are cemented together by various climbers, including Convolvulaceae, Cucurbitaceae, *Vitis*, *Thunbergia*, *Clerodendron* and others. In open places *Cassia didymobotrya*, a tall shrub with handsome yellow flowers, is found in masses, and the bracken fern is often plentiful along the edge of the forest and in the open ground outside it.

(8) *Other evergreen types*.—An evergreen type, drier in character than the moist rain forests, occurs at elevations usually between 6,500 and 7,500 feet, and with a rainfall of perhaps 45 to 55 inches. The component species include some of those of the cedar forests on the one hand and the moist rain forests on the other, and the type may be taken to be a transition form between these two main types; the vegetation is of a drier and less luxuriant character than in the case of the rain forests, but there is often a dense undergrowth of evergreen shrubs. In places this type merges into the plateau type. Among the commoner trees met with are: *Olea chrysophylla*, *O. Hochstetteri*, *Weihea africana*, *Calodendron capense*, *Teclea* sp., *Ochna* sp., *Nuxia congesta*, *Canthium Schimperianum*, *Warburgia ugandensis*, *Maba abyssinica*, *Ekebergia Ruepelliana*, *Pygeum africanum*, *Bersama abyssinica*, *Eugenia* spp., *Ficus* spp. and others. Sometimes cedar trees are found scattered in this type, while sometimes the remains of cedar stumps indicate that this tree once existed but had failed to regenerate itself. This type of forest would probably prove suitable for artificial conversion into cedar forest.

Among other types may be mentioned that in which the prevailing tree is *Pygeum africanum*, a type well developed in the cool moist region above the Kikuyu escarpment, at an elevation of 8,000 feet and with a rainfall of 55 inches. In the same region occur pure forests of *Dombeya Mastersii*, often associated with bamboos.

Dry evergreen bush forest occurs in various parts of the highlands, chiefly between 5,500 and 7,000 feet, among characteristic species being *Acokanthera Schimperi*, *Olea chrysophylla*, *Elaeodendron* sp., *Carissa edulis*, giant *Euphorbia*, and various stiff leathery-leaved, often thorny, evergreens. This type often represents the remnants of forest of better quality which has deteriorated through cutting, burning and grazing.

(9) *Bamboo forests*.—These forests, consisting of the one species, *Arundinaria alpina*, occur mainly between 7,500 and 10,000 feet, often forming a more or less continuous and extensive belt above the tree limit, but the bamboo, at its lower elevations, forms an undergrowth in tree forest. Some details regarding the bamboo will be found in paragraphs 37 to 41.

4.—FOREST RESERVATION.

4. DESTRUCTION OF FOREST.—The forest area of the Colony was at one time considerably greater than it is now. The curtailment of the area is due to various causes. Severe inroads have been made by the grazing fires of the Masai and by wasteful clearing for temporary cultivation on the part of the Kikuyu who, profiting by the security offered by British protection against Masai raids, have destroyed extensive areas of valuable forest since the advent of the British. In the earlier years of the Protectorate large tracts of forest were needlessly alienated before their value was fully appreciated or the machinery for reserving them could be brought into operation. More recently considerable areas have been alienated by surveyors anxious to secure good boundaries on paper without considering the actual existence of forest or grass-land respectively.

It has been noted above (paragraph 1) that from the producing point of view alone the forest area of the Colony has already been curtailed to the utmost limit of safety. It may be added here that that limit has already been exceeded in respect of the destruction of forest on which the maintenance of the water supply depends. The fact is now too generally known to require emphasising that forests in the catchment areas of streams exercise a most important influence in preventing denudation, and in holding up water in the soil after showers of rain and producing a regular flow from springs. The clearing of forest, on the other hand, results in the erosion of the surface soil and the rapid run-off of water after every shower, producing sudden floods after rain with a corresponding drying up of springs and streams in periods of dry weather. In this respect the forests of Kenya Colony, situated as they are for the most part on hilly country, exercise an important, not to say a vital, influence on the general prosperity of the Colony.

An official with long experience of the country informs me that cases have come under his personal observation in which the destruction of forests on the slopes of the Aberdares has resulted in certain streams which were formerly perennial becoming seasonal. That the effect of deforestation is already being viewed with alarm by settlers themselves is apparent from a resolution passed unanimously by the Ruiru Farmers' Association at a meeting held on the 15th December, 1921, to the effect that the Association viewed the deforestation of the river banks in the Kyambu district with much concern, and wished to draw attention to the serious desiccation of the rivers which was resulting, to the grave detriment of development below the reserves. This resolution refers to denudation on private land over which Government, having no riparian rights, has no control: the remedy is in the hands of the riparian owners, but it is advisable that legislation should be invoked to ensure the protection of streams and their banks against desiccation and denudation. The district in question was until comparatively recently covered with

forest, as was that part of the native reserve in which the sources of the streams are situated.

5. FURTHER RESERVATION.—Many forests under the administration of the Forest Department have not yet been gazetted, as the descriptions of boundaries have not yet been fully prepared: it is expected that the bulk of this work will be completed within the next year. In addition, considerable areas of forest still await reservation. These include the forests of Chepalungu (a large tract in the south-west of the Colony), S. Elgon, Nandi, Elgeyo and Marakwet, and the Masai reserve forests. These are all reported to contain quantities of valuable timber, and it is advisable that early steps should be taken to examine them with the view of declaring them forest areas under the Forest Ordinance.

5.—FORESTS IN NATIVE RESERVES.

6. CLASSIFICATION.—Forests and prospective forest areas in native reserves may be divided into two categories, (1) existing forests, sometimes of large extent, which are capable, or can be made capable, of contributing to the general timber or fuel supplies of the country, or whose conservation and maintenance may for other reasons be of more than local benefit, (2) small patches of natural forest, and areas to be afforested, which are only of local benefit and are of no special concern to the country as a whole. The former may be termed *major forests* and the latter *minor forests*. It is not intended to imply, however, that the functions of the two classes of forest should be totally different; thus major forests will be of as much benefit to the population in their neighbourhood as minor forests, while on the other hand there is no reason why surplus produce from the latter, after satisfying all local requirements, should not be sold to outsiders.

7. RESERVATION AND MANAGEMENT.—The reservation of forests in native reserves has been dealt with in the previous section. The question of re-foresting denuded tracts, partly for the supply of fuel and small timber for local use and partly to secure the indirect benefits afforded by the presence of forests, is a matter rightly regarded by officers concerned with the administration of native reserves as an urgent one, and after traversing considerable areas of native reserves which have been completely denuded of tree growth I am convinced that early steps should be taken to prepare schemes of afforestation and put them into operation.

In several respects it will be convenient to adopt the same procedure in dealing with major and with minor forests. Thus, both classes should be gazetted as Native Forest Areas and should be subject to the provisions of the Forest Ordinance, 1911. Their management and upkeep, and all work connected with afforestation, should be in the hands of the Forest Department, which should, however, be in close co-operation with the Administration on questions of general policy with regard to the conservation and extension of forest areas. Except when given free for special reasons, all produce supplied to the local population from the forests and plantations should be charged for at nominal rates. Apart from the fact that this is necessary in order to defray the costs of maintenance, experience shows that produce is valued more if paid for than if received free.

8. ACCOUNTING.—The question of accounting requires some consideration. It is held by the Administrators of the native reserves that gazetted forest land in those reserves would not be in the same category as gazetted forest land in territories outside the native reserves, because whereas all unalienated land in the latter territories is deemed to be Crown land, in the case of native reserves forest land as well as other land is dedicated to the

use of the natives. Hence it is held that so long as the whole of the direct native taxation goes into general revenue, any revenue derived from native forests should be credited to the Natives' Trust Fund. While accepting this principle, I am of the opinion that the most satisfactory way of administering the major forests will be for the Forest Department to assume entire control of them, all items of revenue and expenditure appearing in the Forest Department estimates and accounts under a distinct head "Native Reserve Forests." Separate costing will be necessary for each native reserve, so that the subsequent adjustment of accounts with the different native reserves could be effected without difficulty by the Treasury. The case of the minor forests is somewhat different. As these forests will be managed for the sole use of the natives and will not concern the community as a whole, revenue and expenditure could be dealt with most appropriately in the native reserve estimates and accounts.

9. SUMMARY OF PROPOSALS.—The following is a summary of proposed measures for dealing with forests and afforestation in native reserves:—

(1) Suitable areas of natural forest should be selected, demarcated, permanently reserved, and brought under systematic management and regeneration.

(2) Where no natural forest exists, suitable areas should be selected for afforestation under well-considered schemes for the supply of local requirements or for other purposes.

(3) Areas dealt with under (1) and (2) should be gazetted as native forest areas and should be subject to the provisions of the Forest Ordinance, 1911.

(4) Work connected with afforestation and the management and upkeep of native forests and plantations, should be the duty of the Forest Department, Administrative Officers co-operating so far as questions of general policy are concerned.

(5) Produce supplied to the local population from the forests and plantations should be charged for at nominal rates.

(6) In the case of major forests (*i.e.*, those maintained primarily for the benefit of the Colony as a whole) revenue and expenditure will appear in the Forest Department estimates and accounts: in the case of minor forests (*i.e.*, those maintained for the use of the natives) revenue and expenditure will appear in the estimates and accounts of the native reserve.

6.—DEMARCATIION.

10. PROGRESS OF WORK.—Where forest boundaries adjoin native reserves they are, as a rule, distinctly marked by cleared lines, supplemented in some cases by a line of gum trees. The work of continuing and completing the clearing of these boundaries is in progress for existing forest areas, but much requires to be done in respect of the forests which have not yet been gazetted, and it is advisable that this work should be proceeded with as rapidly as possible.

Where forest boundaries adjoin farm lands the farm beacons are taken to represent the forest boundary marks. These, however, are small and inconspicuous, and it is advisable that a more distinct form of demarcation, such as a cleared line and conspicuous numbered boundary posts, should be adopted wherever necessary, and particularly where Government forest adjoins private forest. This work is now in progress, but much remains to be done.

11. REVISION OF BOUNDARIES.—In certain localities considerable tracts of grass-land have been included within the forest boundaries, and it has been suggested that the boundaries should be revised so as to exclude these tracts. Certain of these grass-lands could, no doubt, be relinquished without detriment to the Forest Department, but if any scheme of revision is contemplated the Department should be represented on the revising body, and each case should be judged on its merits. It is important to note that suitable areas of grass-land within or adjoining the forests are necessary for the provision of grazing for animals working in the forests and for the flocks of squatters cultivating in them, while in the neighbourhood of bamboo areas or possible pulp-factory sites, special care should be taken not to alienate land suitable for the formation of fuel plantations; some indication of the area required for this purpose will be found in paragraph 42. It should be noted also that grassy glades of comparatively small size intersecting the forests should be maintained as part of the forest area, otherwise the Department will find it impossible to take adequate precautionary measures against fire.

7.—FIRE PROTECTION.

12. In the highlands special fire-protective measures are necessary mainly in the cedar and the plateau (muhugu) forests. Fire is one of the most serious forms of injury to which the cedar forests are subject, and it is no exaggeration to say that the damage from this cause alone has run into at least a million pounds, and in all probability greatly exceeds this figure. Apart from this, it is probable that much of the damage done by the cedar fungus owes its origin to the admission of spores through wounds caused by fire (*see* paragraph 26).

In former years much of the damage done by fire in the Aberdares and elsewhere was, no doubt, attributable to the grazing fires of the Masai. More recently, in forest areas which no longer adjoin Masai country, the greatest offenders have been Nderobo and Kikuyu honey hunters, who leave fires burning within the forests, or in some cases set fire to trees in order to smoke out bees. For the prevention of fires originating within the forests in this way fire-lines are of no avail, but the Forest Department has achieved considerable success by a system of strict patrolling. Honey hunting without permit is now an illegal act, and the practice is regulated by giving permits for the placing of honey-barrels in trees, the position of which is notified to the Department; such authorized honey-hunters are an assistance rather than a source of danger, in that they assist in their own interests by reporting cases of unauthorized honey-hunting. Recently, experiments have been made in burning grass-lands in the cedar forests early in the season before there is danger of the fire spreading into the forest. This operation, which is regularly carried out in India, has proved successful in reducing the danger from fire, for although the bush round the edges of the forest, and occasional young cedar trees, are scorched at the time of burning, the damage is negligible compared with what it would be in the event of a conflagration in the middle of the fire season.

Fire-protective measures have not yet been fully organized, and are effective only within a comparatively limited radius of forest stations. In certain localities a system of fire-traces is adopted, but so far experience has shown that in the majority of cases strict patrolling is more effective as well as more economical than the maintenance of cleared traces. In dealing with outbreaks of fire the presence of labour on the spot is a valuable asset, and when plantation work on the system advocated in paragraphs 21 and 22 is fully organized the presence of cultivators should constitute an important safeguard. When such plantation work is carried out on a large scale some effective method of safeguarding the cedar plantations will be necessary,

such as their division into blocks separated by cleared lines or belts of heavy evergreens. Along the railway line inflammable coniferous plantations have too frequently been formed close to the railway line without a sufficiently wide fire trace, and have suffered from fires in consequence. It would be advisable in future, when planting cedar near the railway, to protect it by means of a heavy evergreen belt along the sides of the line, supplemented if necessary by a cleared fire-trace.

The necessity of enforcing strict fire-protection in all forests requiring it, and particularly in the cedar forests, cannot be too strongly emphasized.

8.—PLANTATIONS.

13. The total area under plantations is not known, but it must be considerable, since systematic planting has been undertaken each year in tracts near the railway where the natural forest has been cleared for fuel, and a certain amount of planting has been carried out in other forests. In cleared railway fuel areas this work is in arrears to the extent of some 13,000 acres, largely owing to insufficiency of labour.

Planting is done almost entirely with the aid of temporary cultivation with maize or other crops, and the work is carried out efficiently and cheaply. The cost of clearing, planting and initial weeding works out at about £1 an acre, this being exclusive of the cost of staff and of raising the plants in the nursery. With the view of cheapening the work still further, experiments might be made to ascertain if species whose seed is plentiful and not too minute could be raised by direct sowings, preferably in lines or evenly spaced patches.

In the earlier years of the Forest Department too much stress was laid on the introduction of exotics, a procedure which has little to recommend it in a country possessing so many superior timbers as Kenya Colony does. Thus, numbers of cypress plantations have been formed which, judging from their growth, will never have the value that plantations of the local cedar will have. Pines, as a class, and indeed most exotic conifers other than some of the cypresses and their allies, have proved a complete failure, the climatic conditions being unsuitable. Many of the exotic trees mentioned in Appendix III. of Hutchins' "Report on the Forests of British East Africa" (1909) as suitable for the East African highlands must inevitably fail in that locality.

The criticism as regards the introduction of exotics does not, however, apply in regard to the gums, wattles, and certain other Australian trees. Some of these have succeeded admirably, certain species of *Eucalyptus*, and in particular *E. Globulus*, showing remarkable growth. For fast-growing fuel plantations, none of the indigenous trees yet tried can approach them.

The Forest Department has been criticised for converting much of the indigenous forest into eucalyptus plantations. These plantations have been formed mainly along the railway, and are therefore much in evidence, which accounts largely for the criticism. As long as the railway consumes wood fuel the policy of forming them is a sound one, always provided the steam raising capacity of the wood is proved. But in many of the more recent plantations the eucalyptus is planted merely as a nurse for the local cedar, in order to promote clean growth and to afford protection, and in the course of a few years it will be removed and plantations of cedar will remain. Several other indigenous species of value are now being raised in the same way, and the craze for exotics is giving place to the wiser course of encouraging the better local species.

The Forest Department has done an excellent service to the Colony in raising tree seedlings in large numbers for sale to settlers and others at almost cost price. This adds greatly to the work of the Department without producing a corresponding return, but it is of such benefit to the country that it is to be commended in every way, and the service rendered appears to be generally appreciated.

9.—RESEARCH.

14. Although forest research has not yet been placed on an organized basis, a good deal of knowledge has been acquired as a result of experience, particularly in methods of raising plants and forming plantations. A great deal of useful work has been accomplished in regard to the botanical identification of the trees and shrubs of the Colony: this is due largely to the efforts of Mr. Battiscombe, himself a keen botanist. A fairly representative herbarium has already been got together at Nairobi, and the specimens have been named at Kew from duplicates sent there: new specimens are constantly being collected, and in time the herbarium should form a complete representation of the forest flora of Kenya Colony. Mr. Battiscombe has recently prepared a useful list of all the known forest trees and shrubs of the Colony, and proposes later to compile a descriptive list of these: such a list will be invaluable for purposes of reference. Much useful work has also been done in the experimental cultivation of trees, both indigenous and exotic, in the Forest Department arboretum at Nairobi.

Organized research work, however, is urgently required. There is little doubt that the most satisfactory and economical course would be to establish a central Forest Research Institute to serve the requirements of Kenya Colony, Uganda and Tanganyika Territory, work in certain branches being decentralized in matters of detail, but co-ordinated at the central institute. If a union of East African territories ever becomes an accomplished fact the establishment of such an institute should certainly be considered. In the present state of the finances of Kenya Colony and of the Forest Department, however, I hesitate to propose any scheme which is likely to involve much capital and recurring expenditure, even if the expenditure is likely to be recouped later as a result of the knowledge gained by research. As a beginning, therefore, it is proposed to create one post, namely, a Forest Research Officer, to be employed in the first instance on work of an urgent character. He should receive assistance at headquarters from the Personal Assistant to the Conservator (*see* paragraph 54). Such an officer, working in co-operation with local officers, could accomplish much useful work, and this would form the nucleus of more extensive work later on if a well-equipped Research Institute is established, either for Kenya Colony alone or for the combined territories of East Africa.

The work to be undertaken by the Research Officer would be as follows:—

(1) Care of the herbarium, arboretum, and collections of timber and other products.

(2) Study of the silvicultural characters of the more important trees, and the best methods of regenerating them artificially or naturally.

(3) Record of damage done by insects, fungi, and phanerogamous parasites.

(4) Measurements of the rate of growth and outturn of plantations, natural crops, and individual trees.

(5) Investigations into the growth and method of working of bamboos.

(6) Timber investigations, including :—

(a) Technical properties, especially durability. (Note :— Mechanical tests could best be carried out in Britain for the present).

(b) Seasoning experiments, including air seasoning, water seasoning, girdling, and artificial seasoning.

(c) Antiseptic treatment.

(d) Utilization of timber.

(7) Investigations connected with minor products, such as tans, gums, resins, fibres, paper pulp, etc., in collaboration with the Chemical Research Department.

As the work develops it will be necessary to employ an additional Research Officer, in which case investigations falling under (2), (3), (4) and (5) could be conveniently separated from those falling under (6) and (7). The detailed investigation of pests and diseases may yet become a matter of urgency; in the meantime it will be sufficient, under the circumstances, to keep records of the nature and extent of the damage done and to collect specimens for identification. Local officers could assist materially in this work.

The results of research work should be published, and a useful forest literature for the Colony would thus be gradually compiled. Among publications which are most urgently required are (1) a pamphlet, for the use of settlers and others, giving notes regarding the characteristics of the more important indigenous and exotic trees suitable for planting under different conditions, with directions how to raise them and grow them in plantations and otherwise, (2) a pamphlet giving such information as is known regarding the characteristics and uses of the various timbers of the Colony.

10.—SURVEYS AND WORKING PLANS.

15. NECESSITY FOR WORKING PLANS.—In no branch of work is the Forest Department of the Colony so backward as in the preparation of forest working plans, of which none exist at present. Without working plans systematic work is impossible, and no accurate estimate can be made of the contents of the forests or the outturn which they are capable of providing year by year; nor is there any assurance that future supplies will be maintained by means of a regular programme of regeneration. There is little doubt that under existing conditions some of the forests have been and are being overworked and depleted, and that such forests may have to be closed to working for an indefinite period. This is unsound in principle, for a forest, if its productive capacity is to be taken full advantage of, should be worked continuously in such a way as to furnish the maximum sustained yield compatible with the improvement of the growing stock and the maintenance of future supplies by means of regenerative operations. The preparation of working plans, apart from securing the future of the forests, will have the effect of stabilizing the outturn, with the result that licensees will have some assurance as to the probable annual outturn they are likely to obtain and the areas from which the outturn will be available each year or period of years: this will enable them to make suitable plans in advance for the erection of sawmills and the conduct of lumbering work, instead of working in the dark without any clear idea of the duration and location of future supplies. It is therefore of the greatest importance that working plans operations should be commenced as

soon as possible and pushed on as fast as staff and funds will permit. This work will include the preparation of planting plans for areas to be afforested.

16. **WORKING PLAN MAPS.**—The preparation of working plans depends on the existence of accurate topographical maps on a scale of not less than 2 inches to a mile. Of these there are few in existence, although the survey of boundaries has made very fair progress. It has been ascertained that the Land Survey Department is not in a position to carry out the programme of survey work proposed below. This is unfortunate, since that Department is the agency which could best undertake the topographical survey of the forests, as part of the general survey of the country. If it is not in a position to undertake the programme, the work will have to be undertaken by the Forest Department on lines laid down by the Land Survey Department. The maps required are topographical maps showing forest boundaries and all important interior details, such as roads and paths, grass-lands, swamps, ridges, streams and other natural features. Form lines should be drawn in, altitudes being entered where possible: the altitudes of many cadastral points have already been determined, and interpolation can be carried out with the aid of an aneroid. Following the existing practice, the drawing and printing of the maps could best be undertaken by the Topographical Branch of the Geographical Section of the War Office.

The following statement gives particulars of available maps, prepared chiefly from surveys by the Forest Surveyor, which are, so far as they go, suitable for working plans purposes, though some of them are as yet incomplete:—

AVAILABLE MAPS SUITABLE FOR WORKING PLANS PURPOSES.

Division.	Forest.	Area.	Scale.	Remarks.
		acres.		
Nairobi ...	Ngong ...	7,419	Part 1/6,336 or 10·095 in. = 1 mile Part 1/10,000 or 6·336 in. = 1 mile	Nearly complete.
	Karura ...	2,000	1/5,000 or 12·672 in. = 1 mile	Incomplete.
	Kikuyu Escarpment railway areas	—	—	Boundary survey with interior details to to about 1½ miles inside boundary.
Londiani ...	W. Mau ... (whole)	70,922	1/31,250 or 2·028 in. = 1 mile	Interior details not complete.
	W. Mau ... (Lumbwa sawmill cutting area only)	2,513	1/10,000 or 6·336 in. = 1 mile	
	Tinderet ...	75,000	1/25,000 or 2·534 in. = 1 mile	
Coast ...	Arabuko ...	84,760	1/30,000 or 2·112 in. = 1 mile	

There are also various plantation maps available.

17. **PROGRAMME OF WORK.**—The programme below, prepared in consultation with the Conservator of Forests, gives particulars of areas for which working plans are most urgently required, and of surveys to be carried out for the preparation of these working plans. The programme is estimated to

take five years to complete, and at the end of this period a revised programme should be prepared. The areas in several cases are only roughly estimated.

PROGRAMME OF SURVEYS AND WORKING PLANS.

(AREAS TO NEAREST SQUARE MILE.)

DIVISION.	FOREST.	SURVEYS.		WORKING PLANS, AREA AND AGENCY OF PREPARATION.		
		Area already completed.	Area to be surveyed.	Divisional Staff.	Special Working Plan Officers.	Total.
		sq. miles	sq. miles	sq. miles	sq. miles	sq. miles
Coast ...	Mwachi	—	10	10	—	
	Mangrove creeks	—	150	150	—	
	Total—Coast	—	160	160	—	160
Nairobi ...	Ngong	12	—	12	—	
	Karura	3	—	3	—	
	Capell, Dagoreti, Kikuyu...	—	23	23	—	
	Lari	—	50	—	50	
	Escarpment	—	80	—	80	
	Kinobop	—	180	—	180	
	Naivasha	—	10	—	10	
	Total—Nairobi	15	343	38	320	358
Nyeri ...	Nyeri	—	6	6	—	
	Kenya (W., S.W. and Meru)	—	200	—	200	
	Total—Nyeri	—	206	6	200	206
Laikipia ...	N. Aberdares and Laikipia	—	303	160	143	303
	N. Nakuru and Olbelosset	—	57	—	57	57
	Total—Laikipia	—	360	160	200	360
Londiani ...	W. Mau	55*	55	110	—	
	S. Mau and Nakuru Lake...	—	250	—	250	
	Total—Londiani	55	305	110	250	360
Uasin Gishu	Kapsaret	—	5	5	—	
	Sclater Road	—	90	—	90	
	Elgon	—	100	—	100	
	Elgeyo	—	25	25	—	
	Total—Uasin Gishu	—	220	30	190	220
GRAND TOTAL FOR COLONY ...		70	1,594	504	1,160	1,664

* Area estimated to have been completed.

18. **STAFF AND COST.**—(1) *Surveys.*—The present survey staff consists of one surveyor on £300—15—400 (draws £400) with travelling allowance of 4 florins a day. It is estimated that the work proposed in the programme could be carried out by one surveyor at the rate of 180 square miles a year; at this rate a total of 1,594 square miles could be overtaken by two surveyors in about $4\frac{1}{2}$ years, or, say, 5 years, allowing for accidents. It is proposed, therefore, to add another surveyor, though it is doubtful if it will be possible in the near future to obtain thoroughly qualified and experienced survey officers on less than £500 a year; on the other hand, considerable economy could be effected by placing the surveyors in charge of two or three subordinate parties working on the less intricate work, such as the filling in of interior details. So far, the cost of the Forest Surveyor's work has averaged less than £4 per square mile, including his salary. The work to be carried out under the programme, however, will be more detailed, and it is proposed to estimate the cost at £6 per square mile. The total cost will therefore be $£6 \times 1,594 = £9,564$, or, say, £10,000, that is £2,000 a year for 5 years.

(2) *Working Plans.*—Of a total area of 1,664 square miles it is proposed that Divisional Forest Officers should be responsible for the preparation of working plans for 504 square miles, the balance of 1,160 square miles being undertaken by special working plan officers, who will form part of the regular staff of forest officers. Working plans for this area could be prepared by two officers in 5 years, at the end of which period they will be required to proceed with a further programme of work. The cost of the work, excluding the salaries of the working plan officers but including their travelling allowances and all necessary labour, is estimated at £2 4s. per square mile, that is £3,661 or, say, £3,700 for the total of 1,664 square miles, or £740 a year for 5 years. It is important that all forest officers should, at some period in their service, be posted for a time to working plans duty either as officers in charge of parties or as assistants.

Expenditure on surveys and working plans may be regarded as directly remunerative, in that this work will lead to the systematic working and development of the forests on a scale on which this could not otherwise be attempted without grave risk.

19. **PROCEDURE RELATING TO WORKING PLANS.**—A working plan is a document regulating the management of a forest for a period of usually 10 to 20 years ahead, at the end of which time it is revised: its provisions are binding, and may not be deviated from without good reason, and then only under proper sanction. It is necessary, therefore, that a working plan should be scrutinized carefully before it is finally accepted. When a working plan for any forest or group of forests is contemplated, the first step should be the preparation of a preliminary report giving a short description of the forests and a brief statement, with any essential details, as to the lines on which the working plan will be prepared and the treatment proposed, with the reasons therefor: this report should be accompanied by a small-scale map showing proposed working circles and any other information that can be included. The preliminary working plan report should be submitted by the Divisional Forest Officer to the Conservator. In the event of a Chief Conservator being appointed (*see* paragraph 57) the preliminary report should be submitted to him, with the Conservator's remarks, for his approval, after which the preparation of the working plan may be proceeded with.

A working plan officer should be held personally responsible for the accuracy of the statistical and other information collected by him and entered in the working plan, and should be expected to visit the whole area dealt with. On completion of the working plan he should submit it to the Conservator, who will examine it in detail and satisfy himself that it has been prepared on correct lines. It is a recognized maxim, in connection with the preparation of working plans, that they should receive independent scrutiny

by two authorities, and hence, if a Chief Conservator is appointed the working plan should be submitted to him for further examination. Failing the creation of such an appointment, it is advisable that a second professional opinion should in any case be obtained. The working plan should finally be forwarded to Government for formal sanction.

Any deviations from the provisions of a sanctioned working plan should receive the sanction of Government, subject to the delegation of this power to the Conservator or Chief Conservator in cases which do not involve an alteration in the general scheme of management.

It is advisable that working plans should be printed and copies supplied to all forest officers in the Colony. Failing this at least three copies should be prepared, one each to be deposited in the Secretariat (or Chief Conservator's office) and the offices of the Conservator and Divisional Forest Officer.

Extra copies should also be supplied to Foresters to whose districts the provisions of a working plan apply.

In order to ensure that the provisions of a working plan are being correctly followed, the Divisional Forest Officer should submit each year to the Conservator control forms, prepared separately for each working circle, in which the results of operations for the previous year under each head of work are compared with the prescriptions of the working plan, any discrepancies being explained and sanction to deviations recorded. The control forms should be checked by the Conservator, and if a Chief Conservator is appointed they should then be submitted to him for final check.

It is not proposed to encumber this report with details as to the form of the working plan report and control forms: these will be available when required.

11.—SYSTEM OF MANAGEMENT.

20. DISADVANTAGES OF EXISTING SELECTION FELLINGS.—The forests of Kenya Colony have hitherto been worked under a rough-and-ready form of selection fellings, trees often widely scattered over an area being marked for felling if considered exploitable. No attempt has been made to fix the yield in any way, and the consequence has been that in not a few cases the forests have been heavily overworked and depleted of marketable timber without any compensation in the way of regeneration. It is only fair to add that this rough-and-ready method of working is often the only one applicable as a temporary measure to extensive tracts of mixed irregular forest, such as those of Kenya Colony, until a more rational system of management can be introduced. The time has now come, however, when this form of felling should be discarded wherever possible in favour of felling of a more concentrated kind.

Selection fellings under conditions prevailing in East Africa have certain grave disadvantages. In the first place there is great danger of the forest being overworked and of future supplies diminishing. In the second place there is no guarantee that trees removed will be replaced by regeneration; indeed, in the case of the cedar forests the gradual extermination of the cedar over considerable areas will be only a matter of time, since there is, in too many instances, little or no response in the way of natural regeneration as a result of the selection fellings carried out hitherto. In the third place, selection fellings add greatly to the difficulty and cost of working, since scattered trees have to be felled and extracted over a wide area. More concentrated fellings would reduce the cost of working considerably, and would in certain cases justify the construction of roads or other export lines which

would not be justified where selection fellings are in operation; they should also result in higher returns to Government, since prospective licensees are likely to offer higher tenders under a system providing for more concentrated working.

21. GENERAL SCHEME OF MANAGEMENT PROPOSED.—Eucalyptus plantations will be considered separately (paragraph 34): we are concerned here only with the natural forests, and may consider first the general scheme of management proposed, and then certain details as applied to some of the main types of forest.

It may be assumed that working sections have been suitably laid out; in most cases each will represent an area that can be worked continuously and perpetually by at least one sawmill. The rotation is then determined and divided for convenience into a number of periods, preferably equal in length to the revision period of the plan, and the working section is divided into the same number of approximately equiproductive periodic blocks. For example, a rotation of 100 years is divided into five periods of 20 years each; the age-classes in the respective periodic blocks should normally be:—I, 81—100 years; II, 61—80 years; III, 41—60 years; IV, 21—40 years; V, 1—20 years. In allotting compartments or crops to periods, generally speaking those containing most mature timber will be allotted to periodic block I, and similarly the dominant age classes will be taken into consideration in allotting crops to the other periodic blocks; actually, however, allotment by age-classes will probably not often be possible, since the forests are irregular and the age-classes are frequently mixed together, and in this case it is important to allot crops to periods in such a way as to afford the greatest convenience and economy in working, so that regeneration fellings should not be unduly scattered but should follow a regular sequence in conformity with a scheme for the construction and extension of roads and other export lines and the requirements of sawmills.

Final fellings will be of two kinds—(1) Main or regeneration fellings, (2) subsidiary or selection fellings. Main fellings will be carried out only in the periodic block under regeneration, that is, block I during the first period and the other blocks in turn during subsequent periods. In the majority of cases these fellings will be clear fellings with artificial regeneration. The aim will be to fell and regenerate the whole periodic block during the period, and it will facilitate the conduct of the work to allot equal annual coupes. It should be emphasized, however, that *the area actually felled each year should on no account be in excess of what can be planted up immediately*, and any portion of an annual coupe that cannot be clear-felled without being regenerated should be worked under selection fellings for the time being. Experience has shown that the most satisfactory and economic method of forming plantations is with the aid of temporary cultivation with field crops, and the success of this system of regeneration in each case will therefore depend largely on the number of cultivators available for the work.

The term "clear-felling" in the present case requires explanation. It does not necessarily imply that the timber licensee should be required to fell every tree on the area. Ordinarily cultivators will fell trees not felled by the licensee, and where this is the case the latter need not do more than remove all marketable material within a given time. The licence should define the meaning of "clear-felling" in each case.

Subsidiary or selection fellings have for their object the utilization of mature and overmature timber in periodic blocks not under regeneration. As a general rule periodic block II should not be included in the area worked under these fellings, since it will come under regeneration at no distant date, and a supply of mature timber should be retained for the regeneration fellings. The felling cycle adopted for the selection fellings

should if possible be equal to the period and the revision period of the plan, and the yield should be prescribed by area or out-turn, the usual safeguards as to minimum girth limit, etc., being applied. The opportunity should be taken to free promising stems of valuable species from suppression by stems of inferior species or others whose removal is desirable.

It may be objected that anything in the nature of clear felling in hilly country will result in the denudation of the hill-sides and interference with the water-supply. In the case of large permanent clearings this objection would be valid; but it is possible to arrange that no area felled in one place should be so large as to cause any such risk, while in any case all cleared areas would be planted up again without delay.

22. APPLICATION OF SYSTEM TO DIFFERENT TYPES OF FOREST.—
—(1) *Cedar forest*.—So far as can be foreseen it will be impossible to rely to any appreciable extent on natural reproduction as a means of regenerating cedar forests systematically. One fact is certain, namely, that in the great majority of cedar forests of the best quality, where, owing to the fertility of the soil, there is a heavy undergrowth, natural reproduction is for all practical purposes absent. It is true that under certain conditions natural reproduction appears in quantity, for instance, where the mineral soil has been recently exposed, as in borrow-pits along the railway, and round the edges of grass-lands bordering the forest. Again, in certain dry types of cedar forest, where there is no dense low undergrowth, natural seedlings may be found in quantity, particularly under the protection of m'lelishwa and other bushes. Perhaps the best examples of cedar forest arising from natural reproduction in the past are to be seen in the case of pure crops of considerable extent resembling well-stocked plantations, on the western slopes of the Aberdares and elsewhere. So far as can be ascertained, profuse natural reproduction must have taken place as the result of a combination of favourable factors, such as good seeding and timely and sufficient rainfall following on a severe fire. It is more than doubtful, however, if such conditions could be produced systematically with safety or success at a cost in any way comparable to that at which artificial plantations of cedar can be established with the aid of field crops. It is certain, therefore, that artificial reproduction will have to be relied on for the great bulk of the regeneration, and so far as can be foreseen at present the cheapest and most successful method of regenerating will be by means of clear fellings followed by artificial regeneration with the aid of field crops. Where the number of cultivators is insufficient to secure complete regeneration by this means, a subsidiary method, at present only in an experimental stage, may possibly prove successful; this is by means of planting in lines 10 or 12 feet apart cleared through the undergrowth and kept clear until the plants are free from danger of suppression.

Where healthy natural reproduction, whether of cedar, podocarpus or other valuable species, already exists in sufficient quantity to dispense with artificial reproduction, it should be taken advantage of where possible and freed from suppression. In the case of cedar, however, this applies only to masses of size and density sufficient to form a close crop of some extent; the retention of isolated saplings is not advisable in an area to be planted up, since these will develop into branchy trees producing knotty timber and interfering with the trees in the plantation.

(2) *Plateau forests*.—In the plateau (muhugu) type of forest considerable success has been attained by clearing round muhugu seed-bearers, the result being a plentiful crop of natural reproduction of this important species. It is possible, therefore, that much may be done by regeneration fellings and cleanings. The cost of such work, however, should be carefully

recorded, as similar work in Burma has generally proved to be more expensive than the formation of plantations with the aid of field crops. It is possible, therefore, that clear fellings with artificial reproduction may yet be adopted as the cheapest and most satisfactory method of regenerating the plateau forests in such a way as to maintain a stock of the most valuable species.

(3) *Camphor forests*.—The regeneration of the camphor (muzaiti) forests has hitherto proved an insoluble problem. These forests are characterised by the presence of camphor trees of gigantic size, with a great deficiency, and in some cases an entire absence, of smaller trees and young saplings. Seedling regeneration is believed to be absent, although the trees have the power of producing suckers and stool-shoots, and any young trees met with appear to have originated by such means. The number of young trees, however, is totally inadequate to maintain the future supply when the existing mature trees have been removed; the difficulty of the situation is intensified by the fact that artificial reproduction by seed is apparently out of the question, since there is only one record of good seed having ever been collected, and that only in small quantity; normally good seed has hitherto proved to be unobtainable.

What appears to be a solution of the difficulty came to my notice during a recent visit to the camphor forests at Katumayu on the eastern slopes of the Aberdares in company with Mr. H. M. Gardner. In these forests heavy fellings of large camphor trees had been in operation for the past four years. For two years after felling no reproduction had been visible, and the only result appeared to be a dense mass of weeds filling the large gaps created, with no prospect of maintaining the further supply of camphor. At the time of my visit the felled area presented an entirely different aspect. A vigorous growth of suckers and stool-shoots had made its appearance even from the largest stumps; these averaged about 10 in number from each stump, with a mean height of 12 feet in the case of trees felled $3\frac{1}{2}$ years previously, that is, for about $1\frac{1}{2}$ years' actual growth. These shoots had for the most part succeeded in pushing their way through the weedgrowth and were well established; the growth was most vigorous where there was most light.

These observations would appear to indicate (1) that large-sided camphor trees, when felled, are capable of producing stool-shoots; (2) that the felling of the tree stimulates a plentiful growth of suckers; (3) that these make little or no growth during the first year or two, but thereafter they begin to grow vigorously; (4) that the growth is most vigorous where there is abundance of light; (5) that the shoots are capable of pushing their way through a fairly heavy growth of weeds.

These observations require confirmation in other localities, but so far as they go they indicate the lines on which the camphor forests should be worked. Heavy selection fellings would no doubt secure the regeneration of the camphor by suckers and stool-shoots, and they would also result in the regeneration of other species by seed or otherwise. There are, however, two good reasons for not adopting selection fellings, first, that they will not necessarily produce an increase in the proportion of valuable species as a whole, and, second, that the camphor forests are situated on broken country which is difficult to work, and fellings of a more concentrated kind will facilitate working and cheapen the cost of extraction. It would, therefore, be advisable to adopt the general scheme outlined in paragraph 21, though in the present case there is an important modification, namely, that it would be unwise to carry out selection fellings of camphor in any area in which the resulting regeneration will not attain marketable size by the time the main fellings reach the area in question. This would confine selection fellings to areas allotted for regeneration late in the rotation. An exception should,

however, be made in the case of dead or dying camphor trees, and unsound or badly shaped trees interfering with promising camphor poles; these should be felled wherever selection fellings of other species are in progress.

Where camphor is present, the main fellings should consist of the felling of all camphor trees except those which are too small to exploit, with the view of obtaining reproduction by suckers and stool-shoots. Cleanings will probably be necessary from 3 to 5 years after the fellings, and possibly again later. Further experiment is necessary before determining on the precise treatment of the other species, but in areas where camphor is not present it is not improbable that clear fellings with artificial reproduction may prove to be the most economical and satisfactory method of obtaining a complete stock of valuable species. It should not be difficult to obtain labour for this, as the camphor forests border on the Kikuyu reserves.

Experiments are desirable in the artificial reproduction of camphor by means of cuttings taken from vigorous shoots or from roots. Thinnings in clumps of young stool-shoots might supply a certain proportion. If plants can be raised successfully by such means, advantage might be taken of the regeneration fellings to increase the proportion of camphor artificially.

12.—TIMBERS AND TIMBER TRADE.

23. UTILIZATION OF LOCAL TIMBERS.—A useful account of the more important timbers of Kenya Colony is contained in the publication entitled "The Forests and Timber Resources of British East Africa," prepared by the Forest Department for the Empire Forestry Conference in 1920. It is not proposed to delay this Report by the inclusion of further information regarding them which is not yet complete and which may take some time to compile.

The most plentiful and widely used constructional timbers are those of coniferous trees, namely, cedar (*Juniperus procera*) and podocarpus (*Podocarpus gracilior* and *P. milanjanus*). Cedar is the most important building timber in the country, mainly owing to its great durability and its immunity from the attacks of white ants. The question of its utilization for pencil manufacture is dealt with in paragraph 25. Selected planks of sufficient size, free from defects, would command a high price in the London market for panelling and mouldings, for which it has been pronounced by a leading timber merchant to be superior to any other pencil cedar yet imported. Podocarpus, when properly seasoned, is a wood of good quality, well adapted to take the place of imported pine and deal. It has, however, undeservedly acquired a bad name in certain quarters, mainly owing to faulty methods of stacking and seasoning, or to its having been used unseasoned, in which condition it shrinks and warps badly. In South Africa, it has been made the subject of trials in artificial methods of seasoning, the results of which have been published in a pamphlet entitled "The Seasoning of South African Woods," by Nils B. Eckbo (Office of the Chief Conservator of Forests, Pretoria).

Among hardwoods camphor or *muzaiti* (*Ocotea usambarensis*), which is obtainable in planks of very large size, stands first in point of quality and durability. Its merits are known locally, and it commands a high price: if it were available in larger quantities it would be more widely used. It could be employed effectively for many purposes for which teak is now used.

Without going into further detail regarding the timbers of Kenya Colony, it may be said that the variety and quality of these is such that there is scarcely any purpose for which one or other of them could not be used, thus dispensing to a large extent with imports not only of timber but also of manufactured wooden articles, which latter were imported in 1920-21 to the value of £3,113. Much remains to be done, however, in the way of collecting

information regarding the uses of local timbers and experimenting with the view of finding new uses for them. The question of seasoning is also one requiring serious attention. These and other questions mentioned under Research (paragraph 14) should be taken up by the Research Officer when appointed.

One firm has already taken steps to instal seasoning and impregnation plants.

24. PRICES.—Within recent years local timber prices have become inflated beyond all reason. I have endeavoured to form an accurate estimate of working expenses in connection with the extraction and conversion of timber, and am unable to reconcile these, even allowing for all possible difficulties, with the high prices demanded for timber in the local market. Government royalties represent only a small percentage of the working costs, and are not responsible for these high prices, which will have to be reduced considerably before there can be any marked development in the utilization of indigenous timbers.

The following are some of the prices in florins per ton recently quoted for timber at Nairobi :—

Cedar scantlings	162—168, boards	180—240.
Podocarpus „	132—150, „	144—192.
Musharagi „	150—192, „	168—240.
Mneri „	192, „	180—240.

25. CEDAR FOR PENCIL MANUFACTURE.—A certain amount of interest has been shown for some years past in the question of utilizing East African cedar for pencil manufacture, but this has for the most part taken the form of instituting enquiries and collecting information of somewhat academic value, while little of a practical nature has been done so far to develop trade in a wood which has a decided potential value for pencil manufacture. The question is one of Imperial importance, since the East African cedar is the sole source of supply of pencil cedar in commercial quantities within the Empire. Information from reliable sources indicates that future supplies of American pencil cedar (*Juniperus virginiana*) are by no means assured, and substitutes are already in use. On the other hand, with strict conservation and proper management the cedar forests of Kenya Colony should be able to provide large and perpetual supplies of wood for pencil manufacture. This being so, more care should be taken to prevent the wasteful use of cedar of good quality for building, fencing and other purposes. With this end in view it will be advisable to set aside, as early as possible, suitable tracts of cedar forest primarily for the production of pencil wood, only such portions of the outturn as are unsuitable for this purpose, or are in excess of the demand, being utilized for other purposes. Care in the selection of such tracts will be necessary in order to ensure : (1) wood of the best quality for pencils, and (2) easy and cheap extraction.

The question of turning out pencil slats of superior quality at a reasonably cheap rate is a most important one. At the inflated prices for timber which have prevailed in the local markets within recent years, combined with the high cost of railing to the coast, there will be little hope of establishing a trade in East African cedar for pencils in competition with foreign sources of supply. The setting aside of suitable tracts of cedar forest for the production of pencil wood, to be worked by or on behalf of firms interested in pencil manufacture, should remove competition with the local timber market. The industry should be regarded as a pioneer one, to be encouraged for the first few years by reduced royalties and preferential railway rates.

26. THE CEDAR FUNGUS.—The East African cedar is subject to the attacks of a wood-rot fungus, *Fomes juniperinus*, Schrenk, which is identical

with the species which attacks junipers in the United States. In Kenya Colony it is very prevalent in many of the cedar forests, and causes a vast amount of loss in timber production. It attacks the heartwood of standing trees, the spores gaining admission through the exposed bases of broken branches and through other wounds in which the heartwood is exposed. As a rule there is no outward sign of attack, the presence of the disease being revealed only after the tree is felled and cut open. Sometimes, however, the perennial hoof-shaped (ungulate) fructifications, woody in texture, with a rusty brown spore-bearing surface (pileus) on the under side, may be found growing on the side of the tree, almost invariably at a point where a branch has been broken off. When an affected tree is cut open the attack in its early stages is revealed by the presence of small flecks or pockets of whitish decaying tissue separated by sound wood. At a later stage of the attack irregular hollows of considerable size are formed containing masses of brownish yellow felty mycelium, and the tissues of the wood in the neighbourhood of the hollows are disintegrated and permeated by the hyphæ of the fungus. Sometimes the whole tree is hollow. Timber from affected trees may be entirely worthless, and even if a certain proportion of it is sound, conversion is rendered difficult, its cost is increased, and there is at the best a considerable amount of wastage.

The fungus attacks only the heartwood of trees, and it is not known to gain admission otherwise than through wounds. Trees are sometimes found to be hollow at the base, and it might appear therefore that the disease spreads upwards from the roots, gaining admission through them by contact with the roots of affected trees. I was unable to find any evidence of this mode of infection, which, on the analogy of other fungi of similar habits, is probably not characteristic of this fungus, though this statement requires verification. In the case of hollow bases it is more probable that the fungus, where present, has obtained admission through wounds caused by fire or some other form of injury. Trees are more affected in some localities than in others, and the presumption is that in the former case they have been more exposed to injury than in the latter. Young trees are less commonly affected than trees past middle age; this naturally follows from the fact that the latter contain more heartwood and have been exposed longer to the risk of attack.

The disease is to a large extent preventible. Since the spores gain admission through wounds in which the heartwood is exposed, the following measures should go far towards keeping it in check :—

(1) Strict protection from fire and other injury.

(2) The growing of cedar in close crops, preferably with the aid of nurses or in suitable permanent mixtures, with the object of effecting natural pruning of the branches while these are still young and have not begun to form heartwood.

(3) Periodical removal in thinnings of all stems with broken branches or wounds in which the heartwood is exposed, and those actually found to be attacked by the fungus.

Further information should be collected as to the conditions under which the disease is prevalent or the reverse, and as to the minimum age or size of trees attacked; it may thus be possible to fix the rotation so that trees may be felled before they become seriously affected.

27. IMPORTS AND EXPORTS.—The average annual imports of timber for the two quinquennial periods preceding the year 1916 were as follows :—

1905-09	...	...	...	3,079 tons valued at £13,141
1910-15	...	...	...	5,292 tons valued at £25,393

During the later years of the war imports declined considerably in quantity, but more recently they have risen again : thus, in 1918-1919 they amounted to 108 tons valued at £3,141, while in 1920-21 they amounted to 1,265 tons valued at £27,230. Prices rose considerably during and after the war. Imports consist chiefly of teak from Burma and coniferous woods; before the war the latter came principally from Scandinavia, but more recently imports from North America have increased considerably.

The average annual exports for the six years ending 31st March, 1919, amounted to 327,421 cubic feet (6,548 tons) valued at £11,873, of which 320,471 cubic feet (6,409 tons) valued at £10,633 consisted of mangrove poles for Arabia and the Persian Gulf.

The question of building up an export trade in East African timbers is worth consideration. An estimate prepared by the Forest Department shows an available annual surplus of over 24,000,000 cubic feet of timber after satisfying home requirements. Even allowing for a considerable increase in the local demand, and for unforeseen contingencies, there will probably be a very fair surplus for export. So far as is known at present, cedar is the only East African timber likely to be exported to England in any quantity. It is by no means certain that any of the hardwoods which are available in sufficient quantity possess such exceptional qualities that they will bear the cost of transport to the coast and thence to England in successful competition with the timbers of West Africa, or even of Burma and the Andaman Islands. This question, however, should not be considered as finally settled until further enquiries, now being prosecuted, have been concluded. There is a demand in the London market for African blackwood or ebony (*Dalbergia Melanoxylon*), but supplies of this are somewhat problematical. Consignments of specially selected figured wood, burrs and curls, will almost certainly find a remunerative market in the United Kingdom when the present period of trade depression comes to an end.

There is more likelihood of a successful development of trade with South Africa, and the trade with Arabia and the Persian Gulf might be further developed.

The long railway journey to the coast is a serious handicap. Even with the special rate of $1\frac{2}{5}$ pence per ton per mile to the coast, this means a total freight charge of £1 9s. 5d. per ton from Nairobi and £2 4s. 9d. from Londiani, or, say, an average of about £2 per ton from the timber districts. At the end of 1921 sea freights from East Africa to the United Kingdom were 70 shillings per 40 cubic feet for light timber and 100 shillings per 20 cwt. for other timber in logs, planks or boards. To South Africa sea freights were Fls. 20 per 40 cubic feet for timber and Fls. 15 per 40 cubic feet for sleepers.

Thus for freight alone by rail and sea from the highlands of Kenya Colony about £7 per ton weight would have to be reckoned on to the United Kingdom and between £4 and £5 to South Africa.

Even assuming that there may be a reduction in sea freights in future, the prospects of success in the development of an export trade will depend a good deal on the extent to which the cost of extraction and conversion of timber can be reduced by efficient and economical methods of working.

13.—TIMBER EXPLOITATION.

28. AGENCY OF EXPLOITATION.—Timber is felled and extracted entirely by purchasers under leases, licences or permits, departmental extraction never having been undertaken in Kenya Colony. There would be some undoubted advantages to Government if a certain proportion of the forests were worked,

and the timber were marketed, by the direct agency of the Forest Department. It would bring that Department into closer touch with market conditions and would enable it to take a more active part in bringing to notice and finding uses for the less well-known timbers of the Colony, and in developing an export trade in surplus timber : it would almost certainly prove more profitable to Government than most of the concessions now in force. I am not, however, prepared to recommend that this work should at present be undertaken by the Forest Department, partly because it would involve large capital and recurring expenditure which can hardly be justified in the existing state of the Colony's finances, and partly because the energies of the Department will be fully taken up for some time to come in placing the management of the forests on a sounder footing. It is true that forest exploitation could be entrusted to a special staff, but this would not relieve the senior officers of the Department from considerable extra responsibility and work at a time when other more pressing work remains to be carried out.

Provided Government makes a reasonable profit on its forests, and so long as their exploitation by private enterprise is carried out efficiently and timber is placed on the market in a proper condition, at a reasonable price, and with due regard to the development of trade in new timbers, then there is no particular reason why the Forest Department should take a direct share in exploitation work where this would involve undue competition with private enterprise. These desirable conditions, however, are at present not so much in evidence as they might be, and it may yet be necessary for Government to protect its own interests and those of the community in general by undertaking the exploitation of a certain proportion of its forests. In this case the necessary capital could be provided most suitably by means of a loan.

29. DEFECTIVE EXPLOITATION.—There are at present in force between 30 and 40 timber concessions, held under leases, licences or otherwise. Timber conversion is carried out almost entirely at saw mills, most of which are situated in or near the forests. I have had an opportunity of inspecting the lumbering work done and visiting the sawmills operated by several of the concerns in question. In a few instances the work in all branches was being carried out as efficiently and economically as circumstances permitted, wastage in logging as well as in conversion being reduced to a minimum and running expenses being kept at a reasonably low figure. In certain cases, however, the work left much to be desired, the wastage in logging being nothing short of culpable, and little attempt being made to economize by intelligent conversion in the sawmill. Allowance should, no doubt, be made for the fact that in some instances the work is not yet properly organized, the country is sometimes difficult, labour is by no means skilled, and in the case of cedar particularly, there is often much unsoundness to reckon with during conversion. Nevertheless, after making all allowances there should be no excuse for leaving large quantities of utilizable timber lying in the forest, as has been done in some cases. It may be argued that as the trees are paid for standing the purchaser and not Government is the loser. There can, however, be no excuse for wasting the natural resources of the Colony, while in any case Government will be an ultimate gainer by increased production, which means a lowering of the working costs, cheaper prices for timber, and a healthier commercial outlook. As a proof that such waste is inadmissible, it may be mentioned that one small but efficient concern recoups all its forest expenditure as well as the running expenses of its break-down mill from the utilization of outer flitches and branch-wood alone, products which in many cases are wasted.

But, perhaps, the most glaring cases of defective exploitation are to be seen in the manner in which timber is too often handled after conversion. No timber can acquire or maintain a good reputation if placed on the market in an unseasoned or otherwise defective condition, and it is largely on this

account that East African timbers have so frequently been compared adversely with imported timbers. In the case of woods such as cedar and podocarpus all that is required is correct stacking, after conversion, in an airy place protected from sun and rain. For boards and scantlings of no great thickness a period of 6 to 12 months should ordinarily suffice for the purpose of air seasoning. At only a few of the sawmills visited was there any attempt at correct stacking. In too many instances boards and scantlings, after conversion, were thrown out in heaps in the mill yard, there to lie exposed to sun and rain until the majority of them had become warped or split. The loss thus occasioned must far outweigh any expense which would be incurred on correct stacking and seasoning, while the damage done to the reputation of local timbers must be considerable.

There are conditions in the leases and licenses providing for the prevention of waste in logging, and after allowing reasonable time for the organization of labour and other preliminaries the remedy for wasteful logging lies in enforcing these conditions. Defective handling of timber could be taken into consideration when the question of renewing leases and licences is dealt with, for there is sufficient competition to warrant Government in refusing concessions to parties who have proved their inefficiency.

30. METHODS OF EXTRACTION AND TRANSPORT.—Most of the timber extraction is carried out with the aid of oxen, a method which might with advantage be superseded by mechanical means of extraction where conditions are favourable. One large firm, in installing a skidding machine under expert supervision, has made an important advance which may lead to great developments in the methods of extracting timber in Kenya Colony, particularly where large quantities of timber have to be handled. The camphor forests, most of which are situated on narrow ridges and spurs separated by steep gorges, present considerable difficulty, which is increased by the fact that much of the timber is of very large size. Sliding downhill is out of the question, since the bottoms of the gorges have unusually steep sides, and the cost of constructing roads along the bottom of the gorges would be prohibitive. Probably, the solution will lie in dragging uphill by means of movable ground skidders and extracting along the tops of the ridges. Kenya Colony is particularly badly off for means of transporting timber. The unsuitability of the Tana River for the floating of timber to the coast, owing to a long succession of rapids, and the general absence of floating streams leading in the direction of markets, are severe obstacles to cheap timber transport in the Colony. The future development of the less accessible forests will depend largely on railway extensions, but at the best, railways are an expensive means of transporting timber compared with waterways.

31. ASSESSMENT OF ROYALTY.—It has been represented in certain quarters that the royalties charged on timber from Government forests are too high, and that they are in a large measure accountable for the high price of local timber. Such particulars as I have been able to obtain regarding the costs of working lead me to the conclusion that this is not the case, and that the Government royalty bears only a small ratio to the total working costs. The question, however, will settle itself if payment on a standardized royalty basis is abolished except for petty purchases or in special cases, and if the rates charged in the case of future timber concessions are based on tenders subject to a reserve price. This procedure, it is understood, is already contemplated and is to be recommended.

Under the system generally in force at present royalties (per cubic ft.) are levied on the results of measurements of standing trees made at the time of marking the trees for felling. Such measurements, besides taking up much of the time of the marking officer, can at the best give only rough estimates,

and under the system of measurement employed the estimated volume, on which the royalty is assessed, must in nearly every case be less than the true volume. In the event of an overestimate of the volume the licensee may claim a remeasurement after the tree is felled; such claims are very rare. Since the royalty is intended to be assessed on actual measurements and not on estimates, the only satisfactory method is to measure the timber after felling, and it is recommended that this system be employed in future concessions. Whether the timber be measured at stump or after collection at one or more convenient measuring centres is a matter for decision in each case. It has been suggested that this system will cause delay and inconvenience; the system, however, is the usual one employed under similar conditions in Europe, India and Burma, and as long as suitable arrangements are made it is not open to this objection.

It has been proposed by certain licensees that royalty should be levied on the outturn of sawn timber at the mills, the owners of which would be required to furnish correct outturn statements. On the score of simplicity this system has much to be said in favour of it. Assuming, however, that outturn statements of the kind could always be relied on, this system would have the disadvantage of penalizing efficient mills producing a relatively high outturn of sawn material from a given volume of round timber. Again, it would be extremely difficult to compare outturns of different classes of material, such as large squares, scantlings, boards, railway sleepers, shingles, pencil slats, etc., and any attempt to reduce them to a common denominator for the assessment of royalty would lead to great complication. The assessment of royalty on outturn, therefore, has more to be said against it than in favour of it.

32. **TIMBER CONCESSIONS.**—The timber leases and licences now in force date from various times between 1913 and 1921. A few hold good for definite periods, but in the great majority of cases no date of termination is fixed. This is an unfortunate omission, since it is always desirable to provide for a revision of terms or a termination of the lease or licence, should this be deemed advisable, after a reasonable period. In some cases licences will terminate as a matter of course, since the stock of marketable timber will become exhausted, but in other cases their continuance may prove embarrassing if their terms require revision in the light of future experience. It would be advisable to limit future leases and licences to a period of not more than 20 years, at the end of which time they could be made renewable, circumstances permitting, on revised terms.

It would be well to suspend the issue of further leases or licences until some progress has been made in the preparation of working plans, and then to begin issuing them regularly in areas for which working plans have been prepared. This should not, however, apply to cedar left standing in areas felled for railway fuel, or to the extraction of dead timber.

33. **FREE TIMBER PERMITS.**—Existing regulations provide for the issue, to settlers on whose farms there is no timber, of free permits to obtain timber from Government forests, under certain restrictions, for the erection of buildings, fences, etc. There has no doubt been strong justification for such free grants of timber to assist in the development of a new country, but the time has now come to consider whether sufficient justification still exists. The privilege in question has in one respect always operated unfairly, in that settlers near the forests have had special facilities for taking advantage of it whereas those living at a distance from them have had to purchase their timber from sawmills. Nearly all the valuable tracts of farm land have by this time been alienated in farms, and the chief reason for the issue of free permits, namely, to encourage and help the earlier settlers, no longer exists. There are also greater facilities now for obtaining timber from sawmills than

there were formerly. But perhaps the strongest argument against the continuance of free timber permits is that, apart from the value of the timber, they are an expensive tax on the country, taking up much of the time of the staff required to mark trees and adding to their already heavy travelling bill. Their time is fully required for employment on more urgent work. The time has now come when the privileges regarding the free issue of timber to settlers should be rescinded, though they might be permitted to remain in force for a further period of, say, five years in the case of soldier settlers who are developing new land, as distinct from those who have taken over farms on which buildings, fences, etc., are reasonably complete.

14.—FUEL SUPPLIES.

34. No coal or oil has yet been discovered in the Colony, and the question of maintaining supplies of wood fuel is therefore one of great importance. Fuel supplies for the railway have been met by clear-felling the natural forests within easy reach of the line. Replanting is carried out as far as staff and labour permit, though this work is considerably in arrears. In considering the fuel problem economy of space is a most important factor. Although the natural forests contain some excellent fuel woods, the yield per acre is by no means high. Fuel plantations formed on areas cleared of natural forest, therefore, should aim at producing the highest possible yield of suitable fuel per acre per annum.

Judging by the rapid rate of growth of some species of eucalyptus, and particularly the blue gum (*E. Globulus*), in the highlands of Kenya Colony, it is doubtful if plantations of any trees, indigenous or exotic, will give yields in any way comparable to those of the eucalypts. But before finally deciding on the extensive cultivation of eucalypts for railway or industrial fuel, it would be well to test the steam-raising capacity of wood obtained from plantations of different species and ages. Such tests have already been instituted, but no results are yet to hand. The point is an important one, since it may influence not only the choice of species, but also the rotation on which the plantations are worked. Apart from this factor the rotation should be that which will produce the highest volume yield per acre per annum under the system of simple coppice, which is the most satisfactory one to adopt.

In the Nilgiri hills of Southern India the average yields from blue gum coppice worked on a rotation of 10, 15 and 20 years were ascertained in 1912 to be as follows :—

Age in years.	Average volume on 1 acre.		Mean annual increment per acre.
	Cubic feet solid.	Cubic feet stacked.	Cubic feet solid.
10	4,850	7,348	485*
15	8,050	12,197	537
20	11,200	16,970	560

Above the age of 20 years the *data* were too scanty to be of much value. These figures indicate that a rotation of 20 years will give a higher yield per acre per annum than one of 10 or 15 years, though the increase between the yields for 15 and 20 years is not great. Similar figures are required for Kenya Colony. Even if it is decided to burn oil on the railways the maintenance of fuel plantations, on a more limited scale, will be none the less an important question, since regular supplies will be required not only for domestic use but also for power production, lime-burning and other purposes.

As the natural forests and scrub become more limited and the fuel species give place to the more valuable timber trees under scientific treatment, the need for special fuel plantations will be still more felt. For reasons of transport it is advisable that these plantations should be situated in proximity to the railway.

The question of charcoal-burning on a fairly extensive scale has been raised. There is certainly scope for a more extensive use of charcoal, which has the great advantage over wood in portability alone, apart from other advantages. It might also find a wide use in suction gas plants on estates. It is somewhat doubtful if a use could be found for the other products of destructive distillation of wood, since the country is not sufficiently industrialized to make use of them.

The black wattle (*Acacia decurrens*), if grown in a sufficiently moist climate, produces fairly high yields of wood suitable for charcoal manufacture.

The whole future policy regarding railway fuel plantations will depend on a decision as to whether oil or wood is to be the railway fuel of the future; it is advisable that this should be settled definitely, and if the decision is in favour of wood, then plantations should be established not only in the highlands but also at convenient centres down the line between Nairobi and the Coast.

15.—MINOR FOREST PRODUCTS.

35. No systematic survey of the minor forest products of Kenya Colony has yet been attempted, but with the appointment of a Research Officer this should be taken in hand with the help of local Forest Officers and with the collaboration of the Chemical Research Department. Such a survey should extend not only to the timber forests but also to the scrub and savannah forests, where it is not unlikely that gums and tanning materials of commercial value may be found.

Tanning materials have received some attention in the past. There is a demand for mangrove bark, but the supply has become almost exhausted owing to excessive exploitation under former concessions. Plantations of Australian wattle (*Acacia decurrens*) have been formed on a considerable scale, chiefly by settlers, in the hope of making profits out of the bark, but latterly the industry has not fulfilled expectations, and many of the wattle plantations are being cleared. It is difficult to say if the future will hold out better prospects, but it is reasonable to suppose that with an increase of stock in the country Kenya should become an important producer of hides, in which case tanning may become an industry of some magnitude. If wattle plantations are formed in future, care should be taken to avoid dry localities, where they are a failure, and to confine them to the damper regions of the highlands.

Meanwhile, experiments on a small scale might be made in the cultivation of *Cassia auriculata*, a shrub yielding the most important tan bark in India, as well as being a useful plant for clothing dry stony ground. It might be tried at different elevations from the coast up to about 5,000 ft., care being taken to select soil which is light and porous, not stiff or waterlogged. It is easily raised by direct sowings on land which has been ploughed or hoed up, and is worked as coppice on a rotation of 2 years for tanning goat and sheep skins and 3 to 5 years for tanning cow-hide.

The question of bamboo pulp is discussed in the next section. The wood of *Neobutonia macrocalyx* (mutundu) was sent recently by the Conservator of Forests to the Imperial Institute for report as to its pulping qualities. The

report showed "that the wood is quite suitable for use as a paper-making material, but in view of the soft nature and shortness of its ultimate fibres it would be best utilized in admixture with stronger materials such as spruce." In any case, it is nowhere plentiful enough to form the sole source of supply of raw material for a pulp factory, though it could probably be used in admixture with bamboo. As the whole future of pulp manufacture in Kenya Colony must depend largely on cheap and plentiful supplies of limestone, no development of the pulp industry in respect of any form of raw material is possible unless the question of supplies of limestone can be satisfactorily solved.

16.—BAMBOO PULP.

36. PROSPECTS.—Attention has been directed recently to the possibility of establishing a bamboo pulp industry in Kenya Colony. In weighing the prospects of success in the enterprise it may be of interest to compare conditions in Kenya with those prevailing in Burma, a country possessing large supplies of bamboo, cheap water transport, and limestone in certain cases conveniently situated. Kenya is at a great disadvantage in respect of transport. Most of the bamboo areas are at present too inaccessible for economic working. In the case of those which are accessible the pulp would have to be transported a distance of 360 to 460 miles by rail to the coast, at a flat rate of £1 11s. 4d. per ton. In some cases water may be a difficulty, but this difficulty could probably be got over in areas likely to be workable. The bamboo is present in gregarious masses which may be clear-felled, rendering working easy. Forest and factory labour, though not abundant, should be adequate. The presence of soda in the country is a decided asset, though it will not influence working costs so much as might be imagined, since by the use of a soda recovery plant over 80 per cent. of the soda used can be recovered, and the net amount used is therefore not very great. The good climate of the highlands of Kenya Colony compares very favourably with the hot and somewhat unhealthy climate of Burma, and this should be a useful asset in the matter of attracting a supervising staff of Europeans.

I have framed a very rough estimate in respect of one of the most accessible bamboo areas, which, however, I am not in a position to publish, since I was unable, with the limited time at my disposal, to collect data which I can regard as sufficiently accurate in all respects. So far as it can be accepted this estimate indicates that bamboo pulp can be manufactured and delivered at Mombasa at a total cost of between £13 and £14 per ton of air-dry pulp without allowing for depreciation, and assuming that lime can be obtained at the factory at a price not exceeding £2 10s. per ton. This estimated cost of production and delivery at the coast is somewhat higher than what may be expected in the case of Burma, but it should allow a very fair margin of profit after deducting freight, insurance and other charges, and providing a reserve for depreciation and renewals.

The whole question, however, hinges primarily on the possibility of delivering large supplies of suitable limestone at the factory at a reasonable cost, and until this question is settled no estimate can have any practical value.

A thorough investigation of all limestone tracts within an economic radius of possible pulp-factory sites ought therefore to be carried out as soon as possible.

If the question of lime is satisfactorily settled there should be no difficulty in interesting reliable firms connected with the pulp or paper trade; such firms could then make investigations on their own account with the view of taking up concessions. The information which follows may be of some use to those who are interested in the matter.

37. THE BAMBOO.—*Arundinaria alpina*, the bamboo of Kenya Colony, grows gregariously, forming extensive tracts at an altitude of 7,500 to 10,000 ft., occasionally descending lower or ascending higher: it appears to thrive best between 8,000 and 9,500 ft. There are no rainfall statistics within the bamboo zone, but the rainfall within this zone is probably for the most part between 40 and 75 in. In its early stages the bamboo forms loose clumps, but these soon spread until there is no further sign of clumps, the bamboo covering the ground in a continuous growth of separate culms, which in a dense crop may be as close as 2 ft. apart on an average. The culms, which attain a height of 30 to 60 ft. with a diameter of 2 to 4 in. or occasionally more, are hollow, with walls 0·4 to 0·7 in. thick.

38. FLOWERING OF THE BAMBOO.—Certain species of bamboo flower gregariously over extensive areas at long intervals of time; the old culms then die and a new generation springs up from seed and takes many years to produce full-sized culms once more. In such an event, a pulp factory would stand a strong risk of being thrown out of work for several years. It is important, therefore, to know whether there is any chance of such a gregarious flowering in the case of the East African bamboo. A study of conditions in several bamboo tracts leads me to the conclusion that there is little risk of a gregarious flowering of such an extent as to necessitate the temporary closing of a factory. This conclusion is based on the fact that the bamboo is always flowering in patches of varying extent, and patches of different ages, produced by sporadic flowering in past years, are constantly met with: this being so, it is unlikely that an extensive gregarious flowering will occur which will embrace those areas where flowering has already taken place within recent years.

39. YIELD OF BAMBOOS.—Measurements of clear-felled plots carried out by the Forest Department in different bamboo areas gave the following figures:—

Number of culms per acre,	average	5,030
	maximum	7,750
	minimum	3,000
Serviceable length,	average	37 ft.
	maximum	50 ft.
	minimum	20 ft.
Diameter	average	2·5 in.
	maximum	4·3 in.

Weight, green culms, 25-65 lbs., average about 40 lbs.

„ dry culms, average about 20 lbs., giving about 112 culms to the ton.

40. YIELD OF PULP.—Laboratory experiments at the Imperial Institute gave 37 per cent. of air-dry pulp (expressed on air-dry bamboo) when treated with a solution of caustic soda. Manufacturing trials by a firm of paper manufacturers at the request of the Imperial Institute, in which the bamboo was treated by the soda process, gave pulp which bleached well and yielded white paper of good quality. Knots were not removed. The yield, including loading and size, was 41·23 per cent. of the weight of the bamboos, which is considered satisfactory.

41. EXPLOITATION OF BAMBOOS.—If a bamboo area is repeatedly clear-felled at comparatively short intervals the culms deteriorate in number and size and the bamboo may eventually be exterminated. In India, the usual custom is to fix a rotation of about 4 years, but to prohibit the felling of any culms of the last season's growth. In the case of the East African bamboo, if worked on a large scale, clear felling would be more practicable than partial felling of this kind, and as far as my observations go, the effect does not

seem to be so harmful as in the case of certain other species of bamboo. Two important points however, require to be cleared up, namely : (1) Is there any season of the year in which felling should be prohibited? and (2) How long will the bamboo take to re-stock a clear-felled area completely and to reach its original size, vigour and density? These two questions can be answered only by carrying out careful experiments. As regards (1), I would suggest clear-felling a number of test plots at different seasons, say, in March, June, September and December, and observing the results. As regards (2), clear-felled plots in different localities should be kept under observation until reliable results are obtained. Meanwhile, if a bamboo concession is given out, clear-felling should be permitted on a rotation of not less than 10 years until it is proved that a shorter rotation will have no harmful effect on the bamboos, when the rotation may be reduced.

42. FUEL.—For a pulp factory in Kenya Colony wood fuel will have to be relied on. For the manufacture of 1 ton of air-dry pulp the consumption of wood fuel may be estimated at 4 tons, of which $\frac{1}{2}$ ton would be required for lime-burning.

In the case of eucalyptus plantations in a favourable locality, one acre clear-felled may be estimated to produce 160 tons of dry fuel if worked as coppice on a rotation of 15 years, giving 10·6 tons per acre per annum. Thus a factory producing 20,000 tons of air-dry pulp a year will require 7,547, or, say, 7,600 acres of eucalyptus plantation of good quality, a correspondingly larger area of plantation of poorer quality, and a much larger area of natural forest. Of the 7,600 acres, about 950 acres would be required for fuel for lime-burning. Although some of the bamboo tracts have considerable areas of natural forest near them, it is doubtful if these could satisfy fuel requirements for more than a limited period of time; for permanent requirements the establishment of eucalyptus plantations in close proximity to the factory will be an essential item in the scheme of working.

Under present conditions the cost of fuel may be roughly estimated at 16s. per ton delivered at the factory, that is, £3 4s. per ton of air-dry pulp : of this, 8s. would be absorbed by lime-burning and £2 16s. by factory and other combustion. When plantations conveniently situated come under regular working it should be possible to reduce the cost.

43. CHEMICALS.—The chief chemical processes used in the manufacture of paper pulp are :—

(1) *The sulphite process*, employing bi-sulphite of lime and SO_2 gas. The production of liquor is less costly than in the other processes, but bleaching is more difficult, and SO_2 may prove too volatile for use in Africa.

(2) *The soda process*, employing caustic soda (sodium hydroxide, NaOH). Recovery of spent liquors is possible to the extent of 80 to 90 per cent. The process is satisfactory, but expensive, and the bleach consumption is high.

(3) *The sulphate process*.—A modification of (2) with sulphate of soda used in the recovery of spent liquors : the active constituents are NaOH and Na_2S (sodium sulphide). According to Raitt it is cheaper than the soda process, and is the best method for bamboo, both in cost and in quality of pulp. It has the disadvantage of giving off a disagreeable smell of sulphuretted hydrogen.

The two raw products required are soda and lime, the quantities required for 1 ton of unbleached air-dried pulp being approximately :—

Soda—5 cwt. of Magadi quality.

Limestone—1 ton, equivalent to $\frac{1}{2}$ ton of lime after it is burnt.

For the purpose of the present estimate 58 per cent. soda may be taken at £9 per ton f.o.r. Magadi. Railway freights on soda in 10 ton lots or over (loading and unloading by owner) are £1 9s. 9½d. and £2 3s. 5½d. per ton from Lake Magadi to Kijabe and Njoro respectively.

Limestone may prove a more difficult item. The present price of burnt lime in Kenya Colony is £4 per ton, as compared with £1 to £1 5s. per ton in Burma. It would be advisable to bring limestone to the factory and burn it there, since quicklime is difficult to handle and transport under conditions prevailing in the Colony. Allowing 16s. for fuel and 8s. for the cost of burning 2 tons of limestone and producing 1 ton of lime, the question therefore turns on the possibility of obtaining large supplies of suitable limestone (that is at least 20,000 tons a year for one factory alone) delivered at the factory at a cost of not more than 13s. per ton, equivalent to £1 6s. per ton of burnt lime. This will mean a maximum price for burnt lime at the factory of £2 10s. per ton. A figure much higher than this will probably render the industry unremunerative. The sources of limestone reasonably near prospective pulp factory sites do not appear to have been sufficiently investigated. The railway freight alone on coral limestone from the coast to Kijabe and Njoro would amount to 57s. and 71s. respectively. Limestone outcrops occur near the railway about 11 miles from Mombasa, but they are open to the same objection of heavy railway freight. Layers of *kunkar* with calcareous nodules occur as deposits in several places on the plains, particularly in the black cotton soil, but even if the limestone is sufficiently pure it would probably not be available in large enough quantities. More promising are the limestones of the Athi River, Machakos and Kyambu districts, and there may possibly be other localities.

The table below, furnished by Mr. V. H. Kirkham, Director of the Chemical Research Department, Nairobi, gives analyses of coral and other limestones carried out in his laboratory. In his opinion any of these limestones would produce a lime sufficiently pure for the causticising of carbonate of soda, though a coral containing sand, such as No. 4, would be rejected.

ANALYSES OF LIMESTONES CARRIED OUT IN THE CHEMICAL RESEARCH
DEPARTMENT LABORATORY, NAIROBI.

	1	2	3	4	5	6	7	8	9	10	11
Silica	2·87	2·99	2·10	11·33	·69	4·13	·68	2·68	1·74	3·00	1·11
Alumina & Iron oxides	·97	1·61	·54	2·85	·62	1·15	1·86	1·93	1·25	2·89	2·29
Lime	55·23	53·19	53·86	46·61	54·23	52·81	54·77	51·82	54·21	51·69	52·49
Magnesia	·21	·07	·11	·08	·77	·50	trace	·97	trace	trace	1·24
Carbonic acid	40·00	41·76	41·96	37·96	43·48	40·48	40·74	42·60	42·80	40·99	42·39
Alkalies, &c. (diff.) ...	·72	·38	1·43	1·17	·21	1·03	1·95			1·43	·48

Nos. 1-4.—Coral from Mombasa. No. 4 contained a quantity of sand.

No. 5.—A grey marble submitted by Mr. Oulton of Thika. Position of deposit not known.

No. 6.—Origin not known, but submitted from Mua Hills—May be Athi River or Machakos.

No. 7-10.—Kyambu district.

No. 11.—Nandi district (other samples from district not suitable).

44. RAILWAY FREIGHT ON PULP.—The Acting General Manager of the Uganda Railway has agreed to a special zone rate of 70 cents per 100 lbs. or Fls. 15·68 (£1 11s. 4d.) per ton on rail for bamboo pulp from stations Lumbwa-Nairobi inclusive to Mombasa, provided the pulp is compressed to 25 lbs. or over per cubic foot and packed in bales, so as to enable some 8 tons to be loaded into a 10-ton truck.

45. POSSIBLE BAMBOO-PULP AREAS.—There are two areas which hold out a reasonable prospect of successful working at present :—

(1) *Njoro area*, estimated at 40 sq. miles, on the slopes of the Mau between Njoro and Elburgon. The area, which is about 8 miles from Njoro railway station (458 miles from Mombasa) should not be difficult to work. The water supply is said to be sufficient.

(2) *Kikuyu escarpment area*, estimated at not less than 50 sq. miles, between the Chania river and the escarpment above Kijabe on the Uganda railway. This area, which I have visited, is the one referred to above as having been taken as a basis for the preparation of a rough estimate of the cost of production of bamboo pulp.

The following area will be worth investigating if the bamboo-pulp industry gains a footing in Kenya Colony :—

(3) *Kinangop area*.—About 40 sq. miles, on the upper slopes of the Western Aberdares above Kinangop plateau, 25 to 30 miles from Naivasha station. The country is hilly, but the bamboo could be extracted by slides or ropeways. Water is plentiful but fuel may be a difficulty.

There are large areas on the eastern slopes of the Aberdares and the western and south-western slopes of Mount Kenya which might be made accessible by means of light railways, but these propositions are hardly worth investigating at present.

Areas at present inaccessible are those on the northern, eastern and south-eastern slopes of Mount Kenya, on Elgon, and on the northern part of the Aberdare range.

There is a considerable area of bamboo forest north-east of Londiani, but it lies in the Equator Saw Mill Company's concession.

17.—THE FOREST DEPARTMENT.

46. WORK OF THE DEPARTMENT.—The Forest Department of the then British East Africa Protectorate had its beginning in 1902. Its earlier energies were rightly devoted, as far as circumstances permitted, to saving the natural forests from destruction, an undertaking which is always unpopular and which meets with opposition wherever it conflicts with personal interests. But for the shorthandedness of the Department this work would have made greater progress than it has done, and in certain cases, particularly in the earlier years, it would have been more successful had Government adopted a stronger attitude in preventing the alienation or destruction of valuable forest tracts. During the course of my visit to the Colony I was struck by the amount of intelligent interest in forest questions shown both by administrative officers and by settlers, many of whom are under no misapprehension as to the necessity for conserving the forests and carrying out further afforestation where required. There is little reason to doubt that in adopting a strong forest policy Government will receive whole-hearted support from a considerable portion of the non-official community.

In the various sections of this report an endeavour has been made to show in what particulars the progress of forest work up to date has been satisfactory or backward and these may be briefly summarized. The Forest Department may be congratulated on the efficiency with which it has conducted its plantation work and organized supplies of plants to the public : it has made creditable progress in the botanical determination of the various trees and shrubs : the reservation and demarcation of forest tracts, though

by no means complete, has made commendable progress, often in the face of considerable difficulties: fire-protection, though not fully organized, is being taken in hand seriously. Among the more important branches of work which still require to be developed are forest surveys and working plans, improved systems of management, and research. It is perhaps insufficiently realized that the Forest Department has always been shorthanded, that it has often worked in the face of great difficulties, and that progressive work had to be curtailed during the war. The officers of the Department will themselves be the first to admit that much remains to be done before the organization of work is in any way complete: but on the other hand they are to be congratulated on the amount they have accomplished during the comparatively short period of the Department's existence.

47. FINANCIAL POSITION OF THE DEPARTMENT.—Judged from a financial standpoint the Forest Department has not yet come into its own. The following statement shows the annual revenue, expenditure and surplus or deficit for the five years 1916-17 to 1920-21 :—

	1916-17.	1917-18.	1918-19.	1919-20 at Rs. 15 to the £.	1920-21 at Rs. 10 to the £.
	£	£	£	£	£
Revenue	11,359	11,980	11,911	15,876	19,710
Expenditure	10,165	10,442	12,967	14,623	29,040
Surplus or deficit ...	+1,194	+1,538	-1,056	+1,253	-9,330

The large deficit in 1920-21 was due partly to the prevailing depression in trade, resulting in a marked decline in sales of timber, and partly to a considerable but necessary increase in the staff, which has not yet had time to take effect in the direction of a corresponding increase of revenue.

Strictly speaking, the Forest Department should not be judged wholly from its financial results. Forests are not maintained entirely for the production of revenue: in certain cases their conservation may be necessary for other purposes, such as the maintenance of the water supply, the prevention of denudation, the mitigation of the extremes of climate, or the supply of produce to meet local requirements. Nevertheless, however important the conservation of forests may be on such grounds, the fact remains that the work of the Forest Department will in practice be judged mainly by its financial results, and with reason, since the forests of Kenya Colony are sufficiently valuable to produce, when fully brought under systematic management, a very considerable surplus. But this will not be possible unless the Department is run strictly as a business concern, as in the case of the Indian Forest Department, which is officially designated a "quasi-commercial department" and produces a net surplus of over £1,000,000 per annum exclusive of the value of produce given free to right-holders. The acceptance of this principle will mean that the Forest Department should charge full royalties or market prices for all timber and other produce supplied to other Government departments, whether Civil or Military. This procedure is not followed at present, the practice being for Government departments to receive forest produce free. It has been said that as the forests are the gift of Nature and cost the Forest Department nothing, there should be no charge to other departments for produce removed from them. This argument is fundamentally unsound, for the forests cost a very considerable sum to reserve, survey, demarcate, protect, bring under systematic management, and regenerate. There is no reason why the Forest Department should furnish produce free to other departments any more than the railway should carry

all the personnel and stores of other departments free. Judged from the point of view of correct book-keeping, the present system of requiring the Forest Department to supply produce free to other departments is indefensible, as it results in entirely erroneous statements of revenue and expenditure in Government accounts. The financial position of the Forest Department will never be correctly exhibited, and can never be fairly criticized, until full payment—adjustable by book transfer—is made for all timber and other produce supplied by it to other departments.

The acceptance of the principle that the Forest Department should be run as far as possible on commercial lines does not imply that necessary expenditure should be curtailed. In forest operations a judicious outlay of expenditure, whether on staff or otherwise, is normally followed by an increase in revenue, although some items of expenditure are more directly remunerative than others.

In view of the present financial stringency, care has been taken, in this report, to avoid recommending any increased expenditure that is not considered urgently necessary.

48. STATUS OF THE DEPARTMENT.—In the Secretariat forest business is dealt with by the Colonial Secretary, who represents the Forest Department on the Legislative Council. This arrangement works well, and in my opinion it should not be altered. If at any time a Chief Conservator of Forests is appointed for all the East African territories it may be found convenient to appoint him an *ex officio* member of the Council, but this is a question which need not be discussed here. I understand that a proposal was recently brought forward to bring the Forest Department into closer touch with the Agricultural Department. I am not in possession of the details of the proposal, but if it in any way involved the absorption of the former by the latter Department, then any such course is to be strongly deprecated. It is true that forestry and agriculture have much in common: indeed, forestry has been aptly termed the handmaid of agriculture. But as technical subjects the two are widely different, and the higher training institutions for forestry in Europe, including British Universities, in America and in India, are entirely separate from those which deal with agriculture. Certain agricultural institutions give courses of forestry so-called, but these are of an elementary nature, involving nothing more than the raising, planting and tending of trees in connection with farming or estate work. In countries where forestry is a very minor branch of work it has sometimes been placed under the Agricultural Department as a matter of convenience and for purposes of economy. But in Kenya Colony there is no justification for such a course: its effect would be to weaken a department which is in need of strengthening, and it would be contrary to all experience and recognized procedure. In Great Britain, when the question of the formation of a Forest Department recently came up for decision, it was decided that forestry business should be entirely dissociated from the Department of Agriculture, and should be administered by a Forestry Commission under its own Chairman. In India the Forest Department is entirely separate from the Agricultural Department: in the Government of India forest business is in charge of the Member of Council for Revenue and Agriculture, a non-technical officer whose portfolio includes Agriculture, Forestry, Public Works, Posts and Telegraphs, Surveys, Emigration, Meteorology, Veterinary Work, and certain other scientific departments.

49. FOREST DEPARTMENT CODE.—At present no Forest Department Code exists, but the Conservator of Forests is engaged on the preparation of one, and when ready it should be a useful help in regulating the work of the Department.

50.—ANNUAL REPORTS.—The annual reports of the Forest Department, prepared by the Conservator of Forests, are not printed, presumably for reasons of economy. This is much to be regretted, for apart from the value of stimulating interest in the work of an important Department, the wide publication of its activities would do much to remove any misapprehensions which may arise regarding its work and aims. Reports on the progress of forest work in Kenya would also be read with interest in other parts of the Empire. It is therefore urged that the annual reports of the Department be printed in future.

18.—STAFF.

51. PRESENT GRADING AND STRENGTH.—The following statement shows the present sanctioned cadre of the Forest Department and the actual staff in December, 1921 :—

Post.	Sanctioned scale.		Actual staff in Dec. 1921.			Remarks.
	No.	Substantive pay.	No.	Substantive pay.	Date of first appointment.	
EUROPEAN STAFF						
Conservator ...	1	£1,000	1	£1,000	15/7/04	(a) Includes one temporarily in abeyance.
Senior Assistant Conservator ...	1	£500-25-750	1	£650	1/6/03	
Assistant Conservators	8 (a)	£400-20-500 efficiency bar -25-600	1	£440	20/5/14	
			2	£420	26/3/20	
			4	£400	1/5/20	
					Aug. to Nov. 1920	
Forest Surveyor	1	£300-15-400	1	£400	21/11/14	(b) Includes one for Native reserves.
Foresters ...	17 (b)	£250-15-350	14	£250 to £340	9/5/04 to 15/4/21	
Seedsman ...	1	£200-15-300	3	Vacant		
			1	£295		
NON-EUROPEAN STAFF.						
Assistant Foresters ...	7	Fl. 1,200-120-2,400 per ann.				(c) Total emoluments for the past year.
Forest Guards ...	—	Fl. 16 permensem and Fl. 1 p.m. extra for every year of approved service	—	Fl. 3720 (c)	—	

The question of Surveyors has already been dealt with (paragraph 18). The case of the non-European staff was discussed with the Conservator of Forests, and it was agreed that no alteration in the existing grading is called for at present : as the work of the Department extends increases in the staff will be necessary from time to time, and such increases should be justified by Divisional Officers.

The European staff is divided into two branches, (1) the Administrative branch (Conservator and Assistant Conservators) and (2) the Executive branch (Foresters). Proposals for the reorganization of these branches are given below (paragraphs 53, 55 and 56).

52. RECRUITMENT AND TRAINING.—Under present rules Assistant Conservators of Forests are recruited from among University students undergoing a course of training in Forestry at Oxford, Cambridge or Edinburgh,

and are appointed on satisfactorily completing their course. The whole question of the recruitment and training of Forest Officers for service in various parts of the Empire is now under consideration, the aim being to furnish the best possible training in the higher branches of forestry: it is hoped that Kenya Colony will benefit by this scheme, for it is hardly necessary to mention that the future success of forest work in the Colony must depend largely on the building up of a staff of controlling officers possessing the highest professional ability.

Foresters are recruited in the United Kingdom, and are required to produce satisfactory evidence of a training in forestry. The Forest of Dean School has furnished several of the present staff, and judging by results the training there has proved satisfactory, though a somewhat more extended course in surveying would be an advantage in the case of Foresters for Kenya: this is a point which I propose to take up in England. The training of the Foresters is, and should be, essentially of a practical nature.

For the Non-European or Subordinate staff there is no training institution at present, and it is doubtful if the time has yet come for the establishment of such an institution, though this is a matter which will require to be taken up later as the work of the Department develops. In the meantime a great deal could be done to improve the utility of the native staff by attaching the more promising men to selected Foresters for practical training. Men so trained could be usefully employed, under supervision, on more responsible work than they do at present, such as measuring, marking, thinning, etc. Inducements in the shape of higher pay should be offered to men who undergo such a training and pass a practical test at the end of it.

53. PROPOSED GRADING, ADMINISTRATIVE BRANCH. — The present grading of the Administrative branch is defective in that there are insufficient prospects for efficient officers of long service who through no fault of their own, but by reason of their position on the list, have failed to reach the rank of Conservator or Senior Assistant Conservator of Forests. Such cases are not likely to be frequent, but the fact that they may occur does not tend to increase the attractiveness of service. A more even grading from the lowest to the highest posts is therefore suggested, with an efficiency bar preventing all but the specially deserving officers from reaching the more highly paid posts.

At present, Assistant Conservators, on appointment, are placed on probation for 3 years, and draw annual increments during that period. It is recommended that increments during the probationary period be abolished as illogical, and that any saving effected thereby be devoted towards improving the pay of the higher grades. In future, the work and responsibility of the Conservator of Forests will increase considerably, and it is not unreasonable to suggest that the Head of a department which administers a valuable State property should receive a salary equal to that of the Heads of the other principal scientific and technical Departments. The value of the forests warrants the employment of a highly-trained and efficient staff, and in order to attract and retain officers of the right type, who have received an expensive University education, reasonably good prospects should be offered. The Director of Public Works and the Principal Medical Officer receive a salary of £1,200, and the Director of Agriculture one of £1,400 a year: it is suggested, therefore, that the salary of the Conservator of Forests be increased to £1,200 a year.

In order to provide for a revised grading on the lines indicated above, it is proposed that the post of Senior Assistant Conservator be abolished and that the staff be divided into three classes—(1) Conservator, (2) Deputy Con-

servators, and (3) Assistant Conservators. On this basis the following revised grading of the Administrative staff is proposed :—

Year of Service.	Rank and Salary.
	ASSISTANT CONSERVATORS :—
1st—3rd.	£400 on probation for 3 years.
4th.	£425.
5th.	£450.
	DEPUTY CONSERVATORS :—
6th.	£500
7th.	£525
8th.	£550
9th.	£575
10th.	£600
	Grade II.
	Efficiency Bar.
11th.	£650
12th.	£700
13th.	£750
14th.	£800
15th.	£850
16th and over.	£900
	Grade I.
	CONSERVATOR :—
	£1,200.

In view of the fact that the great majority of the officers now in the Administrative branch only started their service in 1920, the effect of such a re-organization will scarcely be felt for some years to come, by which time the financial position of the Forest Department will in all probability be in a more satisfactory condition than it is at present.

The present seniority list of the Administrative staff is in a very abnormal condition, consisting as it does of two officers approaching the end of their service, one of nearly 8 years' service, and six with less than 2 years' service at the end of 1921. This calls for the reinforcement of the staff in the direction of obtaining the services of an officer of some experience. Such an arrangement, however, should be strictly subject to the condition that no injustice is done to the existing staff. An officer of some years' service brought on to the graded list should therefore, for purposes of promotion to Conservator, rank junior to any officer appointed before the War: his appointment could not affect the promotion of any officer appointed in 1920 or subsequently, as none of these officers could reasonably expect promotion to Conservator for a good many years. A senior officer appointed in this way should have had special experience of working plans operations, since it is in this important branch of work that the officers of the Colony are most lacking in experience. An officer of the required experience could probably be obtained on a salary of £600-50-900; careful selection would be necessary, and it is doubtful if any officer other than one who has served some years in the Indian Forest Service, would have the requisite qualifications. Although such an officer would be employed primarily on organizing and carrying out working plans operations, he would, owing to his experience, afford useful assistance in other branches of work.

54. DUTIES OF THE ADMINISTRATIVE BRANCH.—Hitherto the work of the Forest Department has been too much centralized in the Conservator of

Forests, who is so much immersed in petty details that he is unable to devote sufficient time to broad administrative questions and to developing the work of the Department. In the understaffed condition of the Department this has been almost inevitable, but there has been an increase in the staff since the War, and it is desirable that work should be decentralized very considerably in future. The Conservator should be provided with a Personal Assistant to relieve him of petty office routine work and to take charge of the office during his absence on inspection duty. The Assistant need not necessarily be a senior officer, but should be drawn from any grade of the Administrative staff. He should, as far as possible, assist the Research Officer at headquarters, particularly in routine work.

The Division should be made the administrative unit, and Divisional officers should be given more responsibility, their clerical staff being strengthened with this end in view. This devolution of responsibility should be effected gradually in those Divisions which are held by officers who are as yet comparatively inexperienced.

Under normal conditions a Division should not ordinarily be held permanently by an officer of less than 5 years' service, that is, by one of lower rank than Deputy Conservator. During the first 5 years, while an Assistant Conservator, an officer should be learning his duties in various directions and acting in the capacity of an assistant. He should hold charge of a Forest District for a time, and should also be employed as a Working Plan Assistant, and, if necessary, on demarcation, special surveys, or other work. Office routine and accounts should form part of his regular course of training.

55. REVISED CADRE, ADMINISTRATIVE BRANCH.—In accordance with the proposals contained in the previous portions of this Report, the following revised cadre of the Administrative branch is proposed :—

	1	Conservator.
	6	Divisional Officers (paragraph 2).
	2	Working Plan Officers (paragraph 18 (2)).
	1	Research Officer (paragraph 14).
	1	Personal Assistant to the Conservator (paragraph 54).
	3	Assistants for District charges, working plans, and other
	—	duties (paragraph 54).
	14	
Add leave		
reserve	3	
	—	
Total	17,	as against 10 on present sanctioned scale.

Including the one existing vacancy, there will thus be eight vacancies to fill, and it is proposed that these be filled at the rate of two a year. Allowing for retirements and other casualties, this rate of recruitment may be estimated to cover a period of five years, at the end of which time a fresh estimate of recruitment for the next quinquennial period will be necessary.

56. PROPOSALS REGARDING THE EXECUTIVE STAFF (FORESTERS).—The seniority list of the Executive staff is at present in an anomalous condition, as the following statement of salaries actually drawn by Foresters of various lengths of service will show :—

Years' service (approximately). Present salary (Dec. 1921).

	£
17½, 13, 12, and 10	340
9	280
8	265
7½	265 to 325
2	265 and 295
under 1	250

Thus men with many years' service to their credit draw salaries not appreciably higher than those drawn by men at the beginning of their service, with the result that there is insufficient encouragement given to Foresters to put forth their best endeavours throughout their service. It is not surprising, therefore, that some of the most efficient men have left the Forest Department to take up other duties.

In order to remedy matters the following revised scale of salaries is proposed for Foresters :—

<i>Year of service.</i>	<i>Salary.</i>	
1st—3rd	£250	on probation for 3 years.
4th	£260	Grade II.
5th	£270	
6th	£285	
7th	£300	
8th	£315	
9th	£330	
10th	£345	Efficiency bar.
11th	£360	
12th	£380	Grade I.
13th	£400	
14th	£420	
15th	£440	
16th and over	£460	

As the work of the Department expands it is probable that the strength of the Forester staff will require to be increased from time to time.

It is proposed that the post of Seedsman on £200-15-300 be merged in the general list of Foresters, as the qualifications and duties of the Seedsman are on a par with those of Foresters.

57. POST OF CHIEF CONSERVATOR OF FORESTS.—If any scheme for the union of the various East African territories comes into force it will be advisable to appoint a Chief Conservator of Forests for the administrative control of the whole. Such an officer will be required to co-ordinate work in the various territories, to advise the supreme Government in Forest matters, and to arrange inter-territorial transfers.

19. SUMMARY OF REPORT.

58. The following is a summary of the main observations and recommendations contained in this Report :—

(1) From the point of view of production the forest area of the Colony has been reduced to the utmost limit of safety (paragraph 1) : from the point of view of conservation of the water-supply it has already been exceeded, and legislation is advisable for the protection of streams (paragraph 4).

(2) The existing territorial divisional charges, 6 in number, are at present adequate (paragraph 2).

(3) A rough classification is given of the main types of forest (paragraph 3).

(4) Considerable areas of forest still await reservation, which should be pushed on (paragraph 5).

(5) Steps should be taken in regard to the administration of forests and the afforestation of denuded areas in native reserves (paragraphs 6—9).

(6) Demarcation is progressing, but should be pushed on, particularly in respect of forests not yet gazetted (paragraph 10): caution should be exercised in any revision of existing boundaries (paragraph 11).

(7) Fire-protection should be strictly enforced, particularly in the cedar forests (paragraph 12).

(8) Plantation work is efficiently and economically carried out: direct sowings might be tried experimentally in certain cases: exotics (mainly gums and wattles) should be confined as far as possible to fuel plantations, the more valuable species of indigenous trees being propagated for timber (paragraph 13).

(9) Some useful silvicultural and botanical work has been accomplished, but organized research is urgently required: the ideal would be a central Research Institute for Kenya, Uganda and Tanganyika: in the present state of the finances of the Colony, however, it is proposed to begin by appointing one Forest Research Officer, to undertake specified lines of work (paragraph 14).

(10) Working plans are urgently required, and their preparation should be pushed on (paragraph 15): as a preliminary to this a programme of topographical surveys should be carried out (paragraphs 16, 17): the cost of surveys is estimated at £2,000 a year for 5 years, including the salaries of two surveyors, that of working plans at £740 a year for 5 years, excluding the salaries of two working plan officers on the regular cadre (paragraph 18): working plan operations should be conducted under a regular procedure (paragraph 19).

(11) The existing system of working the forests has grave disadvantages (paragraph 20), and should be discarded, wherever circumstances permit, in favour of a more rational system (paragraphs 21, 22).

(12) Kenya Colony possesses some timbers of good quality, but more attention should be given to the question of seasoning (paragraph 23).

(13) Local timber prices are unduly inflated, and will have to reach a lower level before any marked development in the utilization of local timbers is possible (paragraph 24).

(14) The question of developing a trade in pencil cedar and safeguarding future supplies of that timber is of great importance: certain proposals are made in this connection (paragraph 25).

(15) The cedar fungus (*Fomes juniperinus*), which causes extensive loss, may be kept in check by certain proposed measures (paragraph 26).

(16) There is some prospect of an export trade in timber, particularly to South Africa, but much will depend on the extent to which the cost of extraction and conversion can be kept down (paragraph 27).

(17) There is no special justification for the exploitation and marketing of timber being carried out by the Forest Department at present, but circumstances may yet render this necessary to some extent (paragraph 28).

(18) In some cases the logging and conversion of timber by licensees is carried out wastefully and inefficiently, and an improvement in this respect is desirable (paragraph 29).

(19) The present system of extracting timber by oxen might with advantage be superseded by mechanical means of extraction where conditions are favourable (paragraph 30).

(20) Tenders should supersede fixed royalties in future concessions except in special cases : royalty on out-turn has more to be said against it than in favour of it : it is suggested that in future concessions measurements for the assessment of royalty should be made after and not before the trees are felled (paragraph 31).

(21) Timber leases and licences should in future be limited to a period not exceeding 20 years : the issue of further leases and licences should ordinarily be suspended until working plans are prepared (paragraph 32).

(22) The further issue of free timber permits should cease except in special cases (paragraph 33).

(23) Future supplies of fuel should be ensured by means of plantations of fast growing eucalypts : future policy in respect of railway fuel will depend on a decision as to whether oil or wood is to be used (paragraph 34).

(24) A systematic survey of possible minor products of economic value should be undertaken by the Research Officer (paragraph 35).

(25) The prospects of success in the development of a bamboo pulp industry depend mainly on the possibility of obtaining large quantities of suitable limestone at sufficiently cheap rates (paragraphs 36—45).

(26) Although the organization of forest work is far from complete, the Forest Department has made commendable progress in certain directions (paragraph 46).

(27) The Forest Department should be run on commercial lines, and should receive full payment for produce supplied to other departments (paragraph 47) : it should remain, as at present, entirely separate from the Agricultural Department (paragraph 48) : a Forest Department Code, now under preparation, will be a useful aid to the work of the Department (paragraph 49) : the annual reports of the Forest Department should be printed (paragraph 50).

(28) The European forest staff is divided into the Administrative and the Executive branches, and there is also a non-European subordinate staff (paragraph 51) ; the question of recruiting and training Forest Officers for service in the Empire generally is now under consideration, and Kenya Colony should benefit by the scheme so far as the Administrative branch of the service goes : the training of the Executive staff (Foresters) should be of a practical nature, and should include a fair knowledge of surveying : the more promising non-European subordinates should receive a practical training under selected Foresters, and the question of a training institution for them should be considered later (paragraph 52).

(29) A regrading of the Administrative branch is proposed, one senior post to be filled by the appointment of an officer with special experience of working plan operations (paragraph 53).

(30) The work of the Forest Department should be decentralized considerably, the Division being made the administrative unit and Divisional Officers, who should ordinarily have not less than 5 years' service, being given more responsibility : Assistant Conservators should be employed in the capacity of Assistants (paragraph 54).

(31) A revised cadre is proposed for the Administrative branch, involving an increase of seven over the present sanctioned scale, and the rate of recruitment during the next 5 years is estimated at two a year (paragraph 55).

(32) A revised scale of salaries is proposed for the Executive staff (Foresters) (paragraph 56).

(33) In the event of a union of the East African territories, a Chief Conservator of Forests should be appointed (paragraph 57).

R. S. TROUP.

15th March, 1922.

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