1911.

NEW ZEALAND.

DEPARTMENT OF LANDS:

STATE AFFORESTATION IN NEW ZEALAND

(REPORT ON).

Presented to both Houses of the General Assembly by Command of His Excellency.

TABLE OF CONTENTS.

SIR,— Department of Lands, Wellington, 3rd July, 1911.

I have the honour to forward herewith a comprehensive report on State afforestation in this Dominion. For convenience sake, it has been divided into two parts, each of which deals thoroughly with phases of the subject.

Part I contains a clear statement of the reasons which induced the Government to commence and continue tree-planting operations in New Zealand, and shows the methods adopted in each Island at the State nurseries and plantations.

Part II comprises the annual reports by the officers in charge of tree-planting operations, showing what has been done in this respect during the year ended 31st March, 1911.

Plans showing the areas planted with the principal species of timber trees at the chief North Island stations are attached. There are also numerous illustrations which indicate in an effective manner the modern methods of tree-planting. Finally, a plan of each Island is attached, showing the locality of the various nurseries and plantations belonging to the Afforestation Branch of this Department.

I have, &c.,

WILLIAM C. KENSINGTON,
Under-Secretary for Lands.

The Right Hon. Sir J. G. Ward, Bart., K.C.M.G., Minister of Lands,
and Commissioner of State Forests.

PART I.—STATE AFFORESTATION IN NEW ZEALAND, 1911.

REASONS FOR AFFORESTATION.

CONSIDERING the apparently vast extent of our indigenous forests, the fine quality of our principal timbers, and their varied usefulness, it has often been the subject of much comment that it is considered necessary by the Government of this Dominion to inaugurate a policy of reafforestation. It can, however, readily be understood that the full facts of the case must be known and comprehended before it is possible to demonstrate clearly and cogently the reasons that have actuated the Government in the past and at the present time.

In the report on "Forestry in New Zealand," published in 1909, statistics were given showing in detail the present estimated supply of timber from all classes of native trees, and the probable demand for timber in the future, and the conclusions then arrived at apply with even greater force at the present day. Before recapitulating them, however, it is desirable to explain briefly the nature of our indigenous trees, and their various drawbacks and good qualities.

New Zealand possesses a large variety of trees in its native forests, there being no less than eighty-six different varieties known to botanists. The majority of these are, unfortunately, useless for commercial purposes to any great extent, through various causes, and, as a matter of fact, the following trees are practically the staple supply of the timber trade:—

Kauri (*Agathis australis*).—Grows only in the Auckland District. The girth of marketable trees range from 4 ft. to 30 ft., and sometimes more, the general average being about 12 ft., and the contents about 3,000 ft. There is no pine in the world superior for all-round use. It is used for joinery, furniture-making, house-building, ship, yacht, and boat building, wharves, bridges, railway, and other works, but is well adapted for high-class joinery, and internal fittings, carvings, &c. When converted into veneers it is highly prized. Unfortunately, it takes from six hundred to three thousand six hundred years to attain its full size, and as it is very inflammable, its growth and preservation is a matter of considerable difficulty.

Totara.—Totara is found throughout the whole of New Zealand except in the Nelson District, though the bulk of the supply is in Wellington, Auckland, Hawke's Bay, and Westland. It is very durable, and of all New Zealand timbers is the best for resisting the ravages of the teredo, and consequently has been largely used in the construction of wharves, bridges, &c. It also lasts well in contact with the ground, and is utilized largely for general building and joinery purposes, telegraph-posts, railway-sleepers, fencing-posts, &c. The mottled variety is much sought after for panels, furniture, inlaying, &c. Its chief drawback is that it is somewhat brittle, but it is probably the best timber for general building purposes in the Dominion.

Rimu, or Red-pine.—This is the principal timber in the New Zealand forests, and is extensively used for building, joinery, &c. The figured variety is often beautifully grained, and is much in demand for furniture. It is a most valuable wood, owing to its wide adaptability and comparative cheapness. Though not equal to totara or kauri, yet, owing to its greater cheapness, it is more largely used.

Kahikatea, or White-pine.—This timber is also in great demand throughout the whole of the Dominion. It is found chiefly on low-lying or swampy land, and grows in all parts of the Dominion. Its lasting qualities vary, but, unfortunately, the dry rot and borer find it comparatively easy prey, and therefore it is not much used for general building purposes. Its greatest use is for making butter-boxes, for which purpose no substitute has yet been found, and large quantities are exported to Australia for this purpose.

Matai.—The next timber in importance is matai, or black-pine, which is a very heavy but short-grained timber. It is used for building purposes, and especially for weatherboards and flooring; also for small bridges and fencing purposes. It is second only to totara for durability, but is inclined to brittleness. It is found all over the Dominion in fairly large quantities.

The only other timbers in New Zealand which are used to any extent for general purposes are—

Puriri, a very hard and tough wood, which makes good sleepers and posts, and is very durable. It is largely used for railway-works, bridge-stringers, and truck-frames. In weight, colour, and texture it somewhat resembles rosewood, but the figured varieties are marked like walnut. It is also largely used as veneers.

Rata, which is mostly used for firewood, is a hard, heavy, tough and very strong wood, mostly straight-grained, and used to a limited extent by wheelwrights, and as arms for telegraph-posts.

The various "*Birches*" (or "beeches," as they should be designated), which grow plentifully all over the Dominion, are being used for railway-sleepers very extensively in the Wellington District. *Fagus fusca* has also been exported to Australia from the Westland and Southland Districts.

The other trees are used to such a limited extent, and chiefly for limited local requirements, that they do not meet the growing demand for superior timbers.

The peculiar characteristics of these trees must be carefully taken into account when considering the possibility of relying on their perpetuation, whether by way of natural regeneration or systematic reafforestation. First and foremost is the great drawback that all the indigenous trees suitable for conversion into marketable timber require such an inordinate length of time to grow and arrive at maturity; although, owing to the comparatively recent settlement of New Zealand by Europeans, it is impossible to arrive with absolute accuracy at the exact length of time required by each tree to mature under average conditions, the approximate times previously given are as nearly correct as it is practicable to insure. Secondly, in consequence of nearly all our native trees being surface-rooters, their adaptation for general afforestation in open lands is practically prohibited through the damaging effects of exposure to sun and wind. Thirdly, most of these trees require special treatment to be raised with success, and need considerable shade from the seedling to the adult stage, which can only be afforded by planting them amongst partially cleared forest land, where the natural undergrowth provides the requisite amount of protection. In such a case, the annual clearing of undergrowth tending to suppress the tree-plants would be of such an exhaustive and expensive character as to prohibit the economical growth of native tree-plants. Fourthly, the principal exotic trees suited for commercial purposes take from one-fourth to one-tenth the time to attain maturity that the local product does, so that it is possible to raise on an average from three to five crops of larch or pine during the same time that it would take to raise one crop of totara or rimu.

Under these circumstances, it has been generally recognized it is out of the question to attempt to renew the indigenous trees for future commercial purposes, except to a very limited extent, and all that can be done is to conserve the remaining supply as far as practicable so as to allow sawmilling to proceed under conditions that will insure the greatest possible use being made of the existing timber. The timber-cutting and forest regulations for years past have been devised with the utmost care to accomplish this result, and, considering the remarkable increase that has taken place of late years in the timber industry, no adverse criticism can justly charge the administration of our native forests with any undue locking-up of natural resources. To assist the progress of settlement, it has been imperative that every facility should be afforded the building and allied trades to obtain cheap and accessible timber; and, as the periodical fires—that it has been impossible to prevent—continually ravage the portions of the forests nearest to settlement, it has been a wise policy to permit as much marketable timber to be used as was needed by the farming community and the building trades, and so serve a twofold purpose—viz., the gradual clearing of forest country adapted for settlement, and its opening for occupation and farming, and the development of the building and constructive trades to cope with the unceasing demand that a growing population constantly makes upon their resources.

Moreover, it must not be overlooked that some of the most fertile and productive soil and country in the Dominion was to be found in those very forests that contained the most valuable timber. The vanished Seventy-mile (or Forty-mile) Bush, in the southern part of Hawke's Bay, and extending to and around Pahiatua and Eketahuna; the Awarua Forest, between Taihape and Mangaweka; and the numerous stretches of forest in the Auckland District all at one time stretched across and occupied mile upon mile of country that now supports a large and thriving population; and it would have been as useless and as difficult a matter to preserve these magnificent forests in their entirety, whether for aesthetic, sentimental, climatic, or commercial reasons, as it would have been to have prohibited the spread of settlement and the onward march of civilization.

But the Government, whilst permitting the gradual conversion of these forests, has never lost sight of the fact that it was necessary to maintain the timber-supply of the country, and to provide for its needs in the future. One of the earlier methods of inducing the planting of suitable trees was by means of "land-grants," a settler being given a free grant of Crown land if he planted a certain portion of his freehold land in suitable trees. This system was chiefly confined to the Canterbury District, though it was partially adopted in the Auckland and other districts, but only to a very limited extent. In Canterbury, where the system came into force in the early seventies, as much as 2 acres of Crown lands for 1 acre put down in plantation was sometimes granted, and every inducement was offered to the settlers to put down part of their farms in plantations. Several large plantations may now be seen in North Canterbury that were established by means of this method. As, however, it did not meet the growing needs of the country, the system was discontinued, and it came to pass that the methods of State afforestation that had proved so successful in older countries eventually came to be adopted in New Zealand.

Demand for Timber.

In common with every manufacturing country in the world, the steady increase in demand for timber for commercial purposes has been experienced in New Zealand, and the following table shows how the timber industry has grown :—

Year.	Number of Mills.	Hands employed.	Output for Year.	Cutting-capacity per Annum.
			Sup. ft.	Sup. ft.
1886	220	3,890	163,740,546	..
1895	299	4,055	191,053,466	..
1900	334	6,085	261,583,518	..
1905	414	6,912	413,289,742	704,930,600
1907	411	7,139	432,031,611	718,940,000
1909	423	7,414	413,868,919	755,465,480

To cope with the present demand taxes all the resources of the Dominion, as the supply of our indigenous forests is rapidly diminishing, as will be seen by the following estimates :—

Year.	Estimated amount of Milling-timber remaining in our Forests.
1905	.. 41,723,574,800 sup. ft.
1907	.. 35,785,873,467 ,,
1909	.. 33,060,883,437 ,,

Judging from the vast quantity of forest that was not likely to be available for sawmilling, either through unsuitability of timber, difficulty of access, or cost of cutting and transport, and taking into consideration the loss annually experienced through accidental fires, and the fact that a large part of the timber stands on Native and private land which may be required for settlement purposes, thereby necessitating the felling and destruction of the timber, it was estimated in 1909 that the indigenous forests of New Zealand will not cope with the full demand for sawn timber for a longer period than from thirty-five to forty years, bearing in mind the fact that a certain amount of foreign timber will be arriving continually so as to ease the strain on local resources. Under these circumstances it will be understood why the Government deemed it advisable, many years ago, to inaugurate a system of tree-planting that would gradually take the place of the native forests and timber-supply.

Inauguration of Afforestation.

The problem before the Government was faced in a systematic and comprehensive manner. Three experimental plantations of various trees, aggregating about 15 acres, were started on the Kaingaroa Plains, between Taupo and Rotorua. Another plantation of 15 acres was started at Tarukenga, on the Rotorua Railway line, and another of 6 acres at Mamaku, not far away. These latter plantations were for the purpose of providing timber for railway requirements. Part of the Rotorua Town Belt was also planted.

Encouraged by the success of these preliminary experiments, a Forestry Branch of the Department of Lands was started in 1896, and three nurseries established, two at Tapanui and Eweburn in the Otago District of the South Island, and the other at Whakarewarewa, near Rotorua, in the North Island. The idea was conceived that, coincident with railway-extension, one or two central nurseries in each Island were sufficient for the growth of tree-plants, which could be distributed at various places in the district, according as circumstances warranted the extension of the system. Later on, another nursery was formed at Hanmer, in the Canterbury District (South Island), and attempts were also made to establish nurseries at Starborough, in the Marlborough District (South Island), and Ruatangata, near Whangarei (North Island), but from various causes these latter two nurseries, with the plantations attached to them, were not altogether a success, and have been discontinued.

It must not be overlooked that New Zealand was the first antipodean country to face the problem of State afforestation, and that it was only by means of continuous experiments and the greatest care and forethought that the Department was able to advance on satisfactory lines with due regard to economy and efficiency. It was inevitable that some out of the many species of trees planted should not have proved so great a success as others, whilst the rapid expansion of domestic trades and industries has demonstrated the inadequacy of the original operations, and induced the Government to enlarge its annual provision for the continued extension of plantations to a scale more commensurate with the exigencies of the case.

It must also be distinctly explained that if the present operations do not, in the opinion of some persons, represent that degree of magnitude that are deemed necessary in order to satisfy the whole of the future demand for timber in New Zealand, there are good and sufficient reasons for proceeding cautiously in the meantime. Although the foreign supply is more or less an unknown quantity, yet it is practically certain that the supply of eucalyptus from Australia, and pine from Siberia, Manchuria, and possibly Korea, together with the Douglas fir from Western Canada, will for generations to come satisfy to a very large extent the continuous demand for sawn timber in New Zealand, and that the remaining forests of the Dominion will also be available for some considerable time to assist in supplying the requirements of the commercial community. Moreover, it is essential that the characteristics of exotic trees planted in the State plantations, and their growth and progress in the climate

and soil of this country as compared with their growth elsewhere, together with their respective liability to or immunity from disease, shall be thoroughly studied and ascertained (and this cannot be done in a few years), before the inhabitants of the Dominion are committed to such a large increase in expenditure as would be necessary to insure the future maintenance of the timber-supply from New Zealand sources. Hitherto the operations of the Forestry Branch have been more successful than was anticipated at the commencement of the project, but the losses that have been experienced have been quite large enough to convince the authorities that it is the best policy to proceed with due caution, and not to suddenly enlarge the operations, but rather to expand them very gradually after repeated experiments and results have proved the advisability of doing so under certain conditions.

It will be interesting to trace the evolution of the present system from the conditions that appeared to the Government to dominate the position at the time the afforestation policy was decided upon in 1896. They may be said to include :—

(1.) The recognition of the principle that land suitable for settlement should not be interfered with for the purposes of tree-planting.

(2.) The desirability of utilizing Crown land as far as practicable.

(3.) The selection of localities for the plantations which would be fairly accessible from existing lines of railway, and which would, in the future, be conveniently situated to the probable trade centres.

(4.) The selection of areas of open land that were not in proximity to standing forests, but the climatic conditions of which appeared suitable for tree-growing operations, and whose soil seemed sufficiently good for the purpose.

Owing to the varied nature of the climate, soil, and conditions in different parts of New Zealand, and the necessity of the officer in charge of operations being thoroughly acquainted with local conditions, it was not deemed advisable to engage a foreign expert to superintend operations, but the services of a young and enthusiastic New Zealand nurseryman were engaged at the commencement of the work, and the results that were achieved under his advice from the very start were a convincing proof of the wisdom of the course adopted. A careful and continuous study of the latest publications and methods in vogue on the Continent and elsewhere has been the practice laid down for the guidance of all officers of the Forestry Branch, and as the work of tree-planting in this Dominion becomes more and more important and extensive, it is probable that further steps will be taken by the Government to keep the branch in touch with foreign systems and methods.

The late Mr. Henry Matthews was the officer whose appointment as Chief Forester inaugurated the formation of the Forestry Branch, and from 1896 to his unexpected death in 1909 he had the sole technical control of the tree-planting operations, and to him must therefore belong much of the credit or otherwise of the planting accomplished during this period. Since his death the technical direction of affairs has been intrusted to two Superintending Nurserymen, one who resides at Whakarewarewa, and supervises operations in the North Island, and the other who resides at Tapanui, and controls all the South Island operations. These two officers keep a careful watch over the several nurseries and plantations under their control, and are responsible for the rearing and planting-out of all the tree-plants in each Island. In charge of each State nursery is a Nurseryman, and in charge of each State plantation is a Forester. These officers direct the work of the labourers and others employed under them, and are carefully trained in the respective duties required of them and their staffs.

The Minister in charge of the State forests and all afforestation-work is the Commissioner of State Forests, and each year he lays before Parliament a report on the year's operations. The permanent officer in charge of the branch is the Under-Secretary of Lands, who has supreme administrative control over all operations ; and it is to him that the Superintending Nurserymen report, and from him that they take instructions. The financial considerations and all forestry problems that arise from time to time are dealt with by hm.

The cost of afforestation operations is defrayed by the sale of timber in State forests, supplemented by a contribution from the Consolidated Fund annually voted by Parliament. Owing to the youth of the plantations, and the immaturity of the timber therein, no returns have yet been derived from them, but it is hoped that in a few years' time a small revenue may be received, which will grow gradually larger as thinnings are available for disposal. When an assured return of thinnings is available in sufficient quantity there may be a possibility of utilizing them for wood-pulp purposes. This is a matter for future consideration, as it depends largely as to whether the timber grown is suitable for that purpose.

To enable a complete knowledge to be gained of the conditions under which tree-planting operations are carried out, it may be well to set out in detail the work of the Superintending Nurserymen, and in Appendices A and B herewith each of these officers narrates the methods and system adopted by him in the nurseries and plantations under his control, from the purchase of the seed to the final transplanting of the young trees from the nursery-beds to the plantation in which they will permanently grow.

Generally speaking, it will be seen that most of the seed is procured abroad until our own trees are large enough to become seed-producers—say, in ten years' time—and that the trees now grown in the State nurseries and plantations are those that continental experience and the results of experiments in New Zealand have shown are best fitted for the soils and climate of this country. In Appendix C is given a full list of all trees grown by the State, and the various qualities and uses to which their timbers can eventually be put. The primary object of the Government is purely utilitarian, as only those trees are grown that are suitable for commercial purposes, and the fact that the formation of plantations will in many cases enrich the soil, regulate to a slight degree the temperature, and conserve the rainfall is more or less secondary, although no efforts have been spared to gain the greatest possible benefits from the operations of the State in this respect.

Now, the full and detailed reports of the Superintending Nurserymen will show how carefully and systematically the preliminary work is carried out, and how advantage is taken of the knowledge gained abroad to carry on work in this far-off country under as favourable conditions as possible: but after all that is possible has been accomplished in this respect, another danger crops up and needs the most skilful attention to enable its evil effects to be checked and counteracted.

In almost every country in the world where forestry operations have been carried on it has been found that sooner or later forms of plant-disease inevitably make their appearance. In some instances great havoc has been worked, whilst of late years modern methods and discoveries have largely diminished the attendant dangers. It is of the utmost importance that in this fruitful land, where the conditions are so eminently favourable to plant-growth, that the equally favourable conditions to the formation and dissemination of plant-disease should be continuously and carefully watched, so that the smallest outbreak of any kind of disease may at once be notified, and every possible precaution taken to deal with it at the very commencement of its attack. Up to the present the indications of disease have been very small, but in order that the scrutiny of the officers of the Forestry Branch may be directed into the proper channels, and that the best advice may be available on this point, a special examination has recently been made by the Biologist of the Department of Agriculture, who has supplemented the constant supervision of the officers with a personal inspection in their company, and his report upon the health of the plants and their comparative freedom from disease will be found in Appendix D attached to this report.

As time goes on, and the trees attain a greater age, whilst the area under plantation annually increases, such inspections will be made at frequent intervals; and by a rigid scrutiny of all plants apparently suffering from any disease or trouble, it is hoped that disease may be kept well in check, and never permitted to spread beyond a confined radius where it originates.

Seeing that the plantations are still young, and that their area only extends to about 15,000 acres, it has been possible to carry on operations with a somewhat inexpensive staff of officers, and no great expenditure in the way of administration has yet been necessary. It has been absolutely necessary to employ the funds at the disposal of the Forestry Branch to their fullest extent in the direction of tree-planting, and consequently a rigid check has been kept upon all outlay that was not immediately and directly needed for present operations. In the future it will undoubtedly be necessary to increase the staff and provide for duties and needs that have as yet hardly entered into practical consideration. Even under these conditions, however, it is essential that no lavish expenditure shall be entered upon, but that the best possible results shall be attained from every new departure. As the scope of operations widens, it will undoubtedly be necessary to select and specially educate a few able and intelligent young New-Zealanders to fill the positions that will later on be required for the development and skilful management of the State plantations, and it is thought that a practical training in the nurseries and plantations of the branch, combined with a university education comprising those subjects specially appertaining to forestry (such as botany, entomology, geology, agricultural chemistry, and other subjects included in the degree of Bachelor of Science), and possibly a visit to the best schools and works in England and the Continent, will enable the operations of the Government to be conducted with the highest degree of economy and efficiency, and insure the best results being attained from past and future expenditure.

Every day increases the store of knowledge and literature appertaining to scientific forestry, and it is of the utmost importance that the training and methods of the officers of the branch should be as complete and efficient as it is possible to insure. At the present time both of the Superintending Nurserymen conduct a winter class, in which all the nurserymen and officers under their control have an opportunity of learning all that can be taught them of the work of their profession, and useful reference libraries have been established in each Island at the headquarters. The keenness and intelligence of the members of these classes is in the highest degree praiseworthy, and reflect the greatest credit on their instructors, and their individual efforts to advance in knowledge and usefulness.

Seeing how far the operations of any particular industry or business extend in modern days, and from what numerous sources it is necessary to gain information and assistance in order to achieve the best results, it will naturally be easily understood that the occasional services and advice of various officers of the Government service may from time to time be requisitioned for, and availed of, in connection with the work of tree-planting. A periodical inspection by a skilled biologist, an occasional examination by an agricultural chemist, visits by modern botanists and entomologists, for instance, will be of immense use in aiding the efforts of the permanent officers of the Forestry Branch; and it may be advisable later on to form a special advisory board of such experts, who would from time to time study and report upon any extraordinary or unexpected development in connection with the operations, and advise (if necessary) upon the general questions affecting the work of afforestation and timber-conservation. It is, however, to be distinctly understood that though it is essential to keep a watchful eye upon modern developments, and to display a foresight compatible with the importance of the subject, it is quite out of the question to lay down any hard-and-fast rules as to future management and administration, and the Government will in all cases be guided by the exigencies of each case as it arises, and meet the problems that constantly arise with the best means at its disposal, and in accord with the special circumstances of the matter. Possible future changes are merely indicated to show that the Government is fully alive to the needs of State afforestation in all its varying phases, and is facing future needs with foresight and discrimination.

APPENDIX A.

NURSERY AND PLANTATION WORK IN THE ROTORUA DISTRICT.

[By H. A. GOUDIE, Superintending Nurseryman, Whakarewarewa.]

The annual reports of the work done by the State Forests Branch during the twelve years of its existence have from time to time given much information relating to the success or otherwise of the various species of trees tried, the extent of work done, and the expenditure incurred. For the benefit of farmers and others who find it necessary to grow trees, it is now proposed to amplify this information somewhat by giving a brief account of the methods used in propagating the trees and forming the plantations in this district. Many useful publications dealing exhaustively with the propagation of trees are easily obtainable, so that in this article it is not intended to detail every known system, but rather to describe only the methods which have been adopted here, and which have been found to give the best results in every respect.

The Rotorua Nursery, where trees are grown for supplying the Whakarewarewa and Waiotapu Plantations, was established in 1898. It is excellently situated about two miles from Rotorua Post-office, and has a north-western aspect, while on the southern side a range of hills affords protection from the early morning sun and cold southerly winds. The largest portion of the property is level, or nearly so, the gradient in the parts under cultivation in no place exceeding 1 in 20. The soil is similar to the general run of land in this district, being of a light pumiceous nature, easily worked, and requiring no artificial draining. Generally such land in a virgin state carries a strong growth of bracken on the slopes, while on the lower-lying parts either manuka-scrub or tussock is usually found. For forest-tree-nursery purposes the soil is perhaps equal to any in the Dominion. It is fairly rich in mineral matter, has a not inconsiderable amount of humus, and a wonderful capacity for holding moisture without becoming waterlogged. This last fact is very apparent in grass paddocks which have been established for some time, and where the land has become consolidated by stock. Through a dry summer the grass will retain a greenness that is absent in most other districts. Continuous tilling such as is necessary in a nursery causes the humus to deteriorate very quickly, and it is absolutely essential that this should be replaced by green manuring, hence an area that is sufficient to permit of change of crops is necessary. Of the manures, lime was applied on all new land broken up for the first time. Bonedust and superphosphate are also used for many crops, but on the seed-beds, which carry dense crops of young trees, stable manure is largely employed. The nursery-area has been laid out into "breaks" 3 chains wide, divided by 20 ft. roads. These breaks are further divided by cross-roads at convenient distances, and by hedges for shelter purposes. Water-pipes are laid throughout the entire area, with standpipes at convenient points for watering the seedlings and puddling the trees.

RAISING TREES FROM SEED.

With few exceptions, all the trees produced in this nursery have been raised from seed. The chief sources from which supplies of seed are procured are as yet necessarily in the Northern Hemisphere, the seed of those species indigenous to North America being procured in North America, while European species are procured in England or Europe. Seeds of a few species are now saved in New Zealand, *Pinus insignis*, *Pinus muricata*, blue-gum, oak, ash, and birch being the principal ones, and these are usually of a high germinative quality. Much of the germinative power of imported seeds is lost by the time we are ready to sow them, but nevertheless the cost of seed for a thousand trees is reasonably low, as will be seen by the following table :—

Table comparing the Germinative Quality of Several Species of Tree-seeds; Cost of Seed for 1,000 Trees; also Amount of Seed usually sown per Square Yard.

Name of Tree.	Average Number raised per Pound of Seed.	Percentage of Germination.	Cost of Seed per 1,000 Trees.	Amount of Seed sown per Square Yard.	Remarks.
			s. d.		
European larch ..	3,500	4·0	0 9	2	European seed.
Corsican pine	5,500	8·0	0 8	1	,,
Heavy or bull pine ..	3,200	25·0	3 4	1¾	American seed.
Weymouth pine ..	2,000	0·23	6 1	1½	,,
Douglas fir	5,400	13·5	2 6	1¼	,,
Pinus insignis ..	11,000	10·0	0 4	1	New Zealand seed.
Redwood	1,200	1·22	12 7	1	American seed.
Eucalypti	22,000	Not known	0 3	0¼	Australian seed.

As a rule, seed-sowing in this district commences in October, and continues well into November, until the work is completed, the method being as follows : The land, which has been top-dressed with well-rotted stable manure, and ploughed during the early part of the previous winter, is formed into beds 6 ft. wide, with an alleyway of 2 ft. between each bed. The beds are then top-dressed with bonedust and superphosphate, and raked level. On one edge a wire line is strained tight, and secured in several places with iron pins. A heavy hardwood roller (see plate No. 1) is then slowly drawn over the bed, care being taken to keep the edge of the roller against the wire to insure straightness. The dimensions of the roller are : Length, 6 ft. ; diameter at the widest parts 12 in., and 11 in. at the narrow parts ; the wide divisions are 13 in. across and the narrow ones 4 in. When the roller passes over the

ground it leaves four depressions 13 in. wide and ½ in. deep, in which the seed is sown by hand. When the whole bed has been sown the roller is brought back over it, and presses in the seed to an even depth throughout. The seed is then covered with soil which has been screened and made free of large lumps. The roller referred to was introduced into the State nurseries by the late Mr. H. J. Matthews, a somewhat similar system having been in force in Germany, and I know of no method whereby seeds can be sown in quantity with such efficiency combined with cheapness. The 4 in. space between each bed serves as a means whereby the seedlings can be wrenched, and during the summer this space is kept well stirred up with hoes in order to catch as much as possible of the rainfall. When the seed is covered, seed-frames with hessian or unwashed paperhanger's scrim stretched over them are placed on the beds for the double purpose of protecting the seed from the birds and excluding the light sufficiently to allow of germination taking place.

The two months following the sowing of the seeds is perhaps the most critical period of the year's operations. Constant care is required in order to cope with "damping off," which may be accelerated either by excessive rain, strong growth of weeds, or a calm humid atmosphere. Usually the trouble cannot be prevented, but the evil results can be much reduced by keeping the seedlings free from weeds, and raising the seed-frames to allow of a good circulation of air amongst the young trees. (Plate No. 2 shows the manner of raising the seed-frames.)

The length of time that it is permissible to leave the seed-frames on the young trees is determined by the weather-conditions during the summer months, and also to a less extent by the species of trees. It has been found in this nursery that generally a hot dry summer has less ill effect upon larch-seedlings if they are protected by the hessian shading. On the other hand, no marked difference is noticeable with the seedlings of Corsican pine, and as a rule the shading is removed from these as soon as they have produced the secondary leaves. Whenever shading is removed, however, the seedlings are gradually prepared for the change by propping up the frames so that the sun strikes them gradually and for a short period only each day, and this procedure goes on until the leaves are somewhat hard to the touch. In this nursery all shading is, as a general rule, removed by the middle of March, and if possible dull weather is chosen for doing the work.

Before entering upon a description of the further progress of the seedlings through the nursery, a few general remaks as to the most suitable age and size for sending trees to the plantations seem advisable. Amongst nurserymen and foresters much difference of opinion exists upon this question, and there is undoubtedly room for such, as local conditions will in each case go a long way towards shaping out a general policy to follow. On one point, however, there seems to be a consensus of opinion——namely, that trees must have a good fibrous-root system if success in transplanting is to be assured. The root-growth of trees varies considerably according to species. Some, such as spruce, keep very much to the surface, and have a mass of fibrous roots, and practically no tap-root. Birch and alder usually develop several strong roots which spread in the surface soil and from which rootlets are sent down into the subsoil. Oak, ash, larch, Corsican pine, and heavy pine produce decidedly strong tap-roots, which descend well into the subsoil, and from which rootlets of varying sizes are given off. It is through the small rootlets or root-hairs that the tree absorbs the soil-moisture, and consequently a tree which has a fair amount of such roots, as a rule, suffers very little when transplanted. Those trees which produce a strong tap-root with little or no fibrous roots are the kinds which usually transplant badly. Corsican pine, Canary Island pine, and eucalypti are instances of this. Deciduous trees, such as oak, ash, and larch, although producing more or less strong tap-roots, do not need the fibrous root to insure successful transplanting to the same extent as is necessary with the evergreen pines and eucalypti.

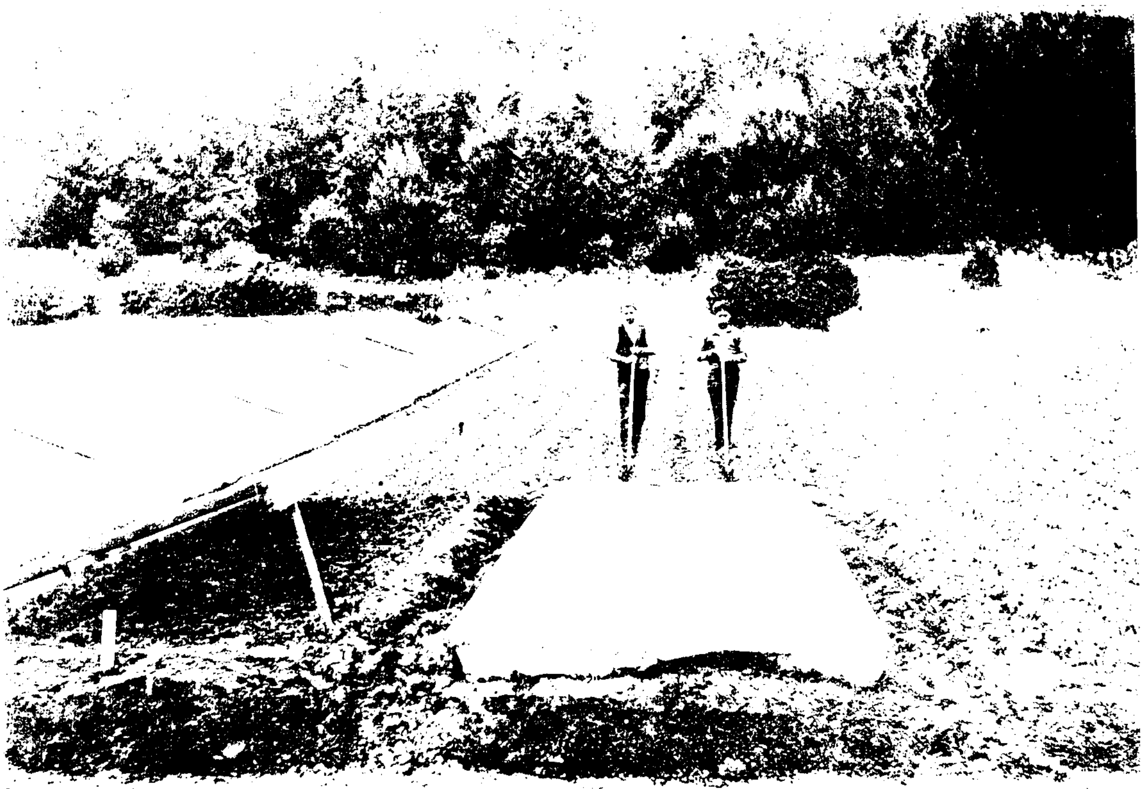
In order to cause trees to produce fibrous roots, it is necessary to prune the main root or roots either before or after the trees are lifted. If this is done before the trees are lifted it is termed "wrenching." This consists in cutting off about one-third of the root-growth by inserting a sharp spade on each side of the row of trees. The spade is held at an angle of about 45°, and is pushed well under the trees, care being taken that only the extreme ends of the tap-root and rootlets are severed (see plate No. 3). In this nursery "wrenching" is usually done in the spring, and generally only those trees which it is intended should remain in the same position for more than one year are so treated. In addition to improving the root-growth "wrenching" is beneficial in that it prepares the trees for removal by arresting the growth somewhat, and causing the wood to ripen and become hard, thus lessening the chance of death occurring when transplanting takes place. When trees are lifted for transplanting in the nursery for a further period the roots are trimmed with sheep-shears in order to bring about the same result as is aimed at in "wrenching," but even in cases of this sort "wrenching" may also be done with advantage where trees making quick soft growth are being dealt with.

Many parts of the plantation-areas on which trees are planted are much exposed to strong winds. This applies chiefly to hill-tops and ridges, where the comparatively dry soil is another factor which militates against successful planting. Altogether, the conditions prevailing on the plantation reserves are unavoidably somewhat more severe than those pertaining to the nursery where the soil is subjected to frequent tillage. As the result of experiments extending over some years, it has been found that comparatively small trees transplant much better than large ones, and that seedling-trees, or trees which have never been transplanted in the nursery, succeed as well as transplanted ones, provided they have been well "wrenched." It is somewhat difficult to define a "small" tree, as the different species that are grown vary considerably in their growth, but, to give some indication of what is meant, the average size of trees usually sent from this nursery is somewhat as follows: Larch, 12 in.; Corsican pine and heavy pine, 6 in.; Weymouth pine, 5 in.; Douglas fir, 8 in.; eucalypti, 6 in. Another very strong argument in favour of using small trees is that the cartage and handling costs less than is the case with large ones. To give some idea of what this means, it may safely be said that each tree which is grown in the nursery is handled, on the average, six times through the processes of sizing, lining-out, lifting and tying into bundles, carting, heeling-in, and finally planting in the permanent position on the plantation.

Wrenching Seedlings, Rotorua Nursery.

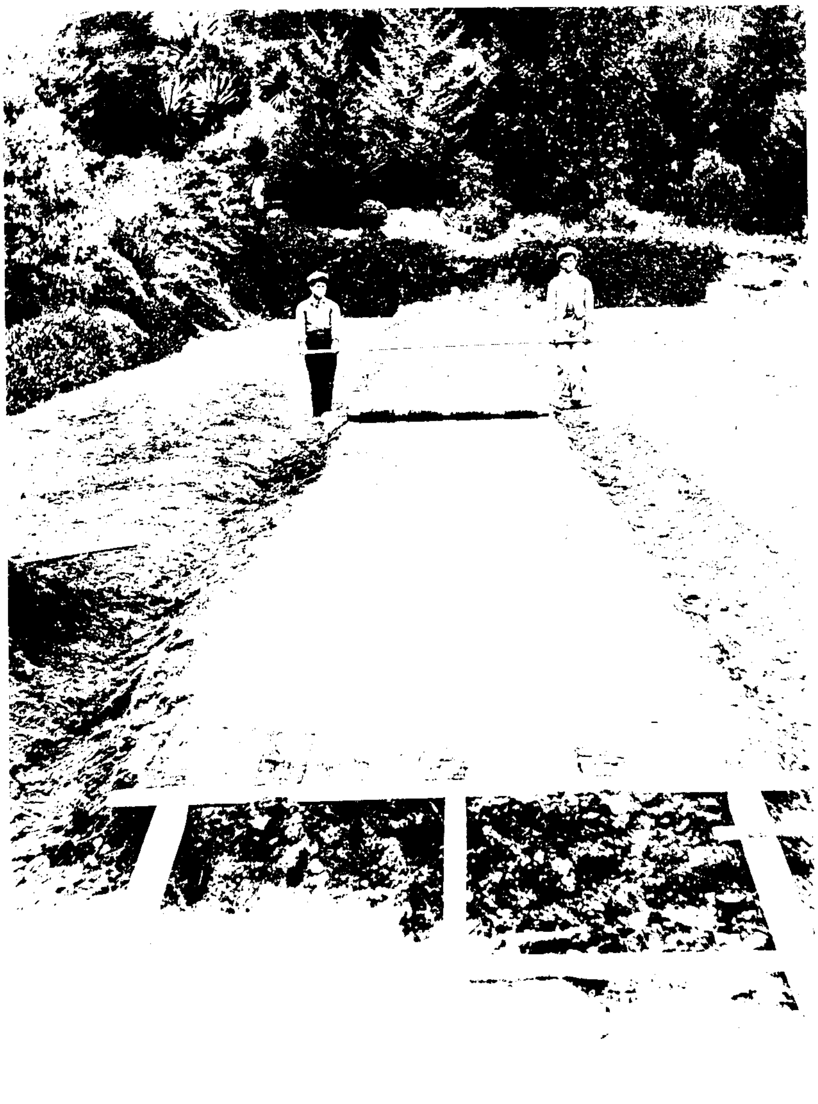
Lining out Seedlings, Rotorua Nursery.

Face page 8.



5789

Seed-frames, showing Method of propping [illegible] Rotorua, N.Z.



5791

Hardwood Roller used for forming Seed-beds, Rotorua, N.Z.

The term "sizing," which is used frequently in this article, refers to the grading of trees into various sizes, in order that each tree when planted out will have a suitable neighbour, and the struggle for existence consequent upon close planting evened up as much as possible. The fact of there being a proportion of small trees in a bed or seedlings is often due to them being too thick, thus causing the strong trees to suppress the weak ones. But even if seeds of some trees are sown ever so thinly there is always a smaller or greater proportion of very weak trees. This fact is more noticeable with European larch than any other tree grown in this nursery, and, as a rule, from 5 to 10 per cent. of a crop of this species are so stunted and weak that no amount of nursing would ever make decent specimens of them. From seeds saved off immature trees there would probably be a large percentage of such degenerates, but in practically every case there is a proportion of trees which it is undesirable to perpetuate. The saving of these "culls" has never been attended with success in this nursery, and it is considered better to destroy them as seedlings than spend money in transplanting and nursing them. Selection of trees by "sizing" has a direct influence upon the results obtained in the plantations, in that it helps towards uniformity of treatment, degenerate trees or trees prone to disease never find their way into the plantation, while the elimination of misshapen trees reduces the necessity for pruning.

Lining-out.

Amongst nurserymen this is a common term, expressing the planting of seedlings into rows in the nursery. The cost of this work is usually about 1s. 6d. per thousand trees, and the method is as follows: The nursery beds, which are 3 chains wide, are divided off into portions not exceeding 3 chains in length. At each end of one of these divisions a furrow is thrown up with a plough, and these are raked fairly level. Wire lines are then stretched across the bed, and the planters, who are furnished with a small bag of trees and a bricklayer's trowel, space themselves along the line, and plant out the trees at from 2 to 4 in. apart, according to the size. Immediately the whole row has been planted the plough throws up a furrow against it, and this is levelled off and the line shifted on to it in readiness for planting another row. The planters in the meantime walk across to the other end of the bed and plant a row of trees there, the plough following as before stated. The rows are thus kept going on both ends of the bed, and the distance between them is gradually decreasing until they meet in the centre. Lining-out adds, of course, to the cost of growing trees, and as far as possible it is avoided in this nursery. Trees which grow fairly fast as seedlings have to be lined out in order to check the growth, because if left in the seed-beds they would become overgrown and unsuitable for transplanting. In some cases it is possible to curtail the work of lining-out considerably by removing from the seed-beds and lining out only the largest of the trees, but the extent of the work is always uncertain, as so much depends upon the weather experienced during the first six months following the sowing of the seeds. As a rule, about 30 per cent. of the seedlings have to be lined out, the remainder being grown in the seed-beds until they are of a suitable size for sending to the plantations.

Owing to the difference in the rate of growth of the several species of trees dealt with, a uniform treatment of the trees after they are raised from seed is not possible. The principal kinds grown are larch, Corsican pine, heavy pine, remarkable pine, Weymouth pine, Douglas fir, and apple-scented gum. A brief description of these species is given hereunder:—

European Larch.—Seed of this varies considerably in quality, but it has been found that good results are generally obtained by sowing it at the rate of about 2 oz. per square yard. Sowing is usually done in October, and for the eight following months the beds are tended by way of weeding, &c. During that period probably 25 per cent. of the trees will have reached 6 in. in height, while the remainder are barely 1 in. high. In the month of July the large trees are carefully removed from the beds and transplanted into rows in the nursery, where they remain until the following May, when they are again lifted and despatched to the plantations. These trees are termed "one year" ones—*i.e.*, one year in seed-beds and one year lined out. The small trees which were left in the seed-beds will, during the same period, have made somewhat stronger growth than the thinnings which were lined out, and, although they vary in size, as a rule 90 per cent. of them are of a suitable size for sending to the plantation. When these "two-year-old" seedlings are sized the small trees which are not large enough for permanent planting may be "lined out" in the nursery for another season, but generally it is not advisable to do so, as these are culls or inherently weak trees, and it is questionable if they would ever reach a profitable maturity.

Corsican Pine.—Next to European larch this pine predominates in the tree-planting operations. Good seed is generally procurable, and when sown at the rate of 1 oz. per square yard the space available for each seedling is usually found sufficient for its requirements. Unlike the larch, this pine makes very regular growth, so that the bulk of the seedlings are usually of an even size. This regularity of growth makes it possible to grow this species for a longer period in the seed-beds without thinning than is possible with the larch, and it is seldom necessary to transplant the seedlings as "one-year olds" into the nursery rows. Corsican pine produces a strong tap-root with very few fibrous roots, and requires to be well "wrenched" in order to make the transplanting of them a success. "Wrenching" is performed in the spring, and the trees are sent out from the nursery for permanent planting, the second April after they are sown—*i.e.*, as two-year-old seedlings. The cost of transplanting into nursery rows is therefore avoided in the case of this pine.

Pinus ponderosa (the heavy or bull pine).—The seed of this valuable American timber-tree is, as a general rule, easily procured, although last year was an exception in this respect. In regard to size, the seed is somewhat larger than that of the Corsican pine, and on this account it is sown at a somewhat heavier rate than that species; 1¾ oz. to the square yard gives good results. This species makes an even quick growth in the seedling stage, and it is necessary to transplant the seedlings into nursery rows, as if they are left in the seed-beds for two years the growth is too rank. All trees of this species are sent from the nursery to the plantations as "two-year-olds."

Pinus Strobus (Weymouth pine).—Seeds of this species are sown at the rate of 1½ oz. to the square yard, and, as a rule, the germination is poor. The growth is very slow in the seedling stage, and on this account the seedlings are seldom "lined out," but sent to the plantations direct from the two-year-old beds.

Pinus radiata (the remarkable pine), better known as *Pinus insignis*, is a very fast grower, and seedlings six months old are usually large and strong enough to send to the plantations for permanent planting. Seed is sown in October, at the rate of 1 oz. per square yard, and in the following March or April the seedlings are lifted, the roots pruned, and then "heeled in" for about a month. This treatment is necessary in order to cause the rapid soft growth to ripen and harden off, and render the plants fit for further transplanting to the plantation-areas.

Pseudo-tsuga Douglasii (Douglas fir).—The seed of this tree is becoming more difficult to obtain, and the germinative quality varies greatly, but it is generally satisfactory if sown at the rate of 1¼ oz. per square yard. This species is treated in a similar manner to *Pinus ponderosa*.

Eucalyptus Stuartiana (apple-scented gum of Tasmania).—Sowings of this species are made at the rate of about 1½ oz. to 8 square yards. The seed, which is sown in November, is exceedingly small, and unless it is carefully sown or mixed with sand the seedlings will be much too thick. Owing to the rapid growth made by this, and in fact all gums, it is necessary that they should be planted out permanently at the seedling stage. The treatment of gum-seedlings is the same as is described under *Pinus radiata*.

Sending Trees to Plantations.

All trees before leaving the nursery are counted into bundles of twenty-five, and tied with strips of flax. The bundles are then brought together, and the straggling ends of the roots are trimmed off with a pair of sheep-shears. Next the roots are dipped in a tub containing a "puddle" of soil and water mixed to a fairly fluid consistency. This process is commonly called "puddling," and is necessary to counteract the drying effect of the air upon the roots whilst the trees are being lifted. A trench is then prepared with a spade, and the bundles of trees "heeled in" until it is convenient to send them to the plantations.

Tools and Implements used.

As far as possible, all cultivation is done by horse-labour. Reid and Gray's double and single furrow ploughs are used, and for the small breaks the short American ploughs are found very convenient. For general summer cultivation the Planet Jr. two-horse and the Syracuse spring-tooth cultivators are used. Amongst the trees the weeds are kept in check mostly with two-wheeled Iron Age hoes and Dutch hoes. A general assortment of spades, forks, and other garden tools is, of course, required, but the use of these is confined mostly to the lifting of the trees.

Cost of Operations.

The costs of the various operations are as follows: Per thousand—Sizing, 2s.; lifting lined-out trees for sending to plantations, 2s. 6d.; lining-out seedlings, 1s. 6d.; weeding, 9d.; sowing, 2s. These costs represent actual labour expenses, without taking into consideration cost of plant, buildings, and upkeep of same. Taking an average of the total expenditure and trees since the inception of the nursery, the raising of trees has cost 18s. 6d. per thousand.

PLANTATION-WORK.

[By D. J. Buchanan, Plantation Foreman, Whakarewarewa Plantation.]

The land on the Whakarewarewa Plantation is principally of a very rough, broken, often precipitous nature, varying in height from 1,200 ft. to 2,500 ft. above sea-level, and covered for the most part with a dense growth of fern, tutu, and various native shrubs, which has to be cleared off before planting operations can be commenced. Where the growth is chiefly manuka it is cut down, left to dry for a time, and then burned off; but if the area to be planted is covered with fern and tutu a fire-break 1 chain in width is cleared around it, and a fire put through the block. After the fire the growth which then remains standing is cut down, slashers and fern-hooks being used for the purpose. Burning-off is usually done in February or the beginning of March, when the conditions are most favourable and a good burn is assured. When the land has been cleared, roads and sledge-tracks for the distribution of trees are formed, and pitting is at once commenced.

The method of pitting employed, and the one found to be the most successful, is by means of the wire line. This line consists of a number of links of No. 12 galvanized fencing-wire, the length of each link corresponding to the distance between the pits; for conifers a line having 4 ft. links is used, and for eucalypti the links are 6 ft. in length. Eighty of these links are contained in a full line, which is found quite sufficient for one man to pull tight. To each end of the line a heavy iron pin is attached, and three sighting-poles—one at each end and one in the middle—are used to keep the line straight. These poles are first set up in a straight line in the direction the rows are required to run, and the line is stretched tightly against the poles, and the pits are then dug all along one side of the line, at the end of each link. The digging of the pits in the pumice soil is a simple matter; with a No. 2 Black spade a deep square sod is lifted out and placed upside down in the hole from which it was taken, and roughly broken up. When the first row of pits is completed the sighting-poles are shifted out, forming a second line parallel with the first, the distance between the rows being in all cases equal to that between the pits. In the second row the pits do not come opposite those in the first, but midway between them; to do this the line in the second row is drawn half a link beyond where it was pegged the first time, and on the third row is again drawn back, so that the pits in every alternate row are opposite. This method of pitting approaches that known as the triangular form, in which the trees are spaced out to form equilateral triangles, thus giving an equal growing-space to each tree.

For convenience in handling, the trees are put up in bundles of twenty-five, and are conveyed from the nursery in covered wagons, up to 100,000 plants being carried in a load. The plantation adjoins the nursery, but the land has been gradually planted up until, at the present time, the trees have to be carted a distance of five miles and a half by wagon, and from a mile to a mile and a half further by sledge. When a wagon-load of trees arrive they are at once "heeled in" in trenches, in order to keep the roots of the plants moist. Deciduous trees, such as larch, are packed much more closely in the trenches than pines, which, owing to their thick bushy foliage, if packed very closely and left for any time in the trench, are very liable to become heated. From the main trenches on to the ground to be planted the trees are carted by sledge, and are again placed in trenches, where they will be most convenient to the planters. The sledge used for this purpose has a short runner on either side in front and a pair of low wheels behind; the wheels making pulling up hill much lighter, and when coming down an incline the runners in front act as a brake, and prevent the sledge leaving the track. This vehicle can be used on fairly rough country, and carries a load of 20,000 average-sized plants.

The planters each carry their own trees, using a canvas bag 18 in. long by 12 in. deep, which will hold from two to three hundred larch or pines; in dry weather, however, when there is a danger of the roots becoming dry, not more than a hundred are carried. Old spades which have been worn too much to be of any further use for pitting are converted into handy planting-tools by cutting off part of each side of the blade, leaving it 6 in. wide at the top and tapering to 4 in. at the bottom or cutting-edge. Although several kinds of planting-tools have been used here, this has proved to be the handiest and most efficient of any.

In operation, the planting-spade is driven deeply into the centre of the prepared pit, and then drawn forward, leaving an opening in the soil behind it in which the plant is inserted, care being taken to place the root in proper position. The spade is then withdrawn, and the soil round the plant trampled firmly. Planting commences in April with the pines, after which the larch are put in, and then the eucalypti, the season, as a rule, finishing about the end of August.

The cost for labour, preparing land, and planting is as follows: pitting, 9s. per thousand; planting, 7s. per thousand; clearing, £1 per acre. These figures represent a fair average, but much depends upon the nature of the land being dealt with. Steep country makes both pitting and planting more costly, while some land will cost as much as £2 per acre to clear, and on other portions no clearing is required.

APPENDIX B.

FOREST-TREE GROWING IN THE SOUTH ISLAND.

[By R. G. Robinson, Superintending Nurseryman, Tapanui.]

Introductory Remarks.

The afforestation-work conducted by the State in the Dominion has, since its initiation, received the whole-hearted support of many enthusiastic tree-growers; but with each succeeding year the increasing prominence of our young artificial forests has atracted the attention of the general public, who, on becoming enlightened regarding the annual progress made, not infrequently express their surprise at the magnitude of the undertaking.

As might be expected, the presence of flourishing State plantations of timber trees in the various districts throughout the Otago and Canterbury Provinces stimulates the desires of farmers and others to produce similar results, and officers of the Department are frequently called upon to supply such information as will materially assist intending tree-planters.

Although certain rules for general guidance have been maintained since the inauguration of the Forestry Branch, it has only been through a sustained series of experiments, together with the introduction of new practical ideas from various sources, that the present measure of success has been attained.

This condensed article on tree-raising methods adopted in the South Island nurseries and associated plantations is prepared with the object of conveying to readers information which recent correspondence and personal inquiries show is mostly solicited.

By the actual observance of the various works in progress, however, more productive knowledge is gained than from any literary source, and departmental officers are ever ready to give a practical demonstration to those contemplating tree-planting.

Whilst the effect of desired brevity and compulsory omission of much detail will be apparent throughout this paper, its object will be accomplished, however, if a concise practical review of the leading items of labour essential in raising seedlings and creating plantations up to their present stage is portrayed.

Tree-seeds.

On learning that the conifer-seed used was chiefly obtained from a foreign market—Europe and America—visitors to the nurseries have advanced theories supporting opinions to the effect that seeds gathered in the Dominion would possess greater germinative qualities, be cheaper, and the resulting plants more speedily adapt themselves to existing conditions. These opinions are partially correct, but the increased expense attached to local cone-gathering and subsequent extraction of an approximate 8 cwt. of seed annually, together with the questionable practice of tree-raising from seed which had perhaps been taken from comparatively youthful trees, has, up to the present, prohibited the utilization of home-grown seed of most of the pine, larch, and *Abies* families. The transportation of certain kinds of seed over long distances, and more especially on sea voyages, often accelerates the decomposition of

seed-kernels. Thick-meated or soft seeds quickly show signs of dryness when stored in a dry place, or, on the other hand, become too moist when placed in a cool situation. A medium and uniform temperature is generally favourable for the successful transport of any seeds, although further precautions in the form of hermetically sealed packages, or packing in finely powdered charcoal, are resorted to in many cases. Small amounts of such seed as *Pinus insignis* and *P. muricata* gathered from mature trees growing in the Dominion have been obtained annually, and such success has attended these sowings that on our plantations reaching a more mature age we hope to become practically independent of foreign supplies.

Certain exotic trees may take generations before becoming acclimatized to the conditions obtaining in New Zealand, and, although such trees may thrive, and yield prolific crops of seed, which on being sown produce strong plants, we do not yet possess sufficient knowledge to state with any degree of certainty if such vigour will be maintained during the life of the plant.

Well-bodied seeds from a healthy mature tree not only possess greater germinative qualities, but are also capable of enduring more adverse conditions after sowing. The possession of these facts has influenced the action of the seed-collectors for the Department in gathering only from specially selected trees.

During the past four years very limited sowings of hardwoods have been undertaken, simply because the nature of the ground now being operated upon is more suitable for coniferous tree-growing.

No difficulty is experienced in securing any desired quantities of hardwood seeds—oak, sycamore—which, on falling during the autumn period, are easily swept up and conveyed to the nurseries in sacks. It is customary to devote more care to the gathering of English ash, alder, beech, &c.; and in these cases hand-picking direct from the parent tree has been found to give the best results.

Before germination is possible, the external covering of the ash-seed requires to be in a decayed state, which is usually brought about by pitting in a mixture of sand and soil immediately the seed is collected—about the latter part of May. If the contents of the pit are kept damp, and periodically "forked," the gradual decay of the seed-shell is brought about after twelve months, when sowing may be undertaken.

Seed-testing is always resorted to before finally preparing the seed-beds, as the quality of the seed at all times influences the density of sowing. In dealing with acorns, a trough half filled with water is used, and on emptying a reasonable quantity of the seed into this receptacle, and stirring the whole, the inferior acorns will immediately rise to the surface. A large proportion of such seed will germinate if sown; but experience proves that the resulting plants do not attain youthful vigour to such a degree as the heavier seed, and should be discarded. The vitality of other varieties is ascertained by simply cutting them open with a penknife.

The appearance of pine-seed kernels is ofttimes deceptive, for whilst the desired milky substance is discernible at the first glance, closer examination reveals the existence of a small cavity between the shell and kernel—a state which generally accompanies seed-decay.

A further test of germinative capacity can be made by placing, say, two hundred seeds on a plate which has been covered with a piece of damp flannel. The plate should be allotted a dark place, and care taken that the flannel retains its moisture. Irregular germination will eventuate from such an experiment when stale or immature seed has been used; but on counting the number which sprout, it is possible to estimate fairly accurately what may be expected in the general sowing.

Preparation of Ground for Seed-sowing.

Climatic conditions experienced at the three South Island nurseries are sufficiently favourable for raising the hardier varieties of timber trees, and in this connection it has been possible to adhere to a general working-system, which, however, receives slight modifications according to the variations of the seasons. The ground selected for the raising of seedlings at each nursery is neither of an exceptionally rich nor damp nature, but of fair fertility, moderately compact, well drained, and provided with a reasonable amount of shelter from the prevailing winds. It is also imperative that a fairly level surface be available, otherwise, in all probability, the smaller seeds sown will be washed away if subjected to a heavy fall of rain. Although our germinating-grounds have been specially selected, it occasionally happens that we are compelled through the presence of the destructive bark-eating grass-grub (*Odontria zealandia*) to confine the season's sowing operations to a less-cultivated area, which has been previously utilized for transplanting purposes; and in this case the amount of preliminary labour in connection with the preparation of ground is, of course, considerably increased. It is not always practicable to adhere rigidly to any fixed method in transforming the surface-soil from its rough consolidated condition to a sufficiently fine state for the reception of seeds; but the following procedure, very briefly described, possesses many advantages, and is generally adopted:—

1. Assuming that we are about to operate on virgin ground, the first point of importance will be the removal of any heavy surface vegetation, preferably by burning, after which the area should be trench-ploughed to a depth of about 14 in. This first heavy plough-work (which usually costs 17s. 6d. per acre) is generally undertaken by private contract in the late springtime, to permit of the ground becoming sufficiently settled to receive a second cross-ploughing before winter.

2. Previous to the second working, a light dressing of decayed stable manure is applied, and two small ploughs are then brought into requisition, the leading one taking the opening furrow to a depth of from 6 in. to 8 in., whilst the following plough (from which the mould-board has been removed) is directed over the same course, and stirs up the subsoil to a further depth of from 4 in. to 6 in. By this means the ground is thoroughly loosened some 12 in. or 14 in. deep, and the gradual incorporation of surface with subsoil is almost as effectually accomplished as by the old and less speedy trenching by hand method.

3. By the advent of spring, through its lengthened exposure to air, moisture, and frosts, the upturned soils should be in a state of pulverization, although it is customary to again stir the whole thoroughly with a Planet Jr. cultivator, after which a few strokes with the harrows should complete the initial process of preparation.

SEED-SOWING.

Coniferae.—Undoubtedly the most important and interesting item of labour connected with the nursery-work is the propagation by seed of the various species of *Coniferae*, which includes larch, pines, and spruces. This operation is generally carried out during the month of October, when sap is most active; but as the actual sowing of small seeds can only be performed successfully in comparatively calm weather, frequent intermissions are not unusual.

The arrangement of seed-beds requires some little forethought. Although a casual observer is inclined to discredit the necessity of keeping lines of trees and beds straight and parallel, more intimate acquaintance with the work shows that the little extra labour thus entailed not only improves the appearance of the tree-raising station, but also promotes economy in the working of small blocks of ground. The seed-bed area having been measured at each end, iron pegs are driven in the exact width of beds, which vary according to the size of frames being used. Between each seed-bed, which may be either 27 in., 34 in. 42 in., or 72 in. wide, an alleyway or path, for convenience in weeding, &c., is marked off, measuring from 21 in. to 27 in. in width. Three or four light wire lines are then stretched across the block, and attached to corresponding pegs, after which the building of the beds is commenced.

Experience has shown that the rougher the nature of the soil being operated upon the greater the necessity in the first place of elevating the seed-beds, and as the soil for this purpose is taken from the alleyways, a hollow remains, into which all lumps are drawn when raking is in progress. A light dressing of bonedust or superphosphate, according to fertility and soil-requirements, is then applied to the beds in their rough state and thoroughly incorporated with the soil by the agency of small six-toothed potato-drags, which also take the place of rakes in drawing off the larger stones and lumps of clay.

A perfectly fine and uniform surface is lastly prepared by the most skilled workers, who, after pushing and drawing the toothed side of the rakes across the bed, and extracting any small pea-like lumps, reverse the tool, and conduct what is termed the final "back-raking." The bed should now be nearly an inch higher than the adjoining alleyways, and in readiness for sowing.

To direct the roller, the line is again connected at each end of the bed, and a wooden cylinder is drawn by two men (as shown in illustration). Four surface impressions, about 12 in. in width, are thus regularly formed. Several smaller sizes of similarly constructed contrivances are used, and are manipulated in precisely the same manner.

Immediately the rolling-process has extended to the end of the "break" seed-sowing is commenced, and on the return journey the sowers precede the roller, which firmly presses the seed to the required depth.

It may here be mentioned that the ground should not be in an absolutely dry condition, as in this state it is impossible to imbed the seed with the desired firmness. A certain amount of dampness is essential to insure success, although on no account should the work be attempted when the soil is in so moist a condition as to adhere to the working-tools.

The firmly pressed seeds may now be covered with a composition of finely sifted soil, sand, and ashes, to which is added during the mixing-process a light dusting of bonedust.

The correct depth for sowing varies according to the size of the seed, so that English birch (which is usually sown broadcast) receives merely sufficient top-dusting to keep it in its place, whilst the heavier seed of, say, *Pinus Benthamiana* would require to be under the surface to a depth of about $\frac{1}{8}$ in. Generally speaking, we adhere as nearly as possible to the recognized formula, and endeavour to effect a uniform covering which will, on examination, disclose the seeds at a depth of about one and a half times their own diameter.

Density of sowing calls for a few special remarks, although no attempt can be made here to introduce technical detail at any length. To regulate the desired crop, sowers must bear in mind at the outset the germinating-capacity of the seed being operated with; and this information is obtained by testing as previously mentioned. The larch-seeds when subjected to a test give most inconsistent results; one season perhaps 18 per cent. germinating, whilst in the ensuing year probably only one-sixth of this percentage may be reckoned upon. This fact alone will amply demonstrate how impossible it is to conform to any fixed rules regarding thickness in sowing. Included in the table apportioned hereto will be found an estimated average number of seeds required for sowing over 1 square inch of ground.

The young seedlings are protected from birds and wind by covering the beds with frames 18 ft. long, and of various widths, the most convenient size being 6 ft. wide. The sides are made of 6 in. by $1\frac{1}{2}$ in. black-pine or totara, and are secured by four cross-pieces of $\frac{1}{2}$ in. piping, which are then affixed to the sides by means of bored flanges. To give further rigidity to the frame, a piece of angle iron, $1\frac{1}{2}$ in. by $\frac{1}{4}$ in., is screwed to each end, and finally small $\frac{1}{2}$-in.-mesh netting is stapled over the top.

It was generally conceded during the early stages of tree-raising in the southern nurseries that additional shelter would not be conducive to the health of seedlings, and would probably accelerate "damping off"—the common fungus disorder which develops under moist and close atmospheres, crowding, and indifferent watering. Of recent years, however, all seed-frames have been covered with No. 0 scrim, 6 ft. wide (which may be purchased at a wholesale rate of about $2\frac{1}{2}$d. per yard), without influencing the "damping off" to any extent. After the young plants have become well established, this covering is removed, and the gradual tilting of frames harden off seedlings sufficiently to permit of their being taken off a few weeks later.

Hardwoods.—Raising of the hardwoods—oak, ash, sycamore, walnut, chestnut, &c.—is a comparatively easy matter when compared with the system adopted for *Coniferae*, as already explained; but, nevertheless, deep tillage is essential if successful results are to be anticipated.

On roughly raking the whole length of the plot to be sown to a width of about 3 ft., a line is tightly stretched and attached to pegs at each end. Along this line a uniform drill the exact width of the spade is formed, varying in depth according to the variety and size of the seed being sown. On completion of this drill, the seeds are deposited therein, and the surface-soil, which had by this time become hard through employees moving about, is thoroughly stirred up again by the aid of a one-horse Planet cultivator.

The levelling-process is now repeated, and the line brought forward about 20 in., which provides for an alleyway of about 12 in. in width between the drills. Again a drill is formed as before, and the soil removed therefrom is now used to cover the exposed seeds in the previously prepared drill.

In the following table information is disclosed relative to the cost of the principal varieties of seed sown in the South Island nurseries, number of seedlings raised per pound, &c. Although results for some years past have been reviewed in arriving at these figures, and a fair average is presented, the inconsistency both of seed-vitality and variation in size renders the compilation of a thoroughly incontestible estimate impossible :—

Variety of Seed.	Price of Seed per Pound.	Number of Seeds in a Pound.	Number of Seedlings raised per Pound.	Seed-cost per One Thousand Plants.	Number of Seeds sown per Square Inch.	Where sown.	Where procured.
	s. d.			s. d.			
Larix Europaea	2 9½	72,300	3,200	0 10¼	38	T, R, H	Europe.
,, leptolepis	9 6	98,800	3,800	2 6	24	T	,,
Pinus Laricio	3 3½	28,900	6,400	0 5¾	18	T, R, H	,,
,, austriaca	3 11	19,320	5,800	0 8	14	T, R, H	,,
,, strobus	12 5	21,520	1,200	10 4	19	T, R, H	America.
,, ponderosa	11 1½	9,800	4,600	2 3½	12	T, R, H	,,
,, Benthamiana	14 10	3,840	2,740	4 4¼	6	T, R, H	,,
,, muricata	15 9	24,250	8,300	1 10¾	17	T, H	New Zealand.
,, radiata	3 6	18,250	6,800	0 6¼	11	T, H	,,
Picea excelsa	1 8½	50,310	9,200	0 2¼	29	T, H	Europe.
,, sitchensis	19 4	187,000	17,100	1 1¾	32	T, H	,,
Pseudo-tsuga taxifolia	13 7	37,320	3,900	3 5¾	18	T, R, H	America.
Fraxinus excelsior	1 4	6,250	1,500	0 10½	5	T	New Zealand.
,, americanus	3 6	8,500	1,800	1 11½	6	T	America.
Quercus pedunculata	0 0½	120	90	0 5½	1	T, H	New Zealand.
Fagus sylvatica	6 9	995	886	5 3	3	T	,,
Betula alba	1 11	500,000	4,200	0 5½	52	T, R, H	,,
Juglans regia	0 5½	40	30	13 10½	0¼	T	,,
Castanea vesca	0 4½	104	80	4 2	0¾	T	,,
Acer pseudo-platanus	0 8	4,890	1,600	0 5	6	T	,,
,, saccharum	1 6	5,376	500	0 9	6	T	America.
Thuja plicata	4 2	325,500	32,000	0 1½	34	T	New Zealand.
Cupressus Lawsoniana	8 6	115,300	14,500	0 7	20	T, H	,,
Alnus glutinosa	0 10	120,400	7,540	0 1¼	34	T, R, H	,,
Robinia pseudo-acacia	1 3	18,365	2,800	0 5¼	12	T, R, H	,,
Averages	5 8½	67,098	5,622	2 3¾	16¾	..	..

T = Tapanui Nursery; H = Hanmer Springs Nursery; R = Ranfurly Nursery.

Tending Seed-beds.

As may be expected, the greatest care and discretion must be employed in executing the various items of labour directly associated with the tending of forest plants up to the yearling stage. During the currency of a dry season occasional applications of water are necessary, and this is conducted by means of water-pipes, with conveniently situated standpipes, to which are attached hoses with fine-spray nozzles. In this connection, however, it is wiser to moisten the ground thoroughly at limited intervals than adopt a practice of almost incessant surface-watering, which experience proves not only accelerates the formation of a hard, crusty surface, but induces "damping-off."

The removal of weeds from among seedlings is generally repeated two or three times during the season, and is undertaken preferably when the ground is in a thoroughly moist condition. Small pocket-knives after the Pampa style are used, and by keeping a keen edge on them it is an easy matter to sever the weeds a little below the collar, without disturbing the seedlings. It is often advantageous to pull up gently by the spreading roots such weeds as sorrel after the young trees are well advanced, although the adoption of this method during the period of seed-germination would give rise to unquestionable failure. By February the young plants should be growing vigorously, and all scrim-covering may then be dispensed with. To minimize the risk of an abrupt cessation in the progress of seedling-growth, a simple "hardening-off" system is adhered to. Seed-frames are tilted up on one side, and held in that position by specially made bars or blocks of wood. A greater circulation of air is thus permitted to encompass the germinating-ground, and, after about a fortnight of such treatment (or early in March) the permanent removal and stacking of frames may be carried on with perfect safety.

Wrenching.

The success we have achieved in transplanting young pines, evergreens, and seedlings generally that produce lengthened tap-roots is attributed largely to a system of wrenching, which is performed by two employees, who are provided with specially sharpened spades. Each man stands on opposite sides of the drill being lifted, and by brisk foot-pressure drives the spade full depth at such an angle

as will cleanly cut the roots near the extremity. By a gentle leverage on the spade-handles the soil containing plants is slightly raised, and on withdrawing the tools the crevices formed on each side are closed by tramping. This operation is usually conducted in the early autumn, so that sufficient time is given plants to recuperate; and transplantation is facilitated by the consequent formation of numerous fibrous rootlets in place of straight tap-roots.

Lifting and Lining-out Seedlings.

As the nurseries at Tapanui, Ranfurly, and Hanmer Springs transfer an approximate 3,750,000 seedlings annually from beds to nursery-lines, it will be readily understood that the handling of this large number during the months of September and October by thirty-six employees requires to be conducted with as little delay as possible. Through the winter and early spring months the lifting of young plants is steadily carried out, and if it is possible to complete this labour during the dormant season of vegetation, so much the better, as the roots of plants invariably suffer when exposed to air after the sap has become active.

Various rudimentary principles are generally acknowledged in dealing with the different kinds of trees raised, but the precise method chosen is regulated according to the vigour of seedlings. Such trees as larch, Oregon pine, oak, sycamore, walnut, chestnut, alder, ash, and some of the quick-growing pines—*Pinus insignis*, *Pinus muricata*, *Pinus Torreyana*, *Pinus Benthamiana*—are usually transplanted into lines when one year old, whilst it is customary to allow the less speedy growers—*Pinus Laricio*, *P. strobus*, *P. austriaca*, *Picea excelsa*, *P. sitchensis*—an additional year's development in beds before lifting.

Assuming that we are about to deal with a bed of larch: Ordinary digging-forks are used to loosen the trees, which are subsequently pulled up evenly, deposited carefully into shallow boxes, and conveyed to the sizing-shed—a building fitted up with benches, puddle-tubs, &c., for the convenient handling of trees. The classification or sizing-work is now undertaken, and each workman is able to sort out and arrange in two or three sizes between 20,000 and 30,000 plants daily. This treatment is followed by a light root-trimming with ordinary sheep-shears, and the young trees are then immersed in a liquid composition of soil, cow-manure, and water of the consistency of thin paste, which affords protection to rootlets against wind and sun. Although the puddling-process is exceedingly simple, faulty uneven work is always revealed by the speedy withering of seedlings. The uniformity generally of pine-beds renders the sizing of these conifer seedlings more simple, and in many cases it is advantageous to lift, trim, and puddle them direct from the germinating-ground without any classifying.

Success in lining-out operations cannot reasonably be anticipated unless every precaution is taken to protect the plant-roots from the drying influence of sun and wind; and on completion of the sizing-work, all seedlings are placed thickly in small trenches, care being taken to cover the roots thoroughly with fine soil, which is then lightly tramped. By this "heeling-in" process the seedlings not only retain a well-preserved state until required for transplanting, but are more easily handled by planters.

Having indicated the methods adopted in dealing with the young plants up to the "lining-out" stage, it is desirable now to briefly describe the manner in which the transplanting is conducted.

In a well-regulated system of tree-raising, provision should not only be made for the rotation of crops, but transplanting-compartments should be permitted to lie fallow periodically—say, once in every three or four years—and occasionally receive a dressing of lime or other suitable fertilizer. The cultivating of an oat or clover crop up to a certain stage and then ploughing under is also an effective way of restoring soil-fertility; but of late years the increased number of grass-grubs in the ground immediately after a green crop has been turned under made it imperative to dispense with this custom.

Before commencing "lining-out" operations, it is a wise policy to test the working-depth of ground, which should be in a perfectly free state for at least 12 in. or 14 in. below the surface.

Assuming that we are about to plant an area 3 chains long by 2½ chains wide (an averaged-sized "break"), the first point of importance is the digging of two spade trenches from end to end, on the extreme outer edges of the "break." A Wiard hillside plough, drawn by two horses, is then introduced, and being fitted with a swinging reversible mould-board is able to work backwards and forwards along the one side, stirring the soil to a double depth of about 12 in., until a sufficient width has been ploughed.

The workmen whose duties consist of levelling the ground then come along the plough-furrow, and, by brisk movements to and fro with light potato-drags, quickly form a fine uniform surface. The ploughman and levellers now move to the other side of the "break," and similarly prepare the ground, whilst each planter (who is supplied with a bricklayer's trowel and canvas bag for holding trees) takes his allotted place along the line in readiness for planting. A light No. 12 gauge wire is now stretched over the prepared surface from end to end, and, on being tightened by a specially designed straining-machine, is sighted by the leading planter. It is often necessary for one of the experienced workers to "spring" the wire before perfect straightness is attained, after which each planter pegs down the line with the iron pin provided, and proceeds to plant.

The distance between seedlings in nursery lines varies slightly according to the age and strength of the plants, although, after much experimenting, we find that not only is the tending of the lined-out trees facilitated by medium planting of 10 in. between the lines, with plants about 2½ in. apart, but sturdier trees, possessing good leaders and protecting lateral branches, are produced.

It will thus be seen that we are able to transplant about 246,000 seedlings on an acre of ground, after due allowances for borders and centre alleyway are made.

Amongst the varieties that develop sufficiently for transference to plantations when two years old may be mentioned larch, Oregon pine, oak, ash, sycamore, birch, alder, acacia, *Pinus radiata*, *P. muricata*; whilst an additional year's growth in nursery is usually allowed the slower-growing spruce fir, Sitka spruce, *Pinus Laricio*, *P. austriaca*, *P. strobus*, *P. ponderosa*. The adoption of a general planting rule is not rigidly adhered to in connection with the latter-mentioned trees, for at

both Hanmer Springs and Ranfurly Nurseries yearling pines are lined out most successfully, and permitted to occupy the same position for two years; whilst at Tapanui Nursery greater success is attained by transplanting two-year-old seedlings, and allowing only one season for development before permanent removal. Seedlings are conveyed in shallow boxes direct from the "heeling-in" quarter to the planting-ground, and placed in convenient positions there. Every effort is made to conduct the lining-out work with workmen who have previously had special training, as some time must elapse before a casual worker becomes proficient or smart enough to hold his own along the line.

The planter, after putting a sufficient number of trees in his bag (which is strapped round the waist) to complete his "break," firmly grasps the trowel with one hand, whilst with the other he separates about half a dozen plants. Then, assuming as comfortable a position as possible, with the right foot well back into the trench, he thrusts his trowel deeply into the ground, the left edge touching the line, and the right about ¼ in. further out. A vertical crevice for the reception of the tree is then formed by the operator simply drawing the trowel towards him, and into which the tree is quickly placed, as near the line as possible. Briskly withdrawing the trowel, it is again utilized in pushing a little soil against the plant, and the operation is completed by the application of foot-pressure to the base of the young tree. The next plant is similarly dealt with at about 2½ in. distant; and the planter, working along the line to the right, continues in this manner until his allotted "break" is finished. The arrangement of the planting and ground-preparation gangs is so effected that one keeps the other steadily occupied. After completing the planting of one line, a width of about 1 ft. is ploughed and levelled, and the line again brought forward 10 in. The number of plants lined out per man daily depends to some extent upon the nature of the soil worked. It is, however, not unreasonable to expect a trained staff of planters to handle between 8,000 and 10,000 plants each in a day of eight hours, although this does not include the preparation of ground. In the plant-sorting operation a small percentage of undeveloped seedlings generally remain, and these are lined in closely. The plants are placed about ¼ in. apart, in lines 10 in. between; but as the resulting trees mostly develop into unsatisfactory, spindly specimens, which rarely succeed when planted permanently in exposed situations, the lining-in treatment is discarded as much as possible. There is no doubt that the unnecessary crowding of plants in nurseries is often conducive to badly ripened wood, and consequent failure in operating with even the hardier varieties.

Tending Transplanted Trees.

Climatic conditions influence largely the extent of work necessary in keeping the nursery free from weeds and the surface-soil in an open state. The drier the season the less the expense essential in keeping the "breaks" of trees in good order. Dutch-hoeing between the lines is resorted to some few weeks after the transplanting-labour is completed. This has the effect of breaking the surface-crust, and paves the way for the later machine-hoeing. The manipulation of the small Planet wheel-hoe is extremely simple, and requires but little explanation here. The machine is fitted with six cultivator-teeth, 1 in. in width, three of which stir up the soil between each line. On fastening to the arch a light rope with handle-bar attachment, a workman is able to steadily draw the hoe all day without feeling the least fatigue. The hoe follows precisely the same course as the man in front—viz., straddling the line of trees; but the guiding of the machine is done by another workman, who firmly holds the handles, and walks along the last cultivated row, so that on the return journey his footprints are obliterated. The suppression of weed-growth close to young trees cannot be accomplished by the wheel-hoe method, as in attempting to run the cultivator-teeth very closely to the lines there is a decided risk of disturbing the root-system of the growing plants, with disastrous results. Hand-weeding is thus resorted to.

Employees are provided with small weeding-forks, and in a kneeling position extract by the roots all foreign weed-growth—principally sorrel, spurrey-weed, and shepherd's purse—which is deposited in rows about six lines apart. The weeds thus accumulated are then drawn into heaps and removed preferably by means of a hand-barrow. Although in past years we have successfully omitted the early autumn "wrenching" process when the season's growth has matured early, there can be no question that checking the progress of late-growing evergreen and deciduous trees is helpful in bringing about the desired hardening-off state so necessary in tree-growing when carried on in districts where severe winters are experienced.

Lifting and Bundling Trees for Transference to Plantations.

The distribution to State plantations, domains, &c., of an approximate 3,120,000 trees annually from the nurseries at Tapanui, Ranfurly, and Hanmer Springs necessitates tree-lifting being commenced immediately the season's growth has matured. We endeavour to make a start towards the latter part of April, but perhaps the presence of autumnal foliage on larch, rowan, or birch offers the most accurate guide as to how early the removal of trees may be undertaken. The systems adopted in tree-lifting from nursery lines vary somewhat, for whilst one man may conduct the actual spade-lifting of small two-year-old trees, a correspondingly increased cost and labour are involved when dealing with more advanced stock. It is essential, however, that all trees must be loosened to such an extent that no mutilation of roots will eventuate when "pulling-up" is being undertaken. The lifting of a line of medium-sized trees is expeditiously carried out by two workmen, who insert their sharpened spades on each side of the trees, some 5 in. distant. On applying simultaneous foot-pressure the spades are driven down until they almost touch, cleanly cutting all roots that come into contact. After this treatment has been applied to several lines, a workman follows up the lifters, pulling up and counting into twenty-fives all well-developed trees. The employee in charge of the tying operation, having previously prepared a number of flax strips of required thickness and length, fastens a tie around each bundle, just above the collar. Bundles secured in this manner are then removed by hand-cart to the end of the "break," where they undergo a final root-trimming and puddling process. Tree-roots

are shortened so that there is no liability of cramping when permanent planting is in progress, whilst the immersion in a puddle of soil and water has the far-reaching effect of protecting the root-system from exposure, generally so unavoidable during transit. All bundles are now temporarily heeled in, and if the soil be well firmed, the transference of trees to plantation may be delayed for a month or more without risk being incurred.

Poorly-developed trees, or those possessing double leaders, should now be pulled up and carted to the sizing-shed, where removal of superfluous shoots and final classifying is conducted. Undergrown trees are usually put aside, and eventually lined out again; but malformed specimens are at once rejected and committed to the rubbish-heap for conversion into ashes. Of course, it is not always possible or desirable to carry out the bundling-work on any fixed principle—for instance, when large-sized trees are being dealt with the bundles cannot be securely fastened with one tie only. The shortening-in of lateral branches is also a necessary labour with some varieties, and attention to details of this kind before transferring trees from the nursery considerably reduces the future maintenance item of expense.

Transport of Trees.

Local plantations are connected with each tree-raising station, and the transportation of trees —which is effected by specially constructed hooded wagons, each with a maximum carrying-capacity of 30 cwt.—presents no difficulties. The proximity of the Hanmer Springs Plantation to the district nursery (between two and three miles) permits of two trips daily being made when circumstances warrant. Our Otago stations, however, are not so fortunate in possessing suitable adjacent planting areas, and the return wagon journey in each case occupies a full day. The ground at present being operated upon at Naseby is situated about nine miles from the associated nursery at Ranfurly, whilst the distance between Conical Hills Plantation and Tapanui Nursery is recognized as thirteen miles by road. Perhaps the most arduous journey is the latter-mentioned one, during which the negotiation of several steep inclines make it compulsory to work a five-horse team.

In loading the trees from the nursery trenches to the wagon, all bundles are counted and recorded in a duplicate delivery-book, which is taken by the driver, and duly handed to the receiving Forester for acknowledgment and receipt. Visitors frequently show curiosity with regard to the number of trees delivered in one wagon-load.

When one considers the difference in size and weight between bundles of various trees grown, credence must be given to the fact that three-year-old oak are frequently six times more bulky, and therefore require a correspondingly greater amount of cartage than pines of the same age. As many as 100,000 small two-year-old larch and pines have been conveyed to the planting-ground in one load, whilst, on the other hand, 7,000 oak have at times constituted a still heavier load. It is somewhat difficult to determine accurately what number forms an average wagon-load of trees of an approximate 25 cwt., but based on the past season's carting, the number works out at 29,600, and the transport cost at 6¾d. per 1,000 trees.

In cases where railing or shipping of plants is inevitable, a totally different packing course is followed. The deciduous and hardier trees are encased in a covering of wheat straw, and made up into the familiar bottle-shaped bundles, although the inclination to "heating" of pines and other evergreens make it a wiser policy to use crates or partially latticed cases when dealing with these varieties.

Fencing Areas acquired for Tree-planting.

The presence of rabbits and hares in each district where planting operations are being carried out make it absolutely necessary to enclose each area by a combined stock- and rabbit-proof fence, 3 ft. 9 in. to 4 ft. in height. The requirements of no two districts are exactly similar, and the type of fence constructed, of course, varies. At Conical Hills and Naseby Plantations kowhai posts are erected a chain apart, with seven divisional standards.

Three plain wires make an excellent support to the 42 in. wire netting, which is securely let into the ground to a depth of 6 in.

The rigidity and stock-resisting character of the fence is much increased by one and sometimes two barb wires being fixed near the top. Miles of this class of fencing have been constructed at an average cost of £1 5s. 6d. per chain. At one period so troublesome were the hares at Naseby Plantation through gaining access to the planted area by jumping that an additional attachment to the top of the original fence of one-half width of netting was necessary before an effective barrier was created. There being no liability to the ingress of cattle at Hanmer Springs, the height of the divisional fences was accordingly reduced, and barb wire was not required.

Angle iron (1¼ in. by 1¼ in.) also proved a worthy substitute for posts at this station, and, being much lighter and less bulky, the carriage expenses were considerably curtailed.

Extermination of Ground-game.

Precautionary measures having been taken against the further entry of rabbits, the extermination of the pest may now be commenced in the enclosure. To facilitate the eradicating-work, large areas are subdivided into blocks of about 500 acres by temporary netting fences, which are dismantled and re-erected as occasion requires. On a plantation staff we generally include an expert rabbiter, who, with his dogs, ferrets, and traps, is fully occupied until the area is clear. Periodically, phosphorized pollard is laid; but, although occasionally successful results issue from this practice, it is mostly the young rabbits that fall a prey to the poison. A Suddeth fumigating-machine for pumping carbon-bisulphide fumes into the burrows is also used, but this method is only satisfactory when the ground is

of a clayey composition, as in operating the fumigator on sandy or gravelly soils the poisonous gas escapes, or else an insufficient amount penetrates the holes to complete the asphyxiation of the rabbits. Absolutely the most effective mode of ridding any enclosures of the pest is to trap continually, and systematically dig out burrows and under-runners.

An occasional "drive" by the full strength of the gang is often the means of cornering a number of hares, which are thus easily caught by greyhounds or shot by armed members of the hunting party.

The enforcement of these stringent measures to extirpate such ground-game before the commencement of planting is occasionally referred to lightly by those unaware of the immense amount of damage resulting from the presence of the pest. Although the ravages of both hares and rabbits are not at all restricted to any special period of the year, perhaps during frosty weather, or immediately following a fall of snow, when the young tree-tops become very conspicuous, the injury created is greatest. The destructive animals appear to be more partial to larch and ash, and the various pines also rarely escape the injury of having their leaders bitten off; by the judicious cutting-back to ground-surface of such injured deciduous trees as ash, oak, and sycamore, and subsequent disbudding when the young shoots make their appearance, it is possible to effect a remedy, but with larch or pines the result of such treatment is more problematical, and these varieties rarely respond in the manner desired to any such artificial measures.

Although the amount of damage occasioned by the entry of both the red and fallow deer into our southernmost plantations has not, so far, been extensive, there is not the slightest doubt but that wholesale destruction to young trees would eventuate if the animals were allowed to remain in the enclosures for any length of time.

Formation of Fire-breaks.

Perhaps fire-prevention is one of the most difficult problems attached to our afforestation-work. Notwithstanding our experience of one or two conflagrations of a more or less serious nature, any person sufficiently interested to fully examine the method adopted for guarding against the ingress or spread of fires will realize the immense amount of labour done in this direction.

Continental ideas are freely introduced as far as the actual fire-break allocations are concerned, and our system cannot in justice be denounced because a conflagration originates amongst the trees through carelessness or mishap by perhaps a visitor.

Through the presence of rank fern and tussock undergrowth up to a certain stage, a continual source of danger is apparent; but with the advancement of trees a canopy is formed, and the eventuating shade soon kills out all undergrowth. The fern, tutu, and other vegetation is then rapidly converted into moisture-retaining humus, and the risk of surface fires from this stage is considerably minimized.

If the planting-ground possesses a fairly even surface, blocks of about 300 acres are intersected by fire-lines from 1 to 2 chains in width, although in hilly country every effort is made to locate the fire-breaks on the leading ridges, so that equal advantage of combating any outbreak may be gained, no matter from which quarter the wind is blowing.

The formation of roads for vehicular traffic is also undertaken in the centre of fire-breaks, although where the gradient makes haulage impossible deviations are made to one side or the other.

Another safeguard, and perhaps the most important, is the boundary fire-break, which is usually half a chain in width, and follows as nearly as possible the fence-line. Along the interior of this outer break, or fringing the plantation, two or more rows of the partially fire-resisting English birch are planted, and by keeping the surface free from inflammable vegetation by ploughing or cultivating, any encroaching grass-fires may be easily suppressed before any damage is done. The internal fire-break course being decided upon, a heavy double-furrow plough drawn by five horses is then requisitioned, and by gathering the furrows to the centre, and gradually working to the desired width, a serviceable road-crown is thus made, in addition to the preliminary labour connected with fire-barrier formation. Either ploughing, discing, cultivating, or harrowing fire-breaks is commenced towards the latter part of spring, after the transport of trees from nurseries is completed: this gives ample time to finish all horsework before the grass reaches the seeding-stage. A constant vigilance for any outbreak of fire during the summer months is maintained by the adoption of a system of patrol duty, which is undertaken on holidays and Sundays by any one employee. The annual expense thus incurred is only trifling, but with such precaution a feeling of greater security exists amongst responsible officers of plantations.

In conspicuous places fire-notices are erected, and serve to warn persons frequenting the locality of the danger associated with the lighting of fires and of the penalty enforced should any outbreak extend to the planted reserve.

It may be interesting to mention that throughout the South Island plantations thirty-six miles of combined roads and fire-breaks, averaging 50 ft. in width, are cultivated annually, and the expenditure attached to this item alone reaches £138 per annum. When one considers that over 218 acres are actually ploughed and cultivated in this maintenance and formation labour, the amount per acre—12s. 8d.—will appear to be a perfectly reasonable figure. There is, however, every reason to anticipate that in the near future we shall not require to be burdened with this fire-break labour, as the conversion of our present internal lanes into grazing-areas, and judiciously stocking them with sheep, should bring about equally effective results.

Clearing and Draining.

Much importance must be attributed to the preliminary clearing-work, as the thorough removal of manuka-scrub, fern, tutu, danthonia grass, &c., by cutting and burning not only facilitates pitting and planting operations, but influences to some extent the amount of subsequent maintenance-work. If

VIEW OF PORTION OF ROTORUA NURSERY

LIFTING, BUNDLING, TRIMMING, PUDDLING, AND HEELING IN LARCH

Face page [illegible]

Preparation of Seed Beds and Seed Sowing, Talkeetna

Larch and Birch Growing on Dredged Tailings, Wallaburg, Ont.

a clear surface has been attained by cutting and burning, the probability of the tender tree-leaders becoming interfered with by strong surrounding vegetation is more remote, although in sheltered gullies fern re-establishes itself with amazing rapidity. Much discretion requires to be exercised in firing tussock country, and this work is usually conducted when a full emergency gang is available. In sheltered gullies, where vegetation is generally most luxuriant, burning is preceded by mowing with short stout scythes or sickles.

Draining to any considerable extent has not, up to the present, been undertaken in any of the plantations, simply because of the limited amount of swampy ground available, together with the measure of success that has attended the introduction of such trees as alder and poplars to wet low-lying situations. It has been found imperative, however, to occasionally form ditches to carry off excessive surface water; but, with the establishment of trees, the functions of these ditches become disorganized by roots and fallen leaves.

Much benefit is sometimes derived from judiciously formed open side drains on steep hillsides that are partially destitute of vegetation, as such a precaution greatly relieves the consequent erosion when planting operations are in progress.

Pitting for Tree-planting.

Much diversity of opinion exists as to which method of preparing pits for the reception of trees combines the desired economy with successful results. It would, however, be purely speculative to say that any one particular system could be advantageously adopted under any conditions whatever: and we accordingly endeavour to direct the pitting-work by whichever method may be most suitably applied to the surface-conditions of ground being operated upon.

The following four distinct processes of ground-preparation are recognized, each one meriting its adoption as circumstances demand: (1) Spade-pitting, (2) grubber-pitting, (3) scuffling ground (or "spotting"), (4) hole-boring.

The first method is generally employed where the ground is easily worked, and either a No. 2 or No. 3 Black's spade may be used. All vegetation is cleared over a surface of 12 in. to 14 in. square, and the hole, measuring 8 in. square and 10 in. deep, with the front side sloped in such a manner as to reduce the bottom space of pit, is prepared in the centre. Where the soil is light it is customary to merely reverse the sod in the pit; but, when dealing with ground of a more argillaceous composition, the contents of the hole are placed on the front edge of the pit, where the action of rain and frosts reduces it to a pulverized and otherwise favourable state for placing against the tree-roots. In the early stages of our afforestation-work slightly more than £1 10s. per thousand was paid for pit-making; but we are now able to carry on precisely similar work at 50-per-cent. cheaper rate.

In the second method a grubber-pick is used. A surface-clearing is made, as before mentioned, by a well-directed blow or two with the tool, after which a space of 12 in. by 9 in. is worked up roughly to a depth of about 10 in., and allowed to remain in this state until the planting season arrives. Such pronounced success has attended repeated trials of this mode of pitting that it is now being almost exclusively adopted at the South Island plantations. No difficulty is experienced in getting employees to undertake the grubber-pitting at 12s. 6d. per 1,000, and at this rate an average wage of about 8s. per day is earned individually.

In operating on light, porous, or gravelly soils with small plants, scuffling ground (or "spotting") is frequently resorted to with fair results. This work consists of clearing a small space 12 in. square, either with a spade or mattock, and is carried on by day-labour at 8s. 6d. per thousand. As the "spotting" is inseparable from slit or bar-planting, much discretion must be exercised in selecting only the most favoured situations for this mode of pitting, and even then equal success with the previously explained system cannot rationally be anticipated, as no matter how carefully a plant is inserted in the crevice formed by the planting-bar or spade, the roots invariably assume a cramped, unnatural position.

During the past year the successful manipulation in Germany and Austria of an ingeniously contrived hole-boring machine for tree-planting induced the Department to import one, and although we have not yet worked the Rohrwieser Hollow Borer to any great extent, our operators should, on becoming more familiar with the use of the machine, be able to prepare a thousand holes per day on suitable ground. The borer, which is purely a slit cylindrical auger, enters the ground by means of a rotary cutting motion, and by the application of a steady revolving pressure is forced to a desired depth. On withdrawing the machine a reversible twist of the handle-attachment enables the operator to deposit the soil near the plant-hole, which has a diameter of almost 4 in. Planting by this system is scarcely practicable where coarse vegetation exists; but a season's experimenting should enable officers to state with every degree of certainty the desirability of introducing the machine into the plantations generally.

Absolute straightness in lines of trees is not at all essential, although general uniformity is aimed at. Of the two methods at present employed for keeping lines of pits straight, perhaps sighting by means of poles possesses most advantages. A sighting-rod, which is usually about 5 ft. long, and painted black and white alternately, is set up at each end of the planting "break," and between these rods, directly in line, another sighter or two are placed. Facing the poles from the lowest end of the line the workman keeps at least two sighters before him, and on completion of each pit advances 4 ft., and again places his spade in line with the poles. This order continues until the required length is pitted. On fairly level ground it is possible to run the lines absolutely parallel by using a square at each end, but when operating on rough undulating country such accurate pitting is not attainable. On completion of the first line of pits, the rods are shifted over 8 ft., sighted again, and holes prepared immediately opposite those in the first line. We are now able to mark out the intervening line along which the pits are made, half-way between those in the first and third lines. An employee quickly becomes adept in sighting and spacing, and although a measuring-stick is sometimes carried, the pit-

maker is able to measure correctly with his spade, to which an allowance of an additional 9 in. gives him the usual planting-space—4 ft.

At Hanmer Springs (where prison labour is employed) a specially designed pitting-line has been used for some years, and very accurate work is performed, even by totally inexperienced men. Some 70 or 80 links, 4 ft. in length, are constructed from No. 16 gauge wire, and jointed together. On this line being stretched across the pitting-ground in the desired direction, strained, and finally made secure at both ends, each prisoner takes his allotted place, and opens a similar number of pits immediately opposite the link-joints, after which the line is brought forward 4 ft., set parallel to the preceding one, and again pegged in readiness for pitting. Care is taken to have pits opposite each other in every other line. The daily number of spade-pits prepared individually by prisoners depends to a great extent upon the class of ground being afforested. On light easily worked soils as many as 700 each have been made in a day of eight hours; whilst on ground of a hard gravelly nature a similar amount of energy will be required to form 350 holes.

Tree-planting Methods and Climatic Influences.

Before expressing definitely the recognized most suitable time for tree-planting, attention might be directed to the effect upon which our changeable climate has in the matter. In certain seasons abundance of moisture is available from the time of planting onwards, and prospects of success are still further enhanced by the prevalence of a comparatively mild yet moist winter. Under these conditions the losses in planting-out rarely exceed 4 per cent., although when a severe winter is followed by almost persistent winds and a prolonged absence of moisture, it is not unusual to record as high as 8 per cent. in transplantation failures.

Without a doubt greater problems have to be faced in conducting our work in Central Otago. Owing to the severity of winter frosts (on one occasion the thermometer registering as low as 14 degrees Fahr. below zero), which are at times responsible for completely lifting newly planted trees out of the ground, we endeavour to commence the planting-work at Naseby about the early part of August, by which time the surface-soil is relieved of frost. The conditions obtaining at Tapanui and Hanmer Springs Plantations are, fortunately, much milder, and actual planting is often entered upon before the end of April, and continued with occasional intermissions until the beginning of October, during which period between two and a half and three million forest trees are planted out.

The mode of preparing pits having already been alluded to, a few brief remarks will be sufficient to explain the planting in operation. Where practicable a light spring dray is used to convey trees from the temporary depots to the planters; but the hilly and otherwise rough nature of a great proportion of the ground being planted makes it necessary to employ a packhorse, which, with heavy woven baskets, one on each side of the saddle, is able to distribute from conveniently arranged trenches a sufficient number of trees to keep from fifteen to twenty planters fully occupied. By keeping a record of trees thus dealt out, the employee in charge of the packhorse or dray is able to check the number of trees planted daily. For carrying trees, canvas bags, 17 in. long and 14 in. wide, with shoulder-straps, have given most satisfaction.

Although tree-planting was in former years carried on by two operators (one holding the plants and the other using the spade), the equally effective and certainly more economical method of single planting is now employed.

The adherence to the following points, as a rule, is maintained, although at times deviations are both necessary and desirable. Assuming that tree-planting is being carried out in grubber-pits: By a well-directed blow or two with the spade an upright back is formed on the side away from the prevailing wind, and on withdrawing the soil a sufficiently deep crevice is opened to comfortably insert the roots of the trees straight down. The planter—holding the young tree in one hand, with its root-collar on a line with the ground-surface—presses the most pulverized soil available against the roots, and by applying foot-pressure makes the young trees perfectly firm, and more able to withstand the injurious effects of high winds.

At each plantation this class of planting is carried on by day-labour, at an average cost of 10s. 5d. per thousand, each man being able to plant from 700 to 800 daily without undue exertion. At Conical Hills Plantation, where rough steep hillsides are being afforested, over a million trees were planted by contract last season under this system at 12s. 6d. per thousand. Specially careful supervision is essential during the progress of any contract-work, although the result of the experiment justifies its repetition.

Spade-pit planting has been principally carried on at Otago Central and Hanmer Springs Plantations, and at the latter station the prisoners connected ofttimes make excellent planting-tallies, which, under fair conditions, not infrequently reach 800 per man daily.

It invariably happens, in operating over large areas of ground, that small portions of a light or stony nature are encountered. The "notching" or "bar-planting" methods, which are the cheapest forms of planting recognized by officers, are then frequently introduced with advantage. A planting-bar, which is about 5 ft. in length, weighs 8½ lb. The handle is made of ¾ in. gas-piping, to which is welded a wedge-shaped steel-pointed foot 10 in. long and 4 in. across the top, tapering to 2 in. at the extremity. In manipulating the bar on scuffled spots prepared, the operator, by two or three driving movements, forces the tool into the ground some 9 in. deep, and by working the handle backwards and forwards a crevice is formed, into which the young plant is thrust. The opening is then closed by again driving the bar into the ground a couple of inches distant, and prizing the soil towards the plant. In computing the average cost of dealing with trees by this or the similar spade-notching—about 8s. 6d. per thousand—allowance must be made for the rough nature of the surface generally associated with dibbling and notching work. Failures in transplanting by bar are often traced to the omission of the necessary final heel-firming, without which no great success in any method will be realized.

Planting-systems adopted.

The impossibility of explaining thoroughly in the limited space available the planting-systems in vogue and ultimate results anticipated will perhaps be apparent to readers. Touching lightly on a subject of almost paramount importance in tree-growing for profit has, too, a tendency to confuse rather than educate one desirous of receiving a general idea of how the work is being conducted. It is, however, desirable to make a few abbreviated references to our present position, without dwelling too freely on the more speculative future of thinning, under-planting, felling, and timber-utilization.

By judicious blending of our practical knowledge of the requirements of the country, extending over fifteen years, with advanced continental practices, it is not a very difficult matter to determine appropriate modes of associating various trees in plantations.

Adverse criticism on some of our earlier experimental labour is occasionally uttered by persons who evidently fail to realize that without such experiments a suitable general working-basis would never be arrived at. Much knowledge has been gained regarding association of trees and afforestation-work in the various stages by private planters, who do not hesitate to diffuse any information solicited by the departmental officers, and in this way also help to lighten the experimental work.

No matter from what point of view the study of planting-systems is taken, high forest stands out pre-eminent in being specially adapted here for the raising of timber of a desired marketable size. This high-forest system, which may be arrived at by a judicious mixture of varieties suitable for the existing soil and climatic conditions, or by planting suitable light-demanding varieties pure, and eventually introducing shade-enduring species after thinning has been commenced, is now being adhered to. In the first place, close planting is absolutely necessary for ground-protection, and the inducement of straight branchless boles. Certain varieties exhibit greater tendencies to produce strong lateral branches—such as *Cupressus macrocarpa*—and naturally these varieties should be confined to an unusually small growing-space—about 3 ft. apart. On the other hand, the forceful nature of the leaders of eucalypti make it possible to attain equally satisfactory results by planting these as much as 6 ft. between each tree.

The light-demanding *Larix europaea* constitutes one of the most important varieties at present being grown. It is easily raised and transplanted, and up to quite recently has shown decided partiality to all tried situations. Most writers affirm that the growing of a thoroughly healthy crop of larch is a sylvicultural impossibility, owing to its susceptibility to a fungoid disease. There is no doubt that in mixed planting the liability to disease is more remote; but repeated experiments in associating larch in their youth with other trees of commercial value have clearly indicated the undesirability of substituting our present pure-planting for any mixed system.

At the present time larch is planted at 4 ft. apart, and we anticipate being able to conduct the first thinning operations—which will merely consist in removing the dominated or suppressed trees—when plantations are from fifteen to twenty years old. From that time onward periodical thinnings will be undertaken, and be followed by the gradual introduction of shade-bearing species of the Oregon pine or *Thuja plicata* types. Such trees as *Picea excelsa*, *Picea sitchensis*, *Pseudo-tsuga taxifolia*, *Fraxinus excelsior*, *Quercus pedunculata*, *Pinus austriaca*, *Pinus Laricio*, *Pinus ponderosa*, and *Pinus strobus* have been planted pure in suitable localities; but in the cases of the thinly foliaged trees under-planting will subsequently have to be resorted to.

Several large compartments have been filled with a mixture of English ash and spruce fir, and although both varieties have proved intensely slow growers in their youth, where the soil is of good fertility a uniform progress is being maintained. For the ultimate crop *Pinus ponderosa* is being nursed by *Pinus Laricio*, and both species are keeping well together. The yellow-pine, however, being the most valuable tree for succeeding under adverse conditions, is generally allotted the more exposed rocky situations where pure planting is followed.

The Department has practically ceased raising the undesirable *Acer pseudo-platanus* and *Acer saccharum*, both of which have proved to be utterly unsuitable for planting, even on semi-sheltered hillsides. In several deep gullies sycamore are making excellent progress; but as the more valuable ash also thrives under these conditions, the latter tree is now receiving preference. The swaying influence of winds on trees becomes more pronounced the higher the altitude.

Although we endeavour to partially restrain this ill effect by planting double lines of fast-growing shelter-trees—*Pinus insignis* or *Pinus muricata*—where practicable, little or no assistance in this direction can be rendered those trees occupying positions upon steep exposed hillsides.

Labour and Supervision.

The raising of about three million trees and afforestation of 1,025 acres annually, together with the allied maintenance-labour in pruning, &c., the previously planted 3,612 acres, involves an outlay of some £7,670, and provides employment throughout the year for an average number of sixty-four men. These figures, however, do not include prison labour, which is confined to the Hanmer Springs station, where the hearty co-operation of the Justice Department is responsible for the substantial saving effected in dealing with the permanent planting-work there. After due allowance is made for domestic and camp-maintenance duties, about ten prisoners are available, and the annual value of their tree-planting work may be computed at £57 per man. The total expenditure thus devoted to afforestation in the South Island section may be more accurately set down at £8,067. Although the Hanmer Springs tree-planting camp is a comparatively small one when compared with similar institutions in the North Island, equally satisfactory results are attained. Naturally, the amount of labour performed varies according to the nature of the ground being operated upon, and it would indeed be decidedly unfair to expect our Hanmer Springs workers to prepare daily on the existing hard gravelly surface a corresponding number of pits to those working on light pumice lands.

Both nursery and plantation free employees are paid at the rate of from 7s. to 9s. per day, according to length of service and abilities; whilst from a general return recently drafted it was ascertained that contractors in executing the various works carned an average of slightly over 8s. per day individually. This reveals a decided advance in the rate of wages paid by the Department since the initiation of the present afforestation scheme some fifteen years ago, when tree-planters were available at from 6s. to 7s. per day.

By the inclusion on the staff of one or two men skilled in carpentry, horse-shoeing, blacksmithing, and saddlery-work much time is saved, besides providing steady employment to those who would otherwise be idle through wet weather. As a rule, very little difficulty is experienced in securing the desired number of tree-planters, although during the harvesting and shearing periods specially attractive offers from farmers occasionally induce our employees to temporarily leave the service of the Department, only to find on again making application that the vacancy thus created has been filled.

The arrangement of controlling the technical work at each station may be briefly described as follows: At each plantation a foreman is appointed, and is made responsible to the local Nurseryman in charge for work carried on. By periodical visits to nurseries and plantations, the Superintending Nurseryman (who is also Nurseryman in charge at Tapanui) is able to direct operations and account to the Departmental Under-Secretary for all results obtained.

An assistant Nurseryman, or leading hand, is also retained at each nursery to supervise the work during any temporary absence of the officer in charge. Whilst a foreman may confidently direct tree-planting work with a gang of twenty-five or even thirty skilled men, he could not reasonably be expected to maintain the necessary hold upon a similar-sized inexperienced gang of workers, some of whom, however, speedily become quick adept planters, while others require rather more training.

The Gaoler in charge at Hanmer Springs Camp is responsible to the Justice Department for the welfare of the prisoners; and, on becoming acquainted, through the plantation foreman, with the desires of the Forestry Branch, apportions a warder to each working-gang of from four to ten prisoners, according to the nature of the labour undertaken and the numerical strength of the camp.

Much aid is rendered the plantation foreman by warders, who soon become competent overseers, and, as a rule, willingly assist in keeping the records of work daily performed.

Summary of Costs.

In computing the anticipated returns from our afforestation-labour, a vast amount of speculative matter requires to be presented. As milling from private artificially raised forests in the Dominion has been carried on in an extremely limited scale, little or no practical experience has been gained in this direction by officers, and it necessarily follows that in referring to any future yields, &c., we endeavour to judiciously blend our knowledge of tree-culture with the most advanced principles of sylviculture.

This paper is merely designed to illustrate what has already been accomplished by the Department, and space forbids submitting a detailed statement of what revenue might eventually be expected from the outlay. The following information will serve to show at a glance the actual average expenditure now incurred in raising trees, establishing a plantation, and the general upkeep of same for a period extending over ten years. No provision is made for the initial value of the land or buildings, and the fencing item is based on the assumption that an area of about 1,000 acres is being afforested:—

Nursery-work.

	£ s. d.	£ s. d.
Initial expenses in formation of nursery	0 0 9	
Tree-seed cost	0 2 4	
Seed-sowing	0 0 5	
Tending one- and two-year-old seedlings	0 0 11	
Lifting and lining out seedlings	0 1 10	
Tending lined-out seedlings	0 3 4	
Lifting and bundling for plantations	0 2 5	
Transport of trees	0 0 5	
Tools, implements, repairs, &c.	0 0 3	
General maintenance-work	0 1 6	
Supervision	0 0 4	
Cost of raising 1,000 trees for plantation		0 14 6
Fencing	0 3 2	
Rabbiting and clearing	0 5 6	
Pitting for tree-planting	0 12 4	
Tree-planting (including distribution of trees)	0 13 2	
Formation of roads and fire-breaks	0 0 11	
General maintenance for ten years	0 12 2	
Tools, implements, repairs, &c.	0 1 3	
Supervision	0 5 3	
Cost of planting and upkeep of 1,000 trees		2 13 9
Total raising and establishing cost		£3 8 3

As about 2,722 trees are usually planted over an acre of ground, it will thus be seen that the tota estimated expenditure connected with the creation and subsequent maintenance of an acre of plantation up to ten years old will approximately reach £9 5s. 9d., and the corresponding value for a well-grown plantation of forest trees cannot reasonably be reduced below £15 to £20.

APPENDIX C.

NUMBER AND VARIETY OF TREES PLANTED IN THE NORTH ISLAND.

Names of Trees.		Trees planted in Plantation.				Trees at present in Plantation.			
Botanical Name.	Common Name.	Whakarewa-rewa Plantation.	Waiotapu Plantation.	Puhipuhi Plantation.	Totals.	Whakarewa-rewa Plantation.	Waiotapu Plantation.	Puhipuhi Plantation.	Totals.
Acacia melanoxylon	Blackwood	125,214	1,296	5,600	132,110	123,174	1,296	..	124,470
Acer saccharum	Sugar-maple	..	50	..	50	..	..	..	..
,, pseudo-platanus	Sycamore	32,536	..	..	32,536	32,536	..	..	32,536
Aesculus hippocastanum	Horse-chestnut	232	..	..	232	..	..	..	..
Alnus glutinosa	Alder	25,993	2,000	..	27,993	25,993	..	..	25,993
Betula alba	Silver-birch	6,585	39,230	..	45,815	6,585	39,230	..	45,815
Castanea sativa	Sweet chestnut	15,516	1,325	..	16,841	..	..	..	..
Catalpa speciosa	Hardy catalpa	222,125	50	200	222,375	..	..	..	..
Corylus avellana	Filbert	..	660	..	660	..	..	..	..
Cupressus Lawsoniana	Lawson's cypress	..	11,367	..	11,367	..	11,367	..	11,367
Eucalyptus	Australian gums	3,017,115	715,630	1,417,680	5,150,425	1,986,142	72,000	981,500	3,039,642
Fraxinus americana	American ash	..	..	320	320	..	..	..	..
Hikora ovata	Hickory	3,500	..	2,575	6,075	..	..	..	..
Juglans cinerea	Butternut	2,651	..	..	2,651	..	..	..	..
,, nigra	Black walnut	3,402	..	6,490	9,892	..	..	..	..
,, regia	Walnut	25,110	13,084	..	38,194	13,800	..	..	13,800
Juniperus virginiana	Red cedar	670	..	2,650	3,320	670	..	..	670
Larix europaea	European larch	5,353,170	8,440,020	..	13,793,190	5,087,335	8,010,580	..	13,097,915
Liquidambar styraciflua	Sweet gum	1,700	..	..	1,700	1,700	..	..	1,700
Picea excelsa	Norway spruce	197,078	2,650	..	199,728	195,025	..	..	195,025
,, sitchensis	Tideland spruce	97,368	15,625	42,450	155,443	91,175	..	..	91,175
Pinus austriaca	Austrian pine	286,068	1,238,243	..	1,524,311	283,655	1,084,975	..	1,368,630
,, canariensis	Canary Island pine	..	375	..	375	..	..	..	..
,, contorta	Twisted pine	390	8,700	..	9,090	..	3,700	..	3,700
,, Coulterii	Coulter's pine	..	605	..	605	..	605	..	605
,, densiflora	Japanese red-pine	2,325	..	..	2,325	2,325	..	..	2,325
,, excelsa	Blue-pine	..	300	..	300	..	300	..	300
,, halapensis	Aleppo pine	..	63,550	..	63,550	..	..	..	..
,, Jeffreyii	Jeffrey pine	..	4,553	..	4,553	..	3,693	..	3,693
,, Lambertiana	Sugar-pine	..	1,325	..	1,325	..	1,325	..	1,325
,, Laricio	Corsican pine	1,046,300	3,835,150	..	4,881,450	852,525	3,187,260	..	4,039,785

APPENDIX C—*continued.*

NUMBER AND VARIETY OF TREES PLANTED IN THE NORTH ISTAND—*continued.*

Name of Trees.		Trees planted in Plantation.				Trees at present in Plantation.			
Botanical Name.	Common Name.	Whakarewa-rewa Plantation.	Waiotapu Plantation.	Puhipuhi Plantation.	Totals.	Whakarewa-rewa Plantation.	Waiotapu Plantation.	Puhipuhi Plantation.	Totals.
Pinus muricata	Bishop pine	7,445	57,050	18,500	82,995	6,320	43,800	18,500	68,620
,, Murrayana	Lodgepole pine	12,450	4,100	..	16,550	10,225	4,100	..	14,325
,, ponderosa	Heavy pine	587,225	868,500	..	1,455,725	505,650	847,200	..	1,352,850
,, Benthamiana	Bentham's pine	19,600	275,600	..	295,200	19,600	238,275	..	257,875
,, radiata	Remarkable pine	147,800	73,200	..	221,000	147,800	73,200	..	221,000
,, resinosa	American red-pine	..	2,100	..	2,100	..	2,100	..	2,100
,, rigida	Pitch-pine	..	12,200	..	12,200	..	12,200	..	12,200
,, Sabiniana	Nut or gray pine	25	..	..	25	25	..	..	25
,, sylvestris	Scotch fir	..	200	..	200	..	200	..	200
,, strobus	Weymouth pine	..	153,650	..	153,650	..	150,300	..	150,300
,, Thunbergii	Japanese black-pine	700	..	..	700	700	..	..	700
,, Torreyana	Torrey's pine	1,320	500	..	1,820	1,320	..	..	1,320
,, taeda	Torch-pine	1,100	..	..	1,100	1,100	..	..	1,100
Platanus orientalis	Oriental plane	3,900	..	..	3,900	1,900	..	..	1,900
Podocarpus dacrydioides	White-pine (N.Z.)	..	..	4,230	4,230	..	..	..	..
,, totara	Totara	..	..	565,700	565,700	..	..	..	..
,, Hallii	,,	..	..	200	200	..	..	..	..
Populus	Poplar (varieties)	600	1,825	..	2,425	600	..	..	600
Pseudo-tsuga Douglasii	Douglas fir	181,860	95,537	35,680	313,077	148,758	89,712	..	238,470
Pyrus aucuparia	Mountain ash	600	6,250	..	6,850	..	..	..	..
Quercus pedunculata	English oak	1,200	..	..	1,200	..	..	..	..
Robinia pseudo-acacia	Locust tree	100	106,225	..	106,325	..	..	..	..
Sequoia gigantea	Big tree	..	..	330	330	..	..	..	..
,, sempervirens	Redwood	92,491	115,875	30,915	239,281	90,673	..	..	90,673
Thuja plicata	White cedar	2,850	14,775	..	17,625	2,850	13,900	..	16,750
Ornamental shrubs and leguminous plants	..	9,430	53,486	..	62,916	475	34,936	..	35,411
Totals	..	11,535,744	16,236,861	2,133,520	29,906,125	9,640,636	13,926,254	1,000,000	24,566,890

NUMBER AND VARIETIES OF TREES PLANTED IN THE SOUTH ISLAND.

Name of Tree.	Common Name.	Number in Plantations.	Uses to which Timber may be put.
Acer pseudo-platanus	Sycamore ..	280,400	Furniture, reels, blocks, &c.
„ saccharum	Sugar-maple ..	3,425	„ „ „
Aesculus hippocastanum ..	Horse-chestnut ..	2,025	Turnery, rollers, furniture.
Alnus glutinosa	Alder	82,730	Cigar-boxes, brooms, charcoal.
Betula alba	English birch ..	210,945	Bobbins, clogs, staves, &c.
Castanea sativa	Spanish chestnut ..	2,150	Fencing, furniture.
Catalpa speciosa	Hardy catalpa ..	50	Sleepers, fencing-poles.
Corylus avellana	Filbert	650	Carving, inlaying.
Cytisus laburnum	Laburnum ..	16,875	„ „
Eucalypti (vars.)	Gums	4,250	Poles, building construction.
Fagus sylvatica	English beech ..	4,250	Piano-making, tools, furniture.
Fraxinus excelsior	„ ash ..	432,560	Coach-building, tool-handles.
„ americana	American ash ..	12,850	„ „
Griselinia littoralis	Broadleaf ..	2,350	Fencing material, building-piles.
Juglans regia	Walnut	37,130	Gunstocks, furniture, &c.
Larix europaea	European larch ..	4,773,361	Fencing, pit-props, gates, &c.
„ leptolepis	Japanese larch ..	2,850	„ „ „
Picea excelsa	Spruce fir ..	1,187,225	Moulding-poles, flooring, paper-pulp.
„ sitchensis	Tideland spruce ..	166,505	„ „ „
„ canadensis	White spruce ..	1,400	„ „ „
Pinus austriaca	Austrian pine ..	1,634,524	Building construction, poles, scaffolding, joinery, &c.
„ Benthamiana	Bentham's pine ..	140,400	Ditto.
„ contorta	Twisted pine ..	1,325	„
„ halapensis	Aleppo pine ..	1,325	„
„ Jeffreyii	Jeffrey pine ..	250	„
„ Laricio	Corsican pine ..	2,343,605	„
„ maritima	Cluster pine ..	7,000	„
„ muricata	Bishop's pine ..	45,440	„
„ ponderosa	Bull pine ..	602,986	„
„ radiata	Monterey pine ..	17,150	„
„ rigida	Pitch-pine ..	2,312	„
„ strobus	Weymouth pine ..	10,705	„
„ Torreyana	Torrey's pine ..	440	„
Pseudo-tsuga taxifolia	Oregon pine ..	207,205	Ship-masts, building material.
Populus (vars.)	Poplars	17,875	Packing-cases, brake-blocks.
Pyrus aucuparia	Rowan tree. ..	5,195	Turnery, carving.
Quercus pedunculata	English oak ..	376,550	Furniture, ship-building, &c.
Robinia pseudo-acacia	Black locust ..	85,025	Fencing, cabinetmaking, &c.
Salix (vars.)	Willows	2,000	Cricket-bats, charcoal.
Sequoia sempervirens	Redwood ..	200	Cabinetmaking, joinery, &c.
Sophora tetraptera	Kowhai	1,875	Fencing, dowells, joinery.
Thuja plicata	Pacific red cedar ..	25	Shingles, fencing, weatherboards.
Ulmus campestris	English elm ..	775	Pulley-blocks, wheelbarrows, &c.
Ornamental trees and shrubs ..	..	4,747	
*Total	..	12,732,915	

* Also 50,000 trees in the Raincliff Plantation, not enumerated above.

APPENDIX D.

FOREST DISEASES AND THEIR RELATION TO AFFORESTATION.

[By A. H. Cockayne, Biologist, Department of Agriculture.]

Introduction.

"The welfare of the human race is closely connected with that of our trees, and any work looking to their better protection makes for the advancement of mankind."—Felt.

The adequate conservation of trees from their insect and fungoid enemies constitutes one of the most important branches of modern forestry. This science of forest pathology is of quite recent origin, and each year its importance in the economy of timber-production is being more clearly recognized.

At the present time many European countries, India, and the United States—in fact, all countries with efficient forest services—pay special attention to the diseases of forests. Clearly do they recognize that the keeping of the trees healthy is one of the most important of all the problems of forest-management, nor do they hesitate to expend large sums annually to this end. So far, no attention has been paid in New Zealand to forest pathology, but the study of the diseases that are liable to become serious is a matter to which, sooner or later, earnest consideration must be given. The two most potent factors that are apt to cause the wholesale destruction of the forest are fires and diseases. The terrible significance of the former is clearly appreciated even by the layman. The destructive effects of fire are so rapid and so apparent, as they are naturally regarded as the most serious of all menaces to successful extensive tree-culture. On the other hand, the effects of disease are, in general, rather slow in action, and their insidious effects are often passed over unnoticed until it becomes too late to apply remedial methods. Nevertheless, the cumulative effect of diseases in the forest is admitted by experts to be even more disastrous than fire. In the national forests of the United States the loss due to insects

alone is put down by Dr. Hopkins at the sum of £20,000,000 sterling annually, and the timber destroyed by fungi will more than double these figures—and that for one single country alone. Facts such as these should impress on any one the great necessity of disease-control in forests. Especially is this so in artificial ones, which naturally involve the expenditure of large sums of money before any return can be expected from them. The protection of a crop up to the point of harvesting is one of the fundamental principles of agriculture. This is even more important with regard to forests, as they are the slowest of all crops to mature, and their destruction by disease involves not only the loss of the money that has been expended, but also the labour of many years.

The Damage caused by Disease.

The diseases of forests are caused by both insect and fungi, each class being of equal importance so far as its destructive effects are concerned.

It has been conclusively demonstrated that certain species of both insects and fungi are the direct cause of the death of forest trees of all ages, and that from time to time they increase to such an alarming extent that their depredations assume the character of a destructive invasion, which may result in the death of a large percentage of the best timber over thousands of square miles. At no period in the life of a forest are the trees secure from attack. In general, however, it can be stated that the greatest losses may occur when they are attaining maturity. Full-grown trees are naturally of less vigorous growth than younger ones, and they have not the same power of recovery from infection. Certain diseases, however, on the other hand, are of danger only when the trees are small —there are, in fact, a succession of diseases, each of which may be of some particular significance right from the sowing of the seed to the cutting of the mature timber. Although tree-planting has been undertaken for many years past in New Zealand, it has, with the exception of the work of the Forestry Branch of the Department of Lands and Survey, been in the nature of comparatively small and isolated plantations, which give no indication of the diseases that will have to be feared in extensive forests composed of in many cases pure plantings of a single species. The example of the gum-tree scale (*Eriococcus coriaceus*) in the blue-gum plantations of the South Island, where very extensive damage has been done, shows that it is not to be expected that our artificial forests will be in any way less liable to the attacks of disease than is the case of other countries. In fact, so far as plant-diseases are concerned, the conditions in New Zealand seem to be especially suitable for their development. Although the vast majority of our most serious ones are of foreign origin, it must be remembered that this is all the more significant when it is considered that our tree-planting is almost entirely confined to exotic species. The destructiveness of any particular disease cannot, however, be gauged by its effects in other countries, for in many cases diseases of comparative insignificance in their original home have become in New Zealand of prime importance. The reverse is often the case; many serious diseases of other lands when imported here seem to be of little importance. The San Jose scale in certain countries, one of the most dreaded of destructive insects, is a case in point.

Disease-control in Natural and Planted Forests.

There is a great and essential difference in the action of diseases in natural and planted forests. This is, in the main, due to the fact that the trees comprising the natural forest vary greatly in age, and that the individuals liable to attack may be quite widely separated from each other; whereas in planted trees whole blocks will be composed of individuals of the same age. Thus in many cases a disease-invasion in a natural forest may result in only a percentage of the trees being immediately destroyed, but the variation in the size and age of the trees is likely to cause them to be gradually destroyed, and each year a certain number will die. In planted forests, disease attack, owing to the uniform growth of the trees and the equal susceptibility of the individuals to infection, may result in the entire destruction of the whole plantation within a very few years. This has been well shown in European forest plantings, where whole forests of larch have been swept away through the attack of the larch-canker. In New Zealand, owing to the fact that our natural forests do not in the majority of cases reproduce themselves after lumbering, and are in consequence annually diminishing, disease-control will in future years be confined almost entirely to our planted areas, and their adequate protection will become one of the most important problems in our forestry operations.

Present Condition of the Plantations.

The plantations under the supervision of the Forestry Branch, although all of recent origin, the oldest being not more than twelve years' growth, already comprise many thousands of acres. So far, the main planting has taken place on the pumice lands of the Rotorua district, but there are extensive areas under trees in the South Island, notably at Hanmer, and in the vicinity of Tapanui.

Recognizing the importance of disease-control, the Under-Secretary of Crown Lands desired me to inspect the various plantations in both Islands, and report on their present conditions so far as the presence of injurious insects and fungi are concerned. Accordingly, during the past summer I have visited the main plantations and nurseries where the trees are grown prior to being planted out. As one of the main branches of forestry operations at present is the production of the young trees from seed, the prevalence of disease in the nursery beds may well be dealt with first.

Rotorua Nursery.

The nursery at Rotorua is remarkably free from any very injurious diseases, as the small percentage of losses amongst the seedlings amply testify. The main trouble that has to be contended with is the

native grass-grub (*Odontria zealandica*). This beetle, so well known in the larval form as one of the most destructive pasture-insects, is liable to cause extensive damage to seedling trees by eating through the main root just below the ground-surface. The methods that are adopted at all the nurseries—of fallowing a certain number of seed-beds and by continuously cultivating them during the summer—have, however, kept this pest in sufficient check to render it comparatively harmless. It is, however, always liable to occur in more or less destructive numbers; but if the present methods are continued, it will never cause any serious loss.

A disease which occurs especially amongst the larch-seedlings, the New Zealand root-fungus (*Rosellinia radiciperda*), causes a good deal of loss. This fungus, which is generally found in country that formerly carried forest, is one of the most serious of our native fungi so far as tree-destruction is concerned, and its worst feature is its power of remaining in the living state in the soil for several years. The methods adopted against the grass-grub will probably be found sufficient to keep this fungus in check in the seed-beds. In certain cases it may be found necessary to lime more heavily than at present, and in cases of very bad attack the ground may have to be rested and kept cultivated for several years. These two diseases are the main ones that are present in the nursery beds at Rotorua, and it is fortunate that none of the serious seedling-diseases such as *Phytophthora omnivora* and *Herpothichia nigra*—often the cause of widespread destruction in European forest-nurseries—have as yet made any appearance. The latter disease is often of such violence as to necessitate the abandonment of nurseries established at great cost and labour. Special attention should always be paid to any undue loss in the seedling-beds, and the causes should at once be investigated, and in that case any local infection could be dealt with before it had assumed a too serious character. The majority of the seed used being of foreign origin, there is always a liability to diseases being introduced owing to this reason.

Tapanui Nursery.

The Tapanui Nursery is remarkably free from any disease, the grass-grub being the main one that has to be fought against, but the excellent methods of control adopted reduce its effects to a minimum. The large extent of pasture land in the vicinity of the nursery will always render this insect of importance, as infection from without will always occur more or less. The seedling-trees at Tapanui were at the time of my visit looking really splendid, and the large breaks of sturdy uniform young trees could not have been bettered. It is doubtful—and this also refers to the Rotorua Nursery—if in any part of the world the raising of seedling-trees is carried out with more success than at the Tapanui Nursery. I have no recommendations to make regarding the nurseries other than that suggested previously. In the practice of raising trees the Forestry Branch has set an extremely high standard, and it is certainly not an exaggeration to say that in this part of the work there can be very little to learn from other countries where afforestation is carried out.

The Diseases of the Planted Trees.

Rotorua and Waiotapu.

The plantations are, on the whole, in an extremely healthy and vigorous condition. A certain number of diseases are, of course, present, but none of them are of a character that are liable to be the cause of future damage.

The New Zealand root-fungus appears to attack isolated individuals of the larches, and wherever this occurs the trees should be removed and burnt, and the soil well limed; or, better still, a little sulphate of copper should be spread on the ground; it will also be advisable not to replace the trees for two or three seasons.

The pine white-aphis (*Chermes laricis*) is fairly abundant on some of the pines, but it appears to select trees that are of weak constitution, and will probably more or less disappear when the trees are older.

An introduced Australian weevil (*Oxyops concreta*) is extremely serious on the few blue-gums that have been planted, and, largely owing to this insect, its cultivation has been abandoned. I should advise the gradual removal of all the trees (there are not many) of this species of gum, and replace them with those which have been shown to be immune from the attacks of this insect. Another Australian insect (*Psylla acaciae-baileyana*) is at present on the plantations of black wattle (*Acacia decurrens*), but so far has done little harm. If it should be found to be on the increase, it will be well to introduce those natural enemies that keep it in check in its native home.

Tapanui (Conical Hills and Dusky).

The plantations at Tapanui can at present be looked upon as virtually free from any diseases. There is a small amount of pine white-aphis, but not sufficient to cause any alarm. During the summer a considerable amount of defoliation occurred amongst the larches, and it was feared that the destructive larch needle-cast (*Sphaerella laricina*) had made its appearance. This, I am happy to say, is quite without foundation, the cause being due entirely to the unusually dry summer that had been experienced. After the breaking of the drought the fallen leaves were all replaced by a fresh healthy growth, and at the time of my visit the trees were in perfect condition. I was agreeably surprised at the absence of the spruce red-spider (*Tetronchus bimaculatus*), which is at present giving indications of becoming a serious menace to the successful growing of certain species of *Abies* in the Canterbury District.

Hanmer.

The only disease of importance at present in the Hanmer Plantations is the birch green-fly (*Aphis betuli*), which has done a considerable amount of damage to the foliage of the birch-trees that were originally planted as shelter-belts for the slower-growing trees. As, however, these trees will soon have outlived their usefulness, the appearance of the insect, which restricts its attacks to the birch, need not be viewed with any apprehension.

The pine white-aphis is also fairly abundant, being chiefly found on the Austrian pine. I noted with regret that the trees of certain species of *Abies* in the sanatorium grounds are badly affected with the spruce red-spider. This insect is evidently one which will in future be the cause of damage to any *Abies* plantations that are made in the Hanmer district.

From the above, it will be seen that the present conditions of the Department's plantations are in a highly satisfactory condition so far as plant-diseases are concerned.

Future Prospects.

From the fact that the plantations are in a perfectly satisfactory condition from the disease point of view, it must not be inferred that they will always remain so. The liability to infection will yearly become more intensified, and the problem of control which is at present almost non-existent will, without doubt, become a serious factor. The large amount of pure planting that is taking place, which is necessary if the forests are to be brought to the highest pitch of efficiency, will in itself cause the disease-control problem to be an acute one. That serious diseases will appear sooner or later is incontestible, and the Department must on no account lose sight of this fact. To be forewarned is to be forearmed, and the successful control of forest diseases must largely depend on methods of suppression being taken in hand before they have assumed a grave character. With regard to our planted forests, it is probable that the efforts will have to be directed almost entirely against introduced fungi and insects. It is unlikely that any of our native diseases will ever become of any serious menace. This is of great importance, as with a knowledge of the work that has been accomplished against these diseases in other countries, the position will be simpler in certain respects than if new and unknown diseases had to be contended with.

Control-measures.

It is not proposed to deal in this article with the various methods that have been adopted to cope with the insect and fungoid diseases of forests in other countries. In the control of any particular disease, although the main features may be similar in different countries, a knowledge of the local conditions correlated with the habits or life-history of the organism or insect under discussion must of necessity figure largely in its successful control.

So far, in New Zealand, the problems of plant-hygiene have not been sufficiently studied in their relation to local conditions, but in most cases the adoption *in extenso* of the methods advocated in other countries has been followed. Certainly in many cases this has probably been the most rational procedure to adopt, but where the life-history of any particular disease follows a different course to that in those countries where the disease has been studied, it follows that the ordinary control-methods may not be at all applicable. This is well shown in the case of woolly aphis of fruit-trees (*Schizoneura lanigera*), the control of which will not be properly worked out for New Zealand until we are in possession of careful studies on the life-history of the insect.

In the control of forest diseases in New Zealand it is obvious that the first requisite will be a thorough understanding of the causal influences that render them especially injurious. The elimination of these causative factors will naturally form the basis of successful disease-control.

The Line of Action to adopt.

At the present time the most important work that should be done is a periodical inspection of all the planted areas to ascertain the exact position with regard to the presence of disease. These inspections could for some time to come take place not oftener than once a year, but when any special diseases are discovered it will be advantageous to visit all affected areas fairly frequently, to ascertain if the disease is one that, under the local conditions, shows any signs of becoming dangerous. At the first signs of serious injury strenuous efforts at control will have to be made, and the methods adopted in other countries will have to be applied, modified or supplemented as the case may be by a study of the local conditions. Any sickness or mortality of the trees that may occur must at all times be fully investigated, and the causes ascertained, for until the exact cause is known it will, of course, be impossible to formulate any line of action that should be taken.

All responsible officers in the employ of the Forestry Branch should make themselves conversant with the broad principles that underlie the problems of forest-disease control. This can be and is being done by a study of the literature that is rapidly growing up, and which is easily obtainable.

With the increase of the areas planted, in time the work of the individual will become more and more specialized, and it is probable that finally there will be some who devote all their time to forest pathological matters. There will be open two channels from which to recruit the *personnel* for this work—either by the employment of trained foreign specialists, or, as seems preferable, the training of certain of the New Zealand young men entering the forestry service as cadets, and who show some special aptitude for this class of work. This latter method would appear to be the more rational one, for a knowledge of the local conditions must in all cases have an important bearing on the effectiveness of the individual. There is, too, plenty of time in which these officers could be made efficient, for these services will not be urgently required for some years yet.

Two-year-old Seed-beds, Tapanui Nursery.

Machine- and Dutch-hoeing Lined-out Trees.

Face page 8.

Larch planted Five Years in Conical Hills Plantation.

Pinus austriaca and Larch, Conical Hills Plantation.

ACKNOWLEDGMENTS.

In connection with my inspection of the various plantations, my thanks are especially due to the Superintending Nurserymen, Mr. H. A. Goudie and Mr. R. G. Robinson, who gave me every facility for carrying out my work. They also clearly recognize the importance of disease-control in afforestation, and are fully impressed with the necessity for immediate action should any serious disease appear in the plantations under their control.

To Mr. W. G. Morrison, Nurseryman at Hanmer, I must also express my thanks for his assistance. Lastly, to Mr. Jourdain of the Head Office, who not only accompanied me through the Rotorua district, but also gave me much valuable advice, my thanks are due.

PART II.—REVIEW OF YEAR'S OPERATIONS.

A PERUSAL of the reports of the several stations discloses the fact that the afforestation operations during the year have been very satisfactory. Through the South Island generally the weather-conditions have been somewhat unfavourable owing to the comparatively low rainfall, while in the North Island fairly favourable weather was experienced, except that one short spell of dryness in the autumn was responsible for a cessation of growth during that period.

In the four nurseries, 8,951,045 trees were raised from seed during the year, and 7,588,285 trees were sent to the plantations. The area of land under plantations was increased by 2,600¼ acres; making a total of 16,310¼ acres planted since the commencement of operations.

The stock of trees in the nurseries at the 31st March, 1911, was 21,786,740, and of this number about nine million will be transferred to the plantations during the coming winter.

PRISON LABOUR.

The employment of prisoners at the plantations continues to be satisfactory, although the number employed during the year has been considerably less than last year. An average daily number of 41·2 prisoners performed work to the value of £3,744 6s. 9d., and since prison labour was first utilized for this purpose the total value of work done is £32,265 1s. 4d. Of the nature of the work performed, details appear in the reports supplied by the officers in charge, and, as much has been said in previous reports of the exceedingly valuable asset that the prisoners are building up for the country generally, it will suffice to say here that the scheme of employing prisoners should be continued, and, if opportunity affords, extended. At Hanmer Springs and Whakarewarewa Plantations free labour has been employed in addition to the prison labour, but at Waiotapu, where the largest prison camp is situated, almost all of the new country has been planted by prisoners. The remainder of a block in this locality of some 7,000 acres will be afforested during the coming winter, and further planting will then be undertaken on a block of 30,000 acres of Crown lands recently reserved for this purpose on the Kaingaroa Plains adjoining the present plantations in the Waiotapu Valley.

A central position on the new reserve has been selected, and it is intended to shift the prison camp to the new site—some thirteen miles distant from the present one—towards the end of the current year.

EXTENSION-WORK IN CENTRAL OTAGO.

The initial fencing-work in connection with the recently acquired 1,200 acres of undulating ground immediately adjoining the Naseby Reservoir has been completed, and the result of the first season's planting has justified the opinion formed regarding its adaptability for afforestation purposes. It is very evident that more surface moisture is available on the new area, and, as arrangements have been made to collect information by inaugurating a meteorological station here, it will be interesting to compare records obtained with those taken on the Maniototo Plains.

Preparations are well in hand for dealing with considerably over half a million trees at Naseby during the approaching planting season, and this number greatly exceeds that operated with in any previous year in Central Otago.

SURVEY PLANS.

Subdivisional plans of Waiotapu and Whakarewarewa Plantations have been completed, and, together with full information relative to the species of trees and acreage planted, accompany this report. As each of the smaller southern plantations possess defined boundaries, the necessity for having a survey made of these stations has not been so urgent, although every effort will be directed in presenting full working-plans of all plantations not already published in the ensuing returns.

Forestry Literature.

Every assistance has been extended to officers controlling the afforestation-work in creating valuable reference libraries, which have been made available to any departmental employee desirous of improving himself in matters associated with the work. In addition to this, the Superintending Nurserymen have each conducted a correspondence class (as referred to in detailed reports) very satisfactorily, and the various subjects discussed throughout the term will certainly lead to still further improvement in our working-system generally.

Cost of the Work.

Summaries are appended hereto, showing in a condensed form the result of the operations for the year and since the initiation of the afforestation-work in 1896. As far as is possible, this information has been given in such a manner as will facilitate a comparison between each of the stations, and at the same time present the salient features of the work in an easily accessible form.

The average cost per thousand for raising trees in nurseries from 1896 to 1911 has been £2 4s. 9d., but it should be pointed out that this is not a fair representation of the present position, inasmuch that three of the nurseries—viz., Starborough, Kurow, and Ruatangata—where climatic conditions are against the work have been closed. A perusal of the summary in question will show that at the two largest nurseries—Tapanui and Rotorua—the cost of raising trees has been about £1 per thousand, and, as far as can be foreseen, the cost for the next few years will remain much the same.

Turning to the summary of operations in plantations from 1896 to 1911 it will be seen that the average costs of planting one thousand trees has been £3 6s. 5d., while the cost of every acre planted has been £7 14s. The cost of the work naturally depends very largely upon the climatic conditions and nature of the soil, hence the figures for each station vary considerably. It should also be mentioned that at stations where prison labour is employed the value of such labour has been regarded as an expenditure for the purpose of working out these averages.

Taking the cost of raising the trees in the nurseries, together with the expenditure incurred on the plantations, it is found that on the average each acre of plantation has cost £13 15s. Included in these calculations are the stations which have before been mentioned as having been closed, and where the poor results were largely due to the adverse climatic conditions. Again, much valuable experimental work has been undertaken, and the expenditure on this is not likely to recur. At Dusky Hill Plantation the cost has been excessive, owing to the greater part of the area having to be replanted, as the result of a destructive fire in 1908, occasioned by the carelessness of a fisherman. The outlook for the future is much more encouraging. At the principal stations now in existence the work is at present being conducted on strictly economical lines, and the records show that the cost for forming the plantations varies from £6 to £7 per acre.

Detailed Reports.

A report by the Superintending Nurseryman for the North Island will be found in Appendix A following, and the report by the Superintending Nurseryman for the South Island in Appendix B.

Summary of Operations in Nurseries during Year.

Name of Nursery.	Total Expenditure.				Trees in Nursery.							
	Supervision and Clerical.	Permanent Works.	Tree-growing.	Total.	Estimated Trees in Stock at beginning of Year.	Deductions, partly through Deaths, but chiefly Over-estimation.	Estimated Trees raised during Year.	Net Total.	Average Cost per Thousand.	Output of Trees. Trees sent to Plantations during Year.	Output of Trees. Trees sent to outside Places during Year.	Estimated Number in Nurseries at 31st March, 1911.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.					£ s. d.			
Rotorua	706 13 1	519 0 4	3,367 2 10	4,592 16 3	9,924,401	..	3,316,250	13,240,651	0 6 1	4,301,525	1,496	8,937,630
Ruatangata	130 16 8	18 7 9	242 7 0	391 11 5	350,000	..	..	350,000	1 0 7	319,950	3,950	26,100*
Tapanui	176 18 0	156 17 7	1,415 17 0	1,749 12 7	5,527,500	432,900	2,821,245	7,915,845	0 3 10	1,493,605	71,695	6,350,545
Eweburn	160 0 0	27 10 2	637 11 4	825 1 6	1,991,650	257,370	343,350	2,077,630	0 6 10	326,300	1,065	1,750,265
Hanmer Springs ..	146 0 0	352 11 3	890 0 7	1,388 11 10	5,602,680	2,121,775	2,470,200	5,951.105	0 2 7	1,146,905	82,000	4,722,200
Totals and averages	1,320 7 9	1,074 7 1	6,552 18 9	8,947 13 7	23,396,231	2,812,045	8,951,045	29,535,231	0 8 0	7,588,285	160,206	21,786,740

Note.—The number of trees sent from nurseries is arrived at by counting in detail, but the number in stock is only an estimate, subject to revision the next year. See explanation on page 33.

* Destroyed when nursery was closed.

Summary of Operations in Nurseries from 1896 to 1911.

Name of Nursery.	Total Expenditure.				Estimated Number of Trees raised.	Cost per Thousand.	Deductions (Deaths, Overestimation, &c.).	Output of Trees.	
	Supervision and Clerical.	Permanent Works.	Tree-growing.	Total.				To Plantations.	To outside Places.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.			
Rotorua	2,284 6 8	4,183 2 11	32,360 13 6	38,828 3 1	37,336,705	0 18 6	..	27,632,804	766,271
Ruatangata	797 2 8	1,278 19 4	6,633 6 3	8,709 8 3	2,667,868	2 15 2	454,036	2,133,520	54,212
Tapanui	1,775 12 11	3,827 2 1	15,218 7 8	20,821 2 8	19,886,145	1 0 11	4,361,564	8,502,395	671,641
Eweburn	1,051 9 0	2,779 11 9	8,075 14 2	11,906 14 11	5,190,867	2 5 10	1,454,495	1,918,540	67,567
Hanmer Springs ..	745 0 0	2,464 7 7	5,016 12 0	8,225 19 7	12,198,800	0 13 6	2,608,895	4,785,705	82,000
Starborough	423 13 3	2,756 17 3	6,075 16 7	9,256 7 1	3,223,290	2 17 5	163,680	1,679,765	1,379,845
Kurow	205 0 0	1,750 7 2	1,114 15 5	3,070 2 7	219,000	5 2 0	46,540	..	172,460
Totals and averages	7,282 4 6	19,040 8 1	74,495 5 7	100,817 18 2	80,722,675	2 4 9	9,089,210	46,652,729	3,193,996

Note.—A discrepancy of 454,036 appears in the Ruatangata Nursery, and is explained in the detailed report on the nursery, see page 51.

Summary of Operations in Plantations during Year.

Name of Plantation.	Trees. Number received from Nursery.	Number used to replace Losses.	Number planted on New Area.	Expenditure. Supervision and Clerical.	Formation, Buildings, Roads, Fencing.	Planting Operations.	General Upkeep.	Total.	New Area planted.	Cost per Thousand Trees planted.	Cost per Acre planted.	General Upkeep per Acre planted.
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	Acres.	£ s. d.	£ s. d.	£ s. d.
Whakarewarewa ..	1,552,325	277,800	1,274,525	510 0 6	296 8 10	2,520 5 6	1,332 13 10	4,659 8 8	667¼	2 6 10	4 9 3	0 5 10
Waiotapu	2,749,200	278,350	2,470,850	472 0 0	397 18 0	2,629 1 5	710 2 10	4,209 2 3	907½	1 4 9	3 7 4	0 2 8
Puhipuhi	319,950	319,950	..	131 0 0	25 3 2	179 11 9	642 7 1	978 2 0	..	..	..	0 10 9
Dusky Hill	24,630	24,630	..	175 0 0	103 12 10	..	178 18 6	457 11 4	..	..	..	0 4 3
Conical Hills ..	1,468,975	89,275	1,379,700	255 0 0	129 6 11	2,011 3 4	820 0 1	3,215 10 4	506¾	1 7 4	3 14 5	0 8 7
Waitahuna	..	..	..	1 0 0	..	..	5 7 10	6 7 10	..	..	..	0 9 10
Gimmerburn ..	..	..	..	24 0 0	7 19 0	..	60 1 0	92 0 0	..	..	..	0 6 11
Naseby	326,300	24,550	301,750	90 0 0	159 12 4	406 7 9	211 8 9	867 8 10	110	1 7 2	3 13 11	1 18 5
Hanmer Springs ..	1,146,905	34,200	1,112,705	285 0 0	386 4 7	1,447 12 7	310 2 1	2,428 19 5	408¾	1 6 0	3 10 10	0 4 4
Totals and averages	7,588,285	1,048,755	6,539,530	1,943 0 6	1,506 5 8	9,194 2 4	4,271 2 0	16,914 10 6	2,600¼	1 10 5	3 15 2	0 10 3

Summary of Operations in Plantations from 1896 to 1911.

Name of Plantation.	Trees. Number received from Nursery.	Number raised from Seed sown in *situ*.	Number used to replace Losses.	Total Number in Plantation.	Expenditure. Supervision and Clerical.	Formation, Buildings, Roads, Fencing.	Planting Operations.	General Upkeep.	Total.	Total Area planted.	Cost per Thousand Trees planted.	Cost per Acre planted.	General Upkeep per Acre planted.
					£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	Acres.	£ s. d.	£ s. d.	£ s. d.
Whakarewarewa ..	11,426,019	109,725	1,895,108	9,640,636	2,429 19 10	2,307 3 4	21,003 13 6	6,520 9 6	32,261 6 2	4,634	2 8 2	5 0 0	1 8 0
Waiotapu	16,153,740	83,121	2,310,607	13,926,254	3,114 3 0	2,740 10 11	23,086 18 7	4,158 15 0	33,100 7 6	5,423½	1 17 3	4 15 6	0 15 5
Puhipuhi	2,133,520	..	1,133,520	1,000,000	932 9 7	597 12 0	4,572 5 10	2,997 13 0	9,100 0 5	1,200	5 8 3	4 10 3	2 10 0
Dusky Hill ..	2,965,837	..	785,000	2,180,837	1,317 4 2	1,138 16 8	7,426 17 4	2,576 3 5	12,459 1 7	845	3 8 1	9 5 3	3 1 0
Conical Hills ..	5,494,533	..	329,671	5,164,862	1,653 9 4	1,865 6 8	10,237 11 5	3,798 16 6	17,555 3 11	1,897	1 19 7	5 7 9	2 0 1
Waitahuna ..	42,025	..	11,500	30,525	27 9 0	61 1 1	74 0 9	40 9 9	203 0 7	11	2 8 5	6 11 9	3 13 6
Gimmerburn ..	936,235	..	783,339	152,896	302 16 8	514 13 11	984 4 0	809 5 10	2,611 0 5	173	5 10 11	15 1 10	4 13 7
Naseby	826,230	..	144,026	682,204	397 19 2	571 15 3	1,573 15 9	1,101 7 9	3,644 17 11	260	5 2 10	14 0 4	4 4 8
Hanmer Springs ..	4,785,705	..	833,754	3,951,951	1,281 18 0	3,077 6 8	6,778 12 6	2,061 14 4	13,199 11 6	1,451¾	1 14 3	4 13 4	1 8 4
Dumgree	1,679,765	..	1,110,125	569,640	764 2 6	4,162 2 2	3,802 11 9	1,288 14 0	10,017 10 5	209	*	*	*
Raincliff	..	..	..	50,000	..	..	..	..	1,104 12 5	206	*	*	*
Totals and averages	46,443,609	192,846	9,336,650	37,349,805	12,221 11 3	17,036 8 8	79,540 11 5	25,353 9 1	135,256 12 10	16,310¼	3 6 5	7 14 0	2 12 9

* Reliable records not available.

APPENDIX A.

REPORT ON TREE-GROWING OPERATIONS IN THE NORTH ISLAND, 1910-11.

[By the Superintending Nurseryman, Rotorua.]

Afforestation-work at the North Island stations has been attended with much success, which is due in a great measure to the favourable weather experienced during the year. Although the rainfall was exceedingly low, it was fairly well distributed over each month of the year. One very dry spell was experienced during January and the greater part of February, but practically no losses were occasioned thereby. The record of rainfall and temperature attached to the report on Rotorua Nursery may be accepted as giving an indication of the weather experienced in this district generally.

In the nurseries, 3,316,250 trees were raised during the year, making a total to date of 40,004,573. The output of trees from nurseries during the year amounted to 4,626,921, and the number sent out to date is 30,586,807. Trees in nurseries at 31st March numbered 8,937,630. The difference between the sum of trees sent out and stock in hand compared with the number raised is 480,136, which represents deaths in trees grown at Ruatangata Nursery, 26,100 trees—totara—destroyed when the nursery was closed, and to a very large extent an overestimation of stock at that nursery for some years.

Counting the Trees.

It will be readily understood that for stock-taking purposes the only method of arriving at the number of trees in a nursery is by counting portions, and averaging the whole on the counts obtained. The numbers given in the schedules of trees in stock must therefore be understood as being approximate only. When sending trees out from the nursery they are counted into bundles, each containing twenty-five trees, so that the numbers given as being sent out may be relied upon as being accurate. It has been customary to show in the summaries and elsewhere the number of trees raised in each nursery from the time of its inception, and the best method by which this can be arrived at is by adding the total of trees sent out to the estimated number in the nursery. As a consequence, it follows that it is impossible to have an uninterrupted succession of figures balancing year after year.

Another question which has a close bearing upon this subject is the counting of deaths amongst the nursery stock. This is even more impossible than counting the whole stock. A 2-per-cent. death-rate in seed-beds containing 5,000,000 trees would mean the loss of 100,000 trees, yet such a loss, if evenly distributed over the beds, would not be noticed unless each of the deaths occurred at the same time. When stock-taking it has been usual to allow a margin for probable overestimation and losses. The total of seed-beds arrived at by averaging is reduced by one-third, and the lined-out trees by one-fifth, and this method has been proved to give a reasonably accurate count of the stock.

Prison Labour.

The work performed by the prison labour at the Whakarewarewa and Waiotapu Prison Camps during the year is valued at £3,347 7s. 4d., which shows an average of £98 15s. 5d. for each of the 33·89 prisoners employed. In placing a value upon the work done by prisoners, the cost of similar work performed by free labour is taken as a basis; thus, pitting is valued at 7s. 6d. per thousand, and this work by free labour during the year cost 9s. 1½d. per thousand. Planting is also valued at 7s. 6d. per thousand, and the cost of this by free labour was 7s. 3d. Much depends upon the class of land on which the work is done, and the cost by free labour varies accordingly. The rates of values as given above for prison labour is therefore considered fairly average ones.

Details of the work performed by prisoners during the year and since prison labour was first employed is here given:—

Whakarewarewa Plantation—

Average daily number of prisoners employed during year, 10·44.

Average daily number of prisoners employed since camp started, 11·53.

	Value during Year, 1910–11. £ s. d.	Value since Camp started, 1904 to 1911. £ s. d.
Clearing land for tree-planting	258 10 0	1,287 4 8
Pitting	408 11 3	481 11 6
Tree-planting	47 2 0	1,273 1 5
Roadmaking	..	642 11 9
Fencing	..	7 13 0
Buildings, new erections and alterations to	..	205 16 0
Formation of fire-breaks, &c.	75 19 5	342 5 11
General upkeep of plantation	131 15 0	1,049 14 3
General repairs	11 11 3	306 13 11
Miscellaneous works	23 11 4	91 3 5
Totals	£957 0 3	£5,687 15 10

Waiotapu Plantation—

Average daily number prisoners employed during the year, 23·45.

Average daily number prisoners employed since camp started, 27·27.

	Value during Year, 1910–11. £ s. d.	Value since Camp started, 1904 to 1911. £ s. d.
Clearing land for tree-planting	310 10 0	5,600 4 3
Pitting	586 14 6	6,270 19 10
Tree-planting	858 3 0	5,773 11 2
Roadmaking	5 19 0	491 19 10
Fencing	..	399 2 8
Buildings, new erections and alterations to ..	42 13 6	340 12 10
Formation of fire-breaks, &c.	80 0 0	431 7 6
General upkeep of plantation	380 11 1	2,870 1 2
General repairs	125 16 0	137 16 6
Totals	£2,390 7 1	£22,315 15 9

Judging from the results obtained in the plantations, prison labour is a decided success, and an extension of this system would be advantageous, provided the prisoners were available. Both the prison camps in this district have during the year been somewhat short of men, and it has been necessary to employ more free labour in order to get the work accomplished.

The prison camp at Waiotapu will be shifted about next November to a new site on the Kaingaroa Plains, where a large block of land has been reserved for afforestation purposes. Preparations for this are now under way, and include the formation of a paddock, the procuring of a water-supply, and the preparation of a site for the camp. The telephone-line is four miles distant from the site chosen for the camp, which will necessitate the laying of a branch line for that distance. Very few places exist on these vast plains where water can be obtained in any quantity, so that in choosing a site for the prison camp almost every other consideration was subordinate to the question of an adequate supply of water. This, fortunately, has been procured about half a mile from one of the small experimental plantations formed on the plains some twelve years ago. Portion of this plantation will be felled for a camp-site, but it is intended to leave sufficient trees to provide shelter from the cold winds.

When commenting upon the question of shifting the prison camp in last annual report, it was suggested that in order to avoid shifting camp so frequently a central camp should be formed, with small outlying camps a few miles distant from the central camp, but the apparent difficulty of selecting a sufficient number of prisoners who are suitable for tree-planting camps rules this suggestion out as undesirable. Such a scheme would be possible only if the camp could be kept up to the full strength continually.

"Karere" Convalescent Camp.

This camp, which was established for the purpose of giving healthy employment to convalescent consumptive patients, has not been as successful as was anticipated, owing chiefly to the difficulty in finding suitable work for such persons. The planting of trees can perhaps be performed as well by a convalescent consumptive as by a healthy individual, but this work lasts only about five months of the year, and the difficulty mentioned was experienced in providing a sufficiently light employment for them during the remainder of the year. Clearing land and digging pits were tasks which but few of the men could perform, and, as these compose the principal works undertaken on the plantations during the summer months, it was necessary to close the camp towards the latter part of the year.

The land available for tree-planting is every year becoming farther away from the camp, and if the employment of this labour is to be continued it will be necessary to shift the camp nearer to the work. One of the chief causes for grumbling has been the long walk to and from work, but this could not be avoided.

Thinning Plantations.

Some of the oldest parts of the plantations will soon require attention by way of thinning; and, in anticipation of this, it may be as well to touch upon this question generally. To what extent a plantation should be thinned depends very much upon the object aimed at in forming the plantation. A plantation subjected to severe thinning, or one formed with a wide distance between the trees, would produce timber full of knots, while the annual rings would be wide apart, thus causing coarseness of grain, which, in a coniferous tree particularly, is undesirable. Trees planted close together and grown until maturity with a complete leaf-canopy produce timber fine in grain and free from knots. The severity of the thinnings or the frequency of same has, therefore, a large influence upon the quality of the article produced. A quick return can be got from a plantation by the first method but the produce is low in quality.

By way of experiment a small area of the larch-plantation at Whakarewarewa was last year cleaned, by removing all the dead bracken and other *debris*, in order to better enable observations as to the rate of growth of the trees to be made. These trees were planted in 1901, and although many of the lateral branches within 6 ft. of the ground were dead and could be broken off clean to the trunk of the tree, there was a large number of branches which still had life in them, and when broken off left a small jagged end, which, if left, would cause a defect in the timber, and probably an entrance for a disease affecting the trees. The cost of trimming off these branches close to the trunk made it apparent that the thinning of the whole plantation should be deferred for a while longer, because the work could be more economically performed if such growth could be knocked off with the back of a slasher.

About one-third of the trees were strong, healthy, dominating specimens, the same proportion were beginning to show evidence that the struggle for existence was becoming too keen, while the remainder were either suppressed or dead. The thinning-out of all the dead or suppressed trees would benefit the remaining ones, but at the present time the dense, tangled mass of bracken and tree-branches make it almost impossible to get in amongst the trees, and the work could only be carried on at great expense—about £4 per acre. If it were possible to dispose of the thinnings, this would put the question in quite a different light, but the only probable use for the thinnings is for fuel, and in this district, where the native timbers for this purpose are abundant, the disposal of thin larch sticks would be difficult. The conclusion arrived at is that about the twelfth year from the time of planting a larch-plantation may be thinned without unnecessary expense. By that time many of the branches will have dropped off, and what still remain will be sufficiently brittle to knock off easily.

Although larch is a light-loving tree, it is evident that it will remain in close plantation for a considerably longer period in this part of New Zealand than is considered advisable in Great Britain or parts of Europe. A difference in this respect would probably be found between the North and South Islands of New Zealand, according principally to the amount of sunshine recorded at different parts. When this area was cleaned and thinned, a number of different trees were planted under the larch in order to ascertain the amount of shade they would endure. *Thuja gigantea* and totara bear the shade well. Douglas fir and Weymouth pine require considerably more light, while the other species planted were not suitable for bearing shade except in a very slight degree; these were heavy pine, Californian redwood, *Catalpa speciosa*, and *Eucalyptus Stuartiana*.

Survey-work.

Accompanying this report are plans of Whakarewarewa and Waiotapu Plantations, showing the areas under different classes of trees, and the roads and fire-breaks. When afforestation was first started here the yearly operations were much smaller in extent than they are at present, and there was not the same necessity for subdivisional plans as now. As a consequence, much of the data relating to the date of planting and number of trees in each compartment is somewhat obscure, but the tables which have been prepared showing this information is as accurate as was possible under the circumstances, and it is sufficient far all practical purposes. These tables give the approximate number of trees at present existing in each block, and for comparison the actual number planted is also shown. The difference between the number planted on new area and that shown as trees existing is accounted for by numbers of trees grown experimentally in the early years of the operations in this district, and afterwards found unsuitable. The greatest losses were amongst eucalypti, many species of which were tried and found to be too tender. *Catalpa speciosa* also accounts for a large number, while the Californian redwood, which were mixed with the larch, are reckoned as being all dead.

The actual number of trees planted, while being of a certain value for statistical purposes, does not convey as much information as does a record of the area planted. These numbers will be wholly unrepresentative of the growing stock as soon as thinning commences, and this is actually the case now in a few of the oldest blocks, where a proportion of the trees have succumbed in the struggle for existence.

Forestry Literature.

The best publications on forestry and allied subjects are being procured for circulating amongst the officers of the Department, and it is intended to gradually work up an index of all volumes in the library.

During the year papers on set subjects were written by officers, and the prize of £2 given by the Department for the best paper of the year was won by Mr. R. Glass, Plantation Foreman at the Whakarewarewa Prison Camp.

Proposals for 1911–12.

Rotorua Nursery.—The available stock of trees suitable for permanent planting, numbering 5,000,000, will be sent to the plantations during the coming winter.

Whakarewarewa Plantation.—Preparations are now well under way for planting 2,000,000 trees. An area of 740 acres will thus be added to the plantation during the year. It is anticipated that the general upkeep will be unusually heavy next summer, owing to the strong growth of bracken which is prevalent on some of the steep hills recently planted. The work at this station is gradually becoming further away from the Rotorua Township, and it is intended to erect several huts for the accommodation of the free labourers. Tents have been used in the past, but these, besides being uncomfortable during the cold winters, are costly when the upkeep and renewing of them is taken into consideration.

Waiotapu Plantation.—Afforestation-work to be undertaken includes planting an area of 1,100 acres with 3,000,000 trees. The shifting of the prison camp as mentioned elsewhere, and the upkeep of the plantation generally. Huts for workmen will also be erected, as there is no accommodation obtainable at Waiotapu, and once the prison camp is shifted the work will have to be undertaken by free labour entirely.

Puhipuhi Plantation.—It is intended to try and get a local settler to act as caretaker of this plantation. A large part of the area will require no attention for some years, or until thinning is necessary; and beyond the danger from fire, which exists at any of the plantations, the work here will be principally confined to the prevention of trespass by either persons or stock and the apprehension of offenders.

Conclusion.

I am much indebted to the Plantation Foremen and the staff generally for the able and cheerful assistance received in carrying on the work. From the Prison Department's officials with whom we are

associated at the tree-planting camps much valuable assistance has been received. I am particularly grateful to the Gaolers for the interest they have taken in the work, and their ready assistance in helping it along.

Mr. E. H. Taylor, clerk, left the service at the end of February, and was succeeded by Mr. W. Montgomery, of Rotorua Nursery. Mr. S. Curle, Nursery Foreman at Rotorua Nursery, was retrenched when the Ruatangata Nursery was closed, and was succeeded by Mr. A. Gordon, Nurseryman in charge, Ruatangata. Mr. Mason, Plantation Foreman at Puhipuhi Plantation, was transferred to Waiotapu Plantation, where he fills a similar position.

H. A. Goudie,
Superintending Nurseryman, North Island.

Rotorua Nursery.

(Area of enclosure, 163 acres; altitude, approximate, 1,000 ft.)

The operations at this nursery during the past year have been attended with much success, which is due in a large measure to the favourable weather experienced.

The rainfall amounted to 39·58 in. falling on 137 days, and is the lowest fall ever recorded in this nursery. Last year 76·67 in. fell on 173 days. The minimum temperature recorded during the year was 23° on the 25th June, and the maximum 87° on the 31st January. The temperatures show very little variation from last year, when the minimum and maximum was 24° and 88°, in July and December respectively.

Seedling Trees.

Trees raised during the year are estimated at 3,316,250, and their value £3,302. The usual quantities of seeds were sown, and the percentage of germination is up to the average, although in one or two instances very poor results were obtained. Details of the crops raised will be found in Schedule V attached, and the following remarks on the different species grown may be interesting:—

Larch (*Larix europaea*).—Five hundredweight of seed was sown, resulting in about 2,000,000 plants: the percentage of germination being 4. This result is up to the average, and the growth made by the young seedlings is remarkably good, fully 40 per cent. of them being 6 in. high. The dry weather experienced during January and February was commencing to have an ill effect upon the crop, but timely rains early in March soon freshened them up, and practically no loss occurred.

Austrian Pine (*Pinus austriaca*).—From 14 lb. of seed 17,000 trees were raised, 5 per cent. being the rate of germination. The growth is well up to the average.

Corsican Pine (*Pinus Laricio*).—900,000 trees were raised from 3 cwt. of seed, the rate of germination being 8 per cent. Exceptionally good growth has been made by the seedlings, fully 50 per cent. being 2 in. high; but the rate of germination is low in comparison to last year, when 33 per cent. of the seeds produced trees.

Sugar-pine (*Pinus Lambertiana*).—The crop raised from 43 lb. of seed amounted to 12,000; germination being at the rate of 14 per cent. The seed of this pine is exceptionally large, there being about 2,000 to the pound; and on this account it is an expensive tree to grow. Good growth has been made by the seedlings. It is not intended to grow further quantities of this pine, as the cost is too high.

Heavy Pine (*Pinus ponderosa*).—The crop raised from 43 lb. of seed numbered 100,000. Rate of germination, 25 per cent. This is low compared with last year, when 80 per cent. of the seed germinated. Splendid growth has been made by the seedlings, and it is probable that the whole of them will require to be lined out next spring.

Monterey Pine (*Pinus insignis*).—A very poor crop resulted from the 25 lb. of seed sown. These number 50,000, showing that the rate of germination was about 10 per cent. Last year 50 per cent. of the seeds germinated. As usual, this species has made good growth, and the whole of the crop will be fit for permanent planting during the coming planting season.

Bentham's Pine (*Pinus ponderosa* var. *Benthamiana*).—A fairly good crop, 10,000 trees, resulting from 15 lb. of seed sown. Rate of germination, 10 per cent. Good growth has been made by these seedlings, and they will probably need to be lined out next spring.

Weymouth Pine (*Pinus strobus*).—This is the poorest crop of this species ever raised here, the germination of the seed being at the rate of 0·23 per cent. Two thousand seedlings were produced from 30 lb. of seed, which goes to show how inferior was the quality of the seed. A small sample packet of seed was received from the Forestry Department in Canada, and this germinated at the rate of 10 per cent. A trial lot of European-saved seed is being procured for next year's sowing.

Douglas Fir (*Pseudo-tsuga Douglasii*).—This is a good crop. From 30 lb. of seed 120,000 trees were raised, the rate of germination being 10 per cent. Excellent growth has been made by the seedlings, most of which are 3 in. high, and it will be necessary to transplant them into nursery rows next spring.

Apple-scented Gum (*Eucalyptus Stuartiana*).—From 3 lb. of seed sown probably 300,000 seedlings resulted, but as only about one-third of these will make sufficiently strong growth, they have been estimated for stock-taking purposes at 100,000. This latter number will suffice for planting the area set aside for eucalyptus this coming winter. As usual, this species has made strong growth, and all the available plants will be permanently planted as one-year-olds.

Experimental Lots.—The following species were raised for experimental purposes: *Pinus canariensis, densiflora, Massoniana, Monticola,* and *Tsuga Mertensiana.* With the exception of the last-named, seed of all these species were presented by foreign Governments or societies. Specimens of each will be planted, and results noted for future guidance. All of the pines made good growth, *P. canariensis* being particularly noticeable in this respect. *P. Massoniana* is a synonym of *P. Thunbergii*, the latter being now recognized as the correct name for this species. It is a native of Japan, being largely planted in that country for all purposes; it is used for sea-coast planting, is planted for fuel,

and finds a place in most private gardens and temple-enclosures. *Pinus densiflora* is also a native of Japan, where it is as highly esteemed as *P. Thunbergii*. *P. Monticola* is a large-growing tree; native of the mountain-ranges of North-west America. The wood is suitable for the same purposes as the Weymouth pine. *Tsuga Mertensiana* is a native of Western North America, where it has a wide range from California to Alaska; it is a valuable timber tree. The genus embraces the hemlock firs, which are closely allied in character to the larches and spruces. This species, like spruce, is very slow-growing in the Rotorua district, and the seedlings raised this year are no exception to this rule.

Two-year-old Seedlings.

Corsican Pine (*Pinus Laricio*).—This was the principal crop in this class, and is the finest lot of trees ever raised here. All are healthy, have made strong growth, and probably 90 per cent. of them will be fit for permanent planting next winter.

European Larch (*Larix europaea*).—This crop is not as good as usual, which is due to the very dry weather experienced in the first two months of 1911. Grass-grub, too, has been prevalent, and there are several small patches in each bed where the presence of this pest is very noticeable. The root-fungus (*Rosselinia radiciperda*) has not been responsible for so much damage as in former years. This disease is being investigated, and our observations up to the present time would seem to indicate that the root-fungus has an injurious effect only where the roots of the larch have been damaged either by the implements or by the grass-grub. This view is partly confirmed by the fact that perfectly healthy specimens of larch have been lifted, showing large quantities of *Mycelia* adhering to the roots. It is proposed to desist from "wrenching" the larch for a year or two, in order to ascertain if this view of the matter is a correct one.

Western Larch (*Larix occidentalis*).—In last year's report it was stated that this species was of a slower rate of growth than the European larch, and the growth made by the plants during the past year confirms the statement. It is quite as susceptible to the root-troubles as the European larch.

Other trees mentioned in the schedule attached have mostly made good growth, and will be transferred to the plantations during the coming winter.

Lined-out Trees.—Very satisfactory growth has been made amongst all species of trees; the pines being unusually good, and the larch just about the average. The bulk of these trees will be available for sending to the plantations next winter.

Trees sent to the plantations, &c., during the year numbered 4,303,021, and their value £7,608 9s. 10d. The totals to date are 28,399,075 trees, valued at £60,518 18s. 6d.

Seed-sowing was conducted under very good weather-conditions during the months of October and November. An experimental sowing of one bed each of larch and Corsican pine was made early in September, but the results were unsatisfactory, probably owing to there being insufficient warmth in the soil. This trial sowing was made in order to ascertain what difference upon the growth of the seedlings would result; but, although the growth was considerably greater, the rate of germination was so low as to make a repetition of such early sowing undesirable.

The last three months of 1910 were somewhat damper than usual, hence weeding has been an unusually heavy item of expenditure. Sorrel is the most common of the weeds to be contended with, and, owing to the underground stems, it is somewhat difficult to keep in check in the seed-beds.

Lining-out.—This work was commenced on the 13th July, and completed on the 31st August, the number of trees dealt with being 2,500,000. The average cost for this work was 1s. 9d. per thousand. Sizing of seedlings cost 2s. per thousand, and lifting lined-out trees in readiness for sending to the plantations cost 2s. 3d. per thousand.

Horse-feed.—There were 25 tons of oaten sheaf grown and harvested in prime condition; while the previous year's stack, amounting to 17 tons, was chaffed. Cropping of this sort may be regarded as profitable; but during the period that the crop occupies the land the weeds make great headway, so that it is not desirable to use land on which it is afterwards intended to grow crops of trees. For growing horse-feed only an additional area of 14 acres was ring-fenced, and this was sown down in oats during March, 1911. One of the horse-paddocks which has been down for ten years was ploughed, and it is intended to put this in oats next spring.

A five-roomed cottage was erected during the year for the use of the Nursery Foreman, whose duties compel him to live close to the work.

Two new wagons were purchased to replace the old ones. The type of wagons bought are common in this and most country districts. They are strongly built, with no springs, and a body which can be removed; while the under-carriage has a sliding reach, making the vehicle adaptable for carrying long lengths of timber. These wagons will be mostly occupied in carting trees to the Waiotapu Plantation. A lighter spring wagon was also purchased for supplying the Whakarewarewa Plantation with trees.

Proposals for 1911–1912.—It is estimated that between five and six million trees will be available for sending to the plantations this coming winter. Of these, the majority are pines, and, as it is advisable to plant pines before the actual dormant season arrives, an early start will be made in sending them out. This will necessitate an increased expenditure in labour for about the first three months of next year, or until all the pines have been lifted and despatched to the plantation. The larch, which transplant as well in the spring as in the autumn, will not be handled until all the pines have been dealt with.

Manuring.—The nursery soil, with frequent tillage and cropping, has lost much of its natural fertility, owing to the decomposition of the humus. Artificial manures, while improving the productive capacity, have very little effect upon the physical properties of the soil, especially is this so where the crop is taken right out of the ground, as is the case with young trees. There is not even stubble left to plough in to form humus, as for instance after an oaten crop. To improve the soil-conditions, it is proposed that all vacant land next spring be sown down with a leguminous or cruciferous crop for ploughing in, and each piece of land as it becomes vacant will be similarly treated.

Further accommodation for vehicles and implements is required. An addition to the present lean-to at the back of the stable would meet the case in the most economical manner.

The average number of workmen employed during the year was 30·35.

Schedules showing stock of trees in hand at 31st March, and trees sent out during the year, are attached, along with information relating to expenditure and values.

The following is a record of the temperature and rainfall for the year :—

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature.		Number of Days Frosts occurred.
			Maximum.	Minimum.	
1910.	Inches.		Degrees.	Degrees.	
April	1·31	9	74	29	3
May	3·77	12	68	28	6
June	4·60	18	65	23	11
July	5·40	16	63	24	10
August	5·15	13	64	25	9
September	1·77	11	68	30	7
October	4·89	13	73	25	1
November	2·63	7	82	40	..
December	4·25	15	79	37	..
1911.					
January	0·56	4	87	40	..
February	2·84	10	82	40	..
March	2·41	9	83	42	..
Totals	39·58	137	..	..	47

Schedule II.—Statement of Expenditure.

	For Year.			To Date.		
	£	s.	d.	£	s.	d.
Tree-planting and maintenance—						
Tree-growing	2,043	11	6	20,264	9	6
General maintenance and repairs ..	312	13	7	3,261	10	1
Tree-seeds	258	6	0	2,151	13	3
Manures	92	19	8	869	3	9
Horse-feed, purchased and grown ..	222	14	3	1,356	10	1
Miscellaneous works	49	11	6	274	3	11
Stock and material—Tools, implements ..	76	10	0	882	16	9
Permanent works—						
Buildings	392	15	11	2,748	19	2
Nursery-formation	40	14	6	2,208	18	2
Fencing	27	13	7	215	8	2
Water-supply	..			660	18	10
Seed-frames	8	12	8	1,649	4	9
Supervision and clerical—						
Proportion of Superintending Nurseryman's salary	200	0	0	..		
Proportion of Foreman's wages, Nursery-assistant and Cadet's salaries ..	356	13	1	1,742	11	7
Clerical assistance	150	0	0	541	15	1
	£4,592	16	3	£38,828	3	1

Schedule III.—Trees Account.

	During the Year.			Since 1896 to Date.			Estimated Value, as Schedule V.		
	Number.	Cost of Raising per Thousand.		Number.	Cost of Raising and Maintenance, per Thousand.				
		£	s.	d.		£	s.	d.	£	s.	d.
Trees raised	3,316,250	0	6	1	37,336,705	0	18	6	73,500	16	6
Trees sent out	4,303,021	..			28,399,075	..			60,518	18	6
Balance in stock					8,937,630	..			12,981	18	0
Value of land, improvements, and stock (Property Account) ..						..			8,406	1	9
Total value						..			21,387	19	9

Schedule IV.—Property Account.

	£	s.	d.
Land (160 acres); Crown land, not charged to Forestry Account ..	..		
Buildings	2,500	0	0
Stock	..		
Improvements	2,700	0	0
Fencing	150	0	0
Stores in hand	3,056	1	9
	£8,406	1	9

Schedule V.—Details of One-year-old Trees, sown 1910–11.

Name of Tree.	Number in Seed-beds.	Height in Inches.	Amount of Seed sown.	Value per Thousand.	Total Value.	Remarks.
			lb. oz.	£ s. d.	£ s. d.	
Eucalyptus Stuartiana	100,000	6	3 0	0 10 0	50 0 0	Good growth.
Larix europaea	2,000,000	2–6	560 0	1 0 0	2,000 0 0	
Pinus austriaca	17,000	1	14 0	1 0 0	17 0 0	
„ canariensis	4,000	6	1 0	1 0 0	4 0 0	
„ densiflora	50	1	0 1	1 0 0	0 1 0	
„ Lambertiana	12,000	2	43 0	1 5 0	15 0 0	
„ Laricio	900,000	2	336 0	1 0 0	900 0 0	
„ Massoniana	100	1	0 1	1 0 0	0 2 0	
„ Monticola	100	1	0 1	1 0 0	0 2 0	
„ ponderosa	100,000	1½	43 0	1 0 0	100 0 0	
„ „ (var. Benthamiana)	10,000	1½	15 0	1 5 0	12 10 0	
„ radiata	50,000	6	25 0	1 0 0	50 0 0	
„ strobus	2,000	1	30 0	1 0 0	2 0 0	
Pseudo-tsuga Douglasii	120,000	3	30 0	1 5 0	150 0 0	
Tsuga Mertensiana	1,000	1	1 0	1 5 0	1 5 0	
Totals	3,316,250	..	..	..	3,302 0 0	

Two-year-old Trees, sown 1909–10.

Name of Tree.	Number in Seed-beds.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Cupressus thurifera	400	600	7	1 5 0 2 5 0	1 17 0	Very fast.
Fraxinus americana	500	..	6	1 5 0	0 12 6	Fair.
Larix europaea	800,000	600,000	12	1 5 0 2 5 0	2,350 0 0	Good growth.
„ occidentalis	50	100	8	1 10 0 2 10 0	0 6 6	Slow growth.
Liquidambar styraciflua ..	..	1,000	4	2 10 0	2 10 0	Very good.
Picea canadensis	500	..	2	1 10 0	0 15 0	Slow growth.
Pinus Coulterii	..	500	5	2 10 0	1 5 0	Good growth.
„ Jeffreyii	..	4,000	4	2 10 0	10 0 0	„
„ Lambertiana	200	..	5	1 10 0	0 6 0	„
„ Laricio	2,250,000	1,500,000	5	1 5 0 2 5 0	6,187 10 0	Very good.
„ ponderosa	110,000	70,000	5	1 5 0 2 5 0	295 0 0	„
„ „ scopulorum ..	500	1,500	5	1 10 0 2 10 0	4 10 0	Good growth.
„ resinosa	300	200	3	1 10 0 2 10 0	0 19 0	Slow growth.
„ strobus	12,000	..	3	1 5 0	15 0 0	„
„ teocote	4,000	4,000	4	1 10 0 2 10 0	16 0 0	Very good.
Taxodium distichum	..	30	8	2 5 0	0 1 6	„
Tsuga canadensis	900	..	2	1 5 0	1 2 6	Slow growth.
„ occidentalis	1,000	..	4	1 10 0	1 10 0	Fair growth.
Sequoia sempervirens	..	4,000	6	6 0 0	24 0 0	„
Totals	3,180,350	2,185,930	..	..	8,913 5 0	
	5,366,280					

Three-year-old Trees, sown 1908–9

Name of Tree.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
			£ s. d.	£ s. d.	
Alnus glutinosa	400	8	3 0 0	1 4 0	Fair growth.
Larix europaea	50,000	12	3 0 0	150 0 0	Good growth.
Pinus ponderosa	200,000	5	3 0 0	600 0 0	„
Pseudo-tsuga Douglasii	4,000	6	3 5 0	13 0 0	„
Thuja gigantea	700	6	3 10 0	2 9 0	„
Totals	255,100	..	..	766 13 0	

Trees transferred from Nursery to Plantations, &c., 1910–11.

Where sent.	Name of Tree.	Number.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Waiotapu Plantation	Larix europaea ..	442,100	12	2 5 0	994 14 6	Results of all trees planted are satisfactory.
	"	245,450	12	1 5 0	306 16 3	
	"	288,650	12	1 0 0	288 13 0	
	Pinus ponderosa ..	323,000	3	2 5 0	726 15 0	
	" Laricio	1,436,250	4	2 5 0	3,221 11 3	
	" "	11,450	4	3 0 0	34 7 0	
	" strobus	2,300	3	3 0 0	6 18 0	
		2,749,200			5,579 15 0	
Whakarewarewa Plantation	Alnus glutinosa ..	2,200	6	2 0 0	4 8 0	Results of all trees planted are satisfactory.
	Eucalyptus Stuartiana ..	508,925	4	0 10 0	254 9 3	
	Liquidambar styraciflua	1,700	6	1 5 0	2 2 6	
	Larix europaea ..	36,000	12	3 0 0	108 0 0	
	"	20,000	12	2 5 0	45 0 0	
	"	453,950	12	1 5 0	567 8 9	
	Pinus Laricio	77,000	4	2 5 0	173 5 0	
	" Murrayana ..	2,225	4	2 5 0	5 0 1	
	" ponderosa ..	263,550	3	2 5 0	592 19 9	
	" radiata	147,800	6	1 0 0	147 16 0	
	Pseudo-tsuga Douglasii ..	21,125	5	2 10 0	52 16 3	
	Sequoia sempervirens ..	15,000	4	4 0 0	60 0 0	
	Thuja gigantea ..	2,850	4	3 0 0	8 11 0	
		1,552,325			2,021 16 7	
Local bodies, schools, and Councils	Shelter-trees and shrubs	1,496	..	..	6 18 3	

Summary.

Where sent.	Description.	Number.	Value.
			£ s. d.
Whakarewarewa Plantation	Details above	1,552,325	2,021 16 7
Waiotapu Plantation	"	2,749,200	5,579 15 0
Local bodies, schools, and Councils ..	"	1,496	6 18 3
Totals	..	4,303,021	7,608 9 10

H. A. Goudie,
Superintending Nurseryman, North Island.

Whakarewarewa Plantation.

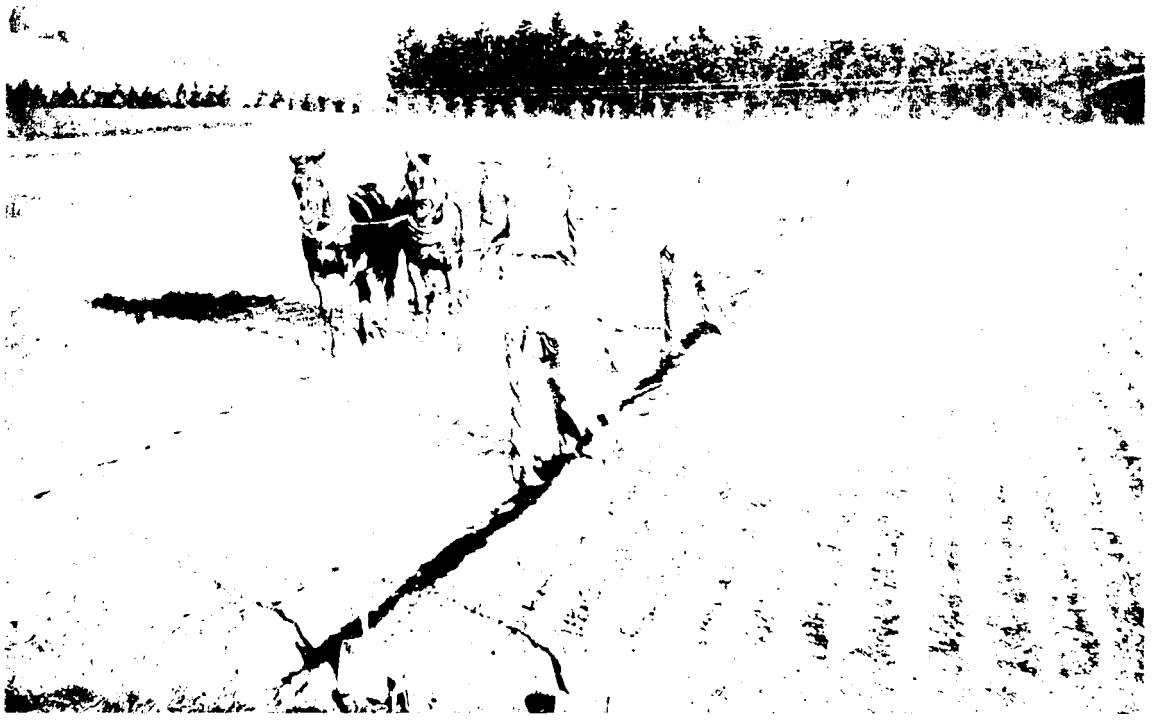
(Area, 9,024 acres; approximate altitude, 1,200 ft.)

During the past year trees to the number of 1,552,325 were received from the Rotorua Nursery. Of this number, 1,274,525 were planted on a new area of 667¼ acres, and 277,800 were used to replace failures in former planting. The estimated number of trees in the plantation is 9,640,161, occupying an area of 4,634 acres.

Prison Labour.—The average daily number employed was 10·44, and their work was valued at £957 0s. 3d., or an average per man of £91 13s. 4d., showing an increase of £19 2s. 6d. on the average earnings per man for the previous year. The Prison Department's officers have done their utmost to make the work a success. A new oil-engine and power pump were installed to replace the old pump and windmill, which were completely worn out. The new plant is giving every satisfaction, and there is now no difficulty in keeping the camp well supplied with water.

Consumptive Convalescents.—The Karere Camp consumptive convalescents resumed work in March, 1910, preparing pits to the number of 144,380, and planting 252,175 trees. At the end of the planting season they were given employment at maintenance-work, which consisted chiefly of clearing growth amongst the younger trees until February of the present year, when they again started pitting. The men, however, found the work too hard for them, and, consequently, as there was nothing else for them to do, the camp had to be closed. All the planting within three miles of the camp will be finished within a few weeks, so that there is not sufficient inducement to open it for the coming season's work. The average daily number of men employed was 4·43, and their total earnings amounted to £434 17s. 3d.

Free Labour.—An average daily number of 24·84 men were employed, and the average cost of the various works undertaken was as follows: Clearing for tree-planting, £1 15s. 9½d. per acre; pitting, 9s. 1¼d. per thousand; planting, 7s. 2¾d. per thousand; pitting and planting, 12s. per thousand; planting blanks, 11s. 5d. per thousand; 63 chains of fire-break were formed, at a cost of 5s. 2¼d. per




5787

Wrenching and weeding Pines, showing Protecting Fraves.

Loading 30,000 Larch for Plantation.

chain: 518,225 trees were put in by a combined system of pitting and planting at one operation; the plants were small and easily carried, and the pits were dug with the planting-spade, being only about half the size of the usual pit. Where the growth of fern is very heavy this system cannot be recommended, as the old pits are difficult to find when replacing failures, and the trees themselves are hard to see when clearing growth among them. Where the ordinary-sized pit is used it serves to maintain a small cleared space immediately around each of the young trees, and thus makes any subsequent work amongst them easier to carry out. Owing to the roughness of the area planted during the past season, the greater portion of the trees had for a considerable distance to be packed on horseback.

A sum of £48 14s. 10d. was spent in survey-work; the boundaries of all the different blocks being accurately fixed for the preparation of the new plans.

In maintenance-work the heaviest expenditure was incurred in clearing growth amongst the trees. As the country now being planted is all heavy fern land, this work is annually increasing, and consequently a larger staff has to be employed to cope with it.

By ploughing and disc-harrowing, the fire-breaks were kept in good order; and some necessary pruning was done amongst the larch and Oregon pine. In the oldest block of blackwood (*Acacia melanoxylon*) about 20 per cent. of the trees were a fast-growing wattle, which completely outstripped the blackwood in rate of growth, and threatened to seriously damage them. This was caused by mixed seed having been supplied to us, and in seedling state the two species were so similar in appearance as to cause the mixture to go unnoticed. These trees have been planted for about six years, and the wattle ranged from 40 ft. to 60 ft. in height, so that it became necessary to cut them out in order to protect the more valuable blackwood. The thinnings were converted into firewood, of which there was nearly 100 cords, and this will be sold as opportunity affords.

Pits to the number of 698,000 are now available for the coming season, when it is expected that slightly over two million trees will be dealt with. Owing to the dry weather experienced during the summer months, the trees planted during the past season have made slightly less than the average growth, but the percentage of failures is no greater than that of previous years. The number of deaths were greatest amongst *Pinus radiata*, which were fast-grown tender plants, and planted on country at a considerable elevation where they were much exposed to the cold winds which prevailed for some time just after planting. Amongst *Eucalyptus Stuartiana*, which were planted on a similar class of land, there are also rather more failures than usual. Practically all the land suitable for this species has been planted, and any plantings of eucalyptus made in the future will be confined to very small areas. Although the growth made by the larch is very poor, very few deaths have occurred, and the same may be said of *Pinus Laricio* and *Pinus ponderosa*, but the growth made by both the latter species is better than that of the larch. Small plantings of Douglas fir and *Thuja gigantea* have both done very well, but the same cannot be said of the redwood, which, being on bare ground, were cut down by frost soon after planting. Two severe frosts in October checked the growth of the larch over a considerable part of the plantation, but the trees had quite recovered by the end of the year. Amongst the established trees no effects of the dry weather are noticeable, and the rate of growth has been quite equal to that of previous years.

A statement of the expenditure incurred during the year is attached.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
General utilization	68 17 7	68 17 7
Tree-planting	483 5 5	4,854 1 4
Pitting	708 19 7	5,280 3 4
Clearing	1,000 13 10	6,864 11 5
Cartage of trees	21 17 7	281 18 5
General upkeep of plantation	1,332 13 10	6,520 9 6
General repairs	70 0 4	649 12 5
Horse-feed	150 19 2	697 5 6
Permanent works—		
Fencing	21 7 6	1,085 14 10
Roadmaking	..	1,011 6 11
Formation	118 4 10	764 8 4
Buildings	..	1,069 3 7
Water-service	86 8 9	86 8 9
Stock, implements, &c.—Tools, implements	85 19 9	597 4 5
Supervision and clerical—		
Salaries—		
Supervision of free labour	268 0 6	1,566 18 9
,, prison labour	195 0 0	863 1 1
Nurseryman's proportion of clerical assistance	47 0 0	..
	4,659 8 8	32,261 6 2
Estimated value of prison labour (apportioned in above items)	957 0 3	5,687 15 10
Actual expenditure	£3,702 8 5	£26,573 10 4

Schedule III.—Trees Account.

	Number.
Trees received during the year	1,552,325
Less, to replace blanks	277,800
Planted on new area	1,274,525
Previously planted	8,366,111
Total number planted on 4,634 acres (average age, four years)	9,640,636

Schedule IV.—Property Account.

	£	s.	d.
Land (9,024 acres); Crown land, not charged to Forestry Account	..	..	
Buildings	900	0	0
Improvements	1,800	0	0
Fencing	950	0	0
Stores in hand	179	4	0
	£3,829	4	0

Balance-sheet.

	£	s.	d.
Total expenditure	32,261	6	2*
Less Property Account	3,829	4	0
Cost of operations	28,432	2	2
4,634 acres planted (average age, four years); cost per acre	£5	0	0
Estimated value of plantation per acre	£9	15	0

*Prison labour included.

Table showing approximately the Trees at present in Whakarewarewa Plantation (to accompany map).

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
1	53·5	Pinus Laricio	1901–2	12,900	
		„ austriaca	„	60,280	
		Sycamore	„	15,736	Mixed with pines.
	4·9	Silver birch	„	5,350	Planted pure.
		Redwood	„	4,900	Mixed with pines.
	58·4			99,166	
2	80·3	Austrian pine	1900–1	108,000	Mixed.
		Redwood	„	8,830	
		Sycamore	„	16,800	
	80·3			133,630	
3	91·7	Larch	1901–2	75,445	Planted in mixture.
		Redwood	„	8,435	
		Larch	1902–3	139,840	
		Redwood	„	12,300	
		Larch	1903–4	13,000	
		Redwood	„	483	
		Larch	1909–10	2,000	Planted pure.
	0·7	Birch	1902–3	955	„
		Oriental plane	„	950	„
	38·0	Eucalyptus	1903–4	48,350	Planted pure, mostly species *amygdalina*.
	3·5	Walnut	„	5,000	Planted pure.
	133·9			306,758	
4	71·4	Larch	1905–6	135,000	Planted in mixture.
		Douglas fir	„	52,233	
	71·4			187,233	
5	42·7	Larch	1906–7	83,400	Planted in mixture.
		Douglas fir	„	28,025	
	42·7			111,425	

Table showing approximately the Trees at present in Whakarewarewa Plantation—continued.

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
6	25·0	Blackwood	1905–6	25,500	Planted pure.
		,,	1906–7	16,800	
	8·5	Larch	,,	16,600	Planted in mixture.
		Douglas fir	,,	5,575	
	42·9	Blackwood	1907–8	72,260	Planted pure.
	167·7	Eucalyptus	1906–8	213,150	Planted pure, composed chiefly of *E. amygdalina* and *Stuartiana*.
	244·1			349,885	
7	0·2	Oriental plane	1902–3	950	Mixed with larch.
		Birch	,,	280	Planted pure.
	40·0	Eucalyptus pauciflora	,,	48,000	,,
	4·0	Larch	1903–4	10,525	,,
	6·2	Walnut	,,	8,800	,,
	2·1	Blackwood	,,	1,839	,,
	170·3	Eucalyptus Stuartiana	,,	89,402	,,
		,, amygdalina	,,	20,000	,,
		,, Stuartiana	1905–8	157,898	,,
	116·7	Norway spruce	1906–7	195,025	,,
		Tideland spruce	,,	91,175	,,
	40·0	Eucalyptus pauciflora	1908–9	60,000	,,
	0·3	Larch	1909–10	1,000	Mixed with planes.
	379·8			684,894	
8	65·7	Eucalyptus	1899–1905	106,550	Planted pure.
9	80·8	Eucalyptus	1905–6	102,700	Planted pure.
	46·0	Corsican pine	1907–8	121,532	,,
	9·0	Larch	,,	23,800	,,
	135·8			248,032	
10	6·0	Alder	1903–4	2,003	Planted pure.
		,,	1904–5	15,842	Planted on river-banks.
	170·7	Larch	1905–6	477,150	Planted pure.
	91·0	Eucalyptus	,,	115,717	,,
	11·0	Larch	1906–7	30,000	,,
	54·7	Pinus taeda	,,	1,100	,,
		,, Thunbergii	,,	700	,,
		,, Sabiniana	,,	25	,,
		,, muricata	,,	850	,,
		Corsican pine	1907–8	144,517	,,
		Red cedar	,,	670	,,
	1·2	Lombardy poplar	1908–9	600	,,
	334·6			789,174	
11	51·0	Larch	1905–6	134,000	Planted pure.
12	2·0	Alder	1903–4	5,948	Planted pure, on river-banks.
	3·7	Pinus Torreyana	1905–6	1,320	Planted pure.
		,, muricata	,,	3,770	,,
	184·3	Eucalyptus	,,	234,250	,,
	2·0	Pinus densiflora	1906–7	2,325	,,
		,, muricata	,,	850	,,
	125·8	Larch	1908–9	305,700	Planted in mixture.
		Redwood	,,	24,000	,,
		Liquidambar styraciflua	1910–11	400	Experimental.
	317·8			578,563	
13	0·7	Pinus muricata	1906–7	850	Planted for shelter.
	175·0	Larch	,,	476,500	Planted pure.
	0·8	Alder	1910–11	2,200	Planted on river-banks.
	176·5			479,550	
14	469·5	Larch	1906–7	323,500	Planted pure.
		,,	1907–8	765,800	Partly pure.
		Douglas fir	,,	36,250	Mixed with larch.
		Redwood	,,	11,850	,,
	469·5			1,137,400	
15	9·0	Blackwood	1908–9	6,775	Planted pure.
	396·7	Eucalyptus	1908–10	504,250	Planted pure, *Stuartiana* species.
	405·7			511,025	
16	55·6	Corsican pine	1907–8	146,895	Planted pure.
	465·8	Larch	1908–9	565,125	,,
		,,	1909–10	579,000	,,
	521·4			1,291,020	

Table showing approximately the Trees at present in Whakarewarewa Plantation—continued.

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
		Corsican pine	1907–8 ..	187,756	Planted pure.
		,, ...	1908–9 ..	150,925	Planted pure, and partly in mixture with heavy pine.
17	315·3	Heavy pine	,, ..	289,375	
		Bentham's pine ..	,, ..	19,600	Planted pure.
		Murray's pine	,, ..	10,225	,,
		Austrian pine	,, ..	115,375	,,
		Corsican pine	1909–10 ..	15,000	,,
	38·2	Larch	,, ..	88,524	,,
	353·5			876,780	
	142·4	Larch	1909–10 ..	331,476	Planted pure.
	2·3	Douglas fir	,, ..	6,100	,,
		Larch	1910–11 ..	392,738	Mostly pure.
	151·8	Douglas fir	,, ..	20,575	Mixed with larch, alternate rows; experimental.
18		Cedar	,, ..	2,850	Ditto.
		Remarkable pine ..	,, ..	147,800	Pure, in rough country with heavy bracken; uneven distance.
	228·0	Corsican pine	,, ..	73,000	Planted pure.
		Heavy pine	,, ..	216,275	,,
	201·8	Eucalyptus	,, ..	285,875	Planted pure, species *Stuartiana*.
	726·3			1,476,689	
19	46·0	Larch	1910–11 ..	117,212	Planted pure.
		Redwood	1909–10 ..	5,575	Pure, planted around banks of lake.
20	20·0	,, ...	1910–11 ..	14,300	,, ,,
		Liquidambar styraciflua ..	,, ..	1,300	Pure, planted experimentally.
	20·0			21,175	

Summary showing Area of Whakarewarewa Plantation (4,634 acres in trees).

How occupied.	Acres.
Larch	2,074·8
Pine	859·8
Blackwood	79·0
Eucalypti	1,476·3
Walnut	9·7
Spruce, picea, Pseudo-tsuga	119·0
Birch	5·8
Alder	8·8
Poplar	1·2
Roads, tracks, and fire-breaks	387·5
Swamps and creeks	242·0
Unplanted land	3,553·2
Land suitable for planting	109·2
Horse-paddocks	98·5
Residence reserves	
Rotorua water-pipe reserve, &c.	
Total	9,024·8

Summary of Trees planted.

How used.	Number.
Numbers on plantation at present day—	
Contents of numbered blocks	9,640,161
Ornamental and shelter trees at prison camps	475
Total trees now living	9,640,636
Numbers planted to replace failures, &c.—	
Experimental trees not suited to district	266,305
Used to replace deaths	1,628,803
	11,535,744
Less trees raised from seeds sown *in situ*	109,725
Trees received from nursery	11,426,019

Summary of Trees growing on Numbered Blocks on Whakarewarewa Plantation.

Larch	5,087,335
Pines	1,831,245
Blackwood	123,174
Eucalypti	1,986,142
Walnut	13,800
Douglas fir	148,758
Birch	6,585
Alder	25,993
Poplar	600
Redwood	90,673
Sycamore	32,536
Oriental plane	1,900
Norway spruce	195,025
Tide-land spruce	91,175
Red cedar	670
Sweet gum	1,700
White cedar	2,850
	9,640,161

D. J. Buchanan,
Plantation Foreman.

Waiotapu Plantation.

(Area, 7,695 acres; approximate altitude, 1,200 ft.)

Trees to the number of 2,749,200 were received from Rotorua Nursery during the year, and of this number, 2,470,850 were planted on a new area, while the balance—278,350—were used to replace deaths in former years' planting. The trees were planted partly by free and partly by prison labour. Prisoners planted 2,146,325 on new area, and 102,250 to replace failures; while the free labour planted 324,525 on new area, and 176,100 to replace failures. Since work commenced at this plantation, 16,153,740 trees have been planted; 14,309,451 were used in planting new area, and the balance—1,790,690—represents those required from time to time to replace failures. An estimate of the actual number of trees now in the plantation is 13,926,254, and the area planted 5,423½ acres, details of which are contained in the schedules and summaries appended hereto. The results amongst the trees planted during the year are most satisfactory. Corsican pine, which composed the greatest part of the trees planted, have done especially well. With the larch the usual good results were obtained. Heavy pine has not succeeded as well as usual, owing to the planting being delayed well into the dormant season. This pine we have come to regard as the hardiest one we plant, so that the poor results can safely be attributed to the planting being done in mid-winter. All pines should be planted before the ground becomes too cold; but it is sometimes impossible to do this, as there are usually a large number of trees to be handled, and the number of prisoners varies considerably. Most of the deaths replaced were in the previous year's planting of Corsican pine. The deaths in the larch were hardly appreciable, and even if deaths are replaced in these, they never catch up to the former year's planting, and are very liable to be destroyed by rabbits and hares, which are attracted by the newly disturbed soil.

The older portions of the plantation continue to make good progress, the principal labour expended on them being the maintenance of the fire-breaks and keeping the bracken-growth down where the trees are likely to be damaged by such growth. Where the trees are large and with interlacing branches, the fire-breaks are being sown down with grass and clovers. The parts treated last year in this manner have done fairly well. Hurdles were erected across them in several places, and sheep belonging to the Prisons Department kept the grass grazed, thus keeping down any growth that was likely to carry fire. So far, there is not a very large portion of the fire-breaks that can be treated in this manner, as many of the blocks of trees are still open enough to permit sheep to get in amongst them, and the only way in which a fireproof break can be maintained is by cultivating. During the year new fire-breaks formed amounted to 80 acres, being principally on the fence-boundaries adjoining public roads, and bracken- and fern-covered country owned either by the Natives or the Crown. This completes the fire-breaks, so far as the present enclosure is concerned, and the maintenance of these will entail a considerable amount of labour for about four years, or until such time as they can safely be sown down in grass and grazed.

Prison Labour.—The employment of prisoners continues to give satisfaction, the only fault being that we cannot get enough of them. To the officers of the Prisons Department much credit is due for the able manner in which they have assisted in carrying out the various works. Mr. Roberts, the Gaoler, who was in charge here for over three years, was transferred to Wellington Prison last June. During his service here he rendered great assistance to this Department by the cordial manner in which he co-operated with us for the common good of the Government at Waiotapu.

The value of the work done by the prisoners during the year was £2,390 7s. 1d., which averages £101 18s. 7d. for each of the 23·45 men employed.

A road is at present being formed through the land to be planted this year, and, when finished, every part of the plantation-area will be easily accessible with a buggy from the prison camp. For the coming planting season the prisoners have dug slightly over two million pits. There will be no difficulty in planting these, and if the numbers of prisoners were increased to the full capacity of the camp, four million trees could be planted, as the work is within easy walking-distance of the camp. This latter number would complete the present enclosure. Rabbits and hares have increased at a rapid rate in this district, owing perhaps to the shelter afforded by the growing trees, and it has been necessary to

keep up a constant war with them, in order to prevent damage being done to the young trees. At this work a prisoner has been almost constantly employed, and with traps, poison, and dogs something like two hundred rabbits a month have been destroyed. These pests take a heavy toll of the trees when newly planted; but when once the trees become established, and the bracken and other weeds spring into growth again, they keep more to the open fire-breaks, where they find sufficient feed without molesting the trees. One of the buildings at the old camp-site was thoroughly renovated and a room added by a carpenter prisoner, for the use of the plantation foreman.

The foot-bridge across the Waiotapu Stream was strengthened in order to permit of light buggies and motor-cars being taken over it. The bulk of the material for this work was obtained in the bush reserve near Galatea, and the work was done by a prisoner.

Free Labour.—The total area of the plantation enclosures is 7,695 acres, while the distance round the outside boundary is something like fifteen miles. Such an extent of country could not be profitably worked from the prison camp, and for this reason free labour has been employed. During the year the average number of free men employed daily was 10·38, and their work was mostly situated at the remote parts of the block some miles from the prison camp. In addition to the general upkeep of the plantation, the free men planted 324,525 trees on new area, and replaced failures in last year's planting to the number of 176,100. There were 855,025 pits dug, at an average cost of 5s. 9d. per thousand. Some years ago the Government decided to offer employment on this plantation to discharged prisoners who, when serving their sentences, had conducted themselves in an exemplary manner, and so far there is no reason for regretting the decision. Many of the men employed have given entire satisfaction in every respect; they all thoroughly understand the work; and that the employment is acceptable is evidenced by the number of applications for work received from prisoners whose sentences have nearly expired.

Extension of Plantations.—It is proposed to shift the prison camp to a site some thirteen miles distant from the present camp, where a block of 30,000 acres has been reserved for afforestation purposes. Preparations for this work have been in hand for some months; and as one of the first considerations is an adequate supply of water, this matter was the first one dealt with. Last winter a bore was put down, which has proved successful, and it has now been decided to dam a small stream in a gully half a mile distant, and lift the water by means of an oil-engine and a pump. Fifty acres of land have been ploughed, and will be enclosed shortly, the fencing-posts being obtained in a bush about four miles distant. The prison camp will be placed inside one of the small experimental plantations, where excellent shelter will be obtained from the prevailing winds. It is probable that the camp will be shifted between October and December next.

The expenditure for the year amounted to £1,818 15s. 2d.; details of which are attached hereto.

The following is a record of the temperature and rainfall for the year :—

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature. Maximum.	Temperature. Minimum.	Number of Days Frosts occurred.
1910.	Inches.		Degrees.	Degrees.	
April	1·40	2	72	25	6
May	4·30	13	67	24	8
June	4·83	16	66	23	14
July	5·54	19	64	19	10
August	3·98	12	64	21	11
September	1·35	11	70	26	7
October	2·37	11	76	22	4
November	3·07	9	82	30	1
December	1·66	9	80	30	1
1911.					
January	0·80	3	84	31	1
February	1·83	7	84	32	..
March	0·42	4	79	34	..
Totals	31·55	116	..	..	63

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	993 19 3	6,251 19 9
Pitting	835 6 0	6,636 13 1
Clearing	394 7 3	5,966 0 0
Cartage of trees	56 10 3	529 17 5
General upkeep of plantation	710 2 10	4,158 15 0
General repairs	148 3 4	285 1 0
Horse-feed	179 16 4	676 16 6
Carried forward	£3,318 5 3	£24,505 2 9

Schedule II.—Statement of Expenditure—continued.

	For Year. £ 2. d.	To Date. £ 6. d.
Brought forward	3,318 5 3	24,505 2 9
Permanent works—		
Fencing	70 19 3	2,093 16 1
Roadmaking	5 19 0	491 19 10
Formation	220 17 4	915 1 4
Buildings	86 9 4	1,246 4 11
Stock, Implements, &c.—Tools, implements ..	34 12 1	733 19 7
Supervision and clerical—		
Salaries—		
Supervision of free labour	185 0 0	
Supervision of prison labour ..	240 0 0	3,114 3 0
Nurseryman's proportion of clerical assistance	47 0 0	
	4,209 2 3	33,100 7 6
Estimated value of prison labour (apportioned in above items)	2,390 7 1	22,315 15 9
Actual expenditure	£1,818 15 2	£10,784 11 9

Schedule III.—Trees Account.

	Number.
Trees received during year	2,749,200
Less, to replace blanks	278,350
Planted on new area	2,470,850
Previously planted	11,455,404
Total number planted on 5,423½ acres	13,926,254

Schedule IV.—Property Account.

	£ s. d.
Land (7,695 acres); Crown land, not charged to Forestry Account ..	..
Buildings	1,000 0 0
Stock	..
Improvements	1,300 0 0
Fencing	1,900 0 0
Stores in hand	456 16 8
	£4,656 16 8

Balance-sheet.

	£ s. d.
Total expenditure	33,100 7 6*
Less Property Account	4,656 16 8
Cost of operations	£28,443 10 10
5,423½ acres planted (average age, four years); cost per acre ..	£4 15 6
Estimated value of plantation per acre	£9 10 0

* Prison labour included.

Table showing approximately the Trees at present in Waiotapu Plantation (to accompany map).

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
1	126·85	Larch	1906–7 ..	88,425	Planted pure.
		Weymouth pine ..	,, ..	22,900	,,
		Austrian pine	,, ..	238,950	,,
				350,275	
2	138·90	Austrian pine	1905–6 ..	30,300	Planted in mixture.
		Heavy pine	,, ..	7,050	,,
		Weymouth pine ..	,, ..	37,450	Planted pure.
		Larch	1906–7 ..	154,575	,,
		Twisted pine	1907–8 ..	3,000	Mixed with Corsican pine.
		Blue-pine	,, ..	200	Planted pure.
		Sugar-pine	,, ..	75	,,
		Lodgepole pine ..	,, ..	4,100	,,
		Pitch-pine	,, ..	6,200	,,
		American red-pine ..	,, ..	2,100	,,
		Austrian pine	,, ..	97,200	,,
		Corsican pine	1908–9 ..	5,000	,,
		Austrian pine	1909–10 ..	2,000	,,
				349,250	

Table showing approximately the Trees at present in Waiotapu Plantation—continued.

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
		Austrian pine	1900–1 ..	12,000	Mixed.
		Bentham's pine ..	,, ..	3,400	
		Corsican pine	1902–3 ..	27,450	
		Heavy pine	,, ..	13,804	,,
		Austrian pine	,, ..	13,556	
3	143·3	Birch	1903–4 ..	5,000	Pure; shelter-belts.
		Larch	,, ..	37,800	Pure.
		,, ...	1904–5 ..	32,000	
		Austrian pine	1906–7 ..	81,000	,,
		Corsican pine	1910–11 ..	25,000	,,
				251,010	
		Birch	1901–2 ..	20,100	Pure; shelter-belts.
		Austrian pine	1902–3 ..	156,587	Mixed.
		Heavy pine	,, ..	41,721	
		Weymouth pine ..	,, ..	9,400	Mixed with Austrian pine.
		Douglas fir	1903–4 ..	18,480	,, Corsican pine.
		Birch	,, ..	6,525	Pure.
		Bentham's pine ..	,, ..	6,900	
		Austrian pine	,, ..	135,457	Mixed.
		Heavy pine	,, ..	52,675	
		Larch	,, ..	11,150	Pure.
		Corsican pine	1904–5 ..	5,750	,,
		Austrian pine	,, ..	76,250	Mixed with Weymouth and Bentham pines.
4	300·0	Heavy pine	,, ..	77,275	Partly mixed with Corsican pine.
		Birch	,, ..	775	Pure.
		Bentham's pine ..	,, ..	15,100	Mixed with Austrian pine.
		Weymouth pine ..	,, ..	12,775	Pure.
		Pitch-pine	,, ..	6,000	,,
		Bentham's pine ..	1905–6 ..	18,825	Mixed.
		Austrian pine	,, ..	16,000	
		Corsican pine	,, ..	20,000	Mixed with Douglas fir.
		,, ...	1906–7 ..	4,000	Mixed with heavy pine.
		Weymouth pine ..	1907–8 ..	8,750	Mixed.
		Austrian pine	,, ..	31,500	
		,, ...	1909–10 ..	14,325	Pure.
		Heavy pine	,, ..	7,650	,,
		Corsican pine	1910–11 ..	5,000	,,
				778,970	
		Eucalyptus	1902–6 ..	60,000	Mixed with larch.
		Douglas fir	1902–3 ..	11,712	,, Corsican pine.
		Birch	,, ..	880	Pure; shelter-belts.
		Douglas fir	1903–4 ..	9,520	Mixed.
		Corsican pine	,, ..	52,650	
		Heavy pine	1904–5 ..	3,000	Mixed.
5	233·75	Austrian pine	,, ..	30,000	
		Larch	,, ..	37,980	Pure.
		Coulter's pine	,, ..	175	,,
		Corsican pine	1905–6 ..	7,000	,,
		,, ...	1906–7 ..	500	,,
		Larch	1907–8 ..	107,000	Mixed with eucalypti.
		,, ...	1909–10 ..	17,625	Pure.
		Corsican pine	1910–11 ..	10,725	,,
				348,767	
		Corsican pine	1901–2 ..	4,425	Pure.
		Bentham's pine ..	,, ..	2,500	,,
		Remarkable pine ..	1903–4 ..	2,425	Pure; shelter-belt.
		Larch	1904–5 ..	74,925	Pure.
6	496·9	,, ...	1905–6 ..	721,125	,,
		,, ...	1906–7 ..	511,000	,,
		,, ...	1909–10 ..	5,000	,,
		Corsican pine	,, ..	15,775	,,
				1,337,175	
		Remarkable pine ..	1903–4 ..	1,775	Pure; shelter-belt.
		Blackwood	,, ..	1,256	Pure.
		Remarkable pine ..	1904–5 ..	69,000	,,
		Bishop's pine	,, ..	43,800	,,
7	163·75	Eucalypti	,, ..	12,000	Mixed with larch.
		Sugar-pine	1906–7 ..	1,250	Pure.
		Austrian pine	,, ..	19,050	,,
		Corsican pine	1907–8 ..	180,000	,,
		Larch	,, ..	50,930	Mixed with eucalypti.
				379,061	

Table showing approximately the Trees at present in Waiotapu Plantation—continued.

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
8	282·3	White cedar	1906–7 ..	13,500	Pure.
		Bentham's pine ..	,, ..	13,225	,,
		Heavy pine	,, ..	43,850	,,
		Corsican pine	,, ..	162,300	,,
		Jeffrey pine	,, ..	3,675	,,
		Corsican pine	1907–8 ..	260,000	,,
		Heavy pine	,, ..	178,275	,,
		White cedar	,, ..	400	,,
				675,225	
9	305·75	Larch	1906–7 ..	74,925	Pure.
		Bentham's pine ..	1907–8 ..	55,825	,,
		Larch	,, ..	686,000	,,
		Corsican pine	1910–11 ..	10,000	,,
				826,750	
10	213·0	Larch	1907–8 ..	475,000	Pure.
		,, ...	1909–10 ..	47,925	,,
		,, ...	1910–11 ..	62,100	,,
				585,025	
11	375·0	Austrian pine	1906–7 ..	38,900	Pure.
		Larch	1907–8 ..	193,020	,,
		Austrian pine	,, ..	91,900	,,
		Corsican pine	,, ..	181,685	,,
		Larch	1908–9 ..	64,700	,,
		Corsican pine	,, ..	60,000	,,
		Heavy pine	1909–10 ..	18,375	,,
		Larch	,, ..	353,225	,,
		Corsican pine	1910–11 ..	20,000	,,
				1,021,805	
12	135·0	Larch	1907–8 ..	121,000	Pure.
		,, ...	1909–10 ..	25,225	,,
		,, ...	1910–11 ..	216,700	,,
		Corsican pine	,, ..	22,000	,,
				384,925	
13	375·75	Weymouth pine ..	1908–9 ..	2,800	Pure.
		Heavy pine	,, ..	42,000	Mixed.
		Corsican pine	,, ..	130,600	Mixed.
		Larch	,, ..	535,930	Pure.
		,, ...	1909–10 ..	254,340	,,
				965,670	
14	388·5	Larch	1908–9 ..	12,000	Pure.
		,, ...	1909–10 ..	507,440	,,
		Bentham's pine ..	,, ..	59,500	Mixed.
		Corsican pine	,, ..	99,480	Mixed.
		Larch	1910–11 ..	270,075	Pure.
				948,495	
15	525·0	Larch	1909–10 ..	1,155,920	Mixed.
		Douglas fir	,, ..	50,000	Mixed.
		Corsican pine	,, ..	206,345	Mixed.
		Weymouth pine ..	,, ..	36,975	Mixed.
				1,449,240	
16	394·25	Heavy pine	1908–9 ..	36,525	Mixed.
		Bentham's pine ..	,, ..	63,000	Mixed.
		Corsican pine	,, ..	241,850	Mixed.
		Larch	,, ..	520,900	Pure.
		Corsican pine	1909–10 ..	66,375	,,
		Larch	1910–11 ..	67,950	,,
				996,600	
17	145·25	Birch	1908–9 ..	5,950	Pure; shelter-belts.
		Larch	,, ..	244,900	Pure.
		,, ...	1910–11 ..	47,600	,,
		Weymouth pine ..	..	2,300	,,
		Corsican pine	..	128,100	,,
				428,850	

Table showing approximately the Trees at present in Waiotapu Plantation—continued.

Block Number.	Area planted.	Name of Tree.	Year of Planting.	Number of Trees planted.	Remarks.
	Acres.				
18	66·0	Weymouth pine	1908–9	16,950	Mixed.
		Corsican pine	,,	101,050	
		Heavy pine	,,	2,000	
		Larch		51,070	Pure.
				171,070	
19	417·75	Corsican pine	1910–11	1,134,200	Pure.
20	196·5	Heavy pine	1910–11	323,000	Pure.
		Larch	,,	173,100	,,
	196·5*B*			496,100	

Summary of Trees planted.

How used.	Numbers.
Numbers on plantation at present day—	
Contents of numbered blocks	13,878,463
On fire-breaks	11,367
Ornamental and shelter trees at prison camp	34,936
Experimental trees	1,488
Total trees now living	13,926,254
Numbers planted to replace failures, &c.—	
Leguminous plants used as bait for rabbits and hares	1,425
Ornamental trees destroyed by rabbits and hares	16,000
Experimental trees not suited for district	757,214
Used to replace deaths	1,535,968
	16,236,861
Less trees raised from seed *in situ*	83,121
Trees received from nursery	16,153,740

Summary showing Area of Plantation (5,423·50 acres in trees).

How occupied.	Acres.
Larch	2,967·95
Pine	2,269·10
Eucalypti	180·50
Birch	5·95
Roads, tracks, and fire-breaks	312·25
Land unsuitable for planting, including swamps, creeks, horse-paddocks, and residence reserves	282·55
Unplanted land	1,676·70
	7,695·00

Summary of Trees growing on Numbered Blocks on Waiotapu Plantation.

Larch	8,010,580
Pines	5,651,785
Blackwood	1,256
Eucalypti	72,000
Douglas fir	89,712
Birch	39,230
White cedar	13,900
	13,878,463

R. McRae,
Plantation Foreman.

Ruatangata Nursery.

As foreshadowed in last annual report, operations at this station ceased on the 30th September, 1910. The horses and tools, to the value of £157 6s. 9d., were sold, and the balance of the tools were transferred to the Rotorua district, for use at the several stations.

Pitting with Spade, Grubber, and Hole-borer for Tree-planting.

Pure Larch Plantation, Conical Hills.

Face page 50.

PLANTING LARCH ON TUSSOCKY PLAIN, HANMER PLANTATIONS.

OPERATIONS IN HANMER NURSERY.

During the six months of the year previous to closing, trees to the number of 323,900 were sent out from the nursery; 319,950 of these were transferred to Puhipuhi Plantation, and the balance (3,950 totara) were supplied gratis to farmers and others. The total output of trees from the nursery from its inception to 1911 was 2,187,732, and the total number raised 2,667,868, thus showing a difference of 480,136. This discrepancy was caused by overestimating the stock for several years, and by the deaths of puriri and other trees unsuitable for the locality, as follows: Overestimation of stock and deaths of trees unsuitable for the locality, 394,036; deaths of puriri, 60,000; and 26,100 unsaleable or destroyed trees which were in the nursery when it was closed. The number of deaths in trees unsuitable for this locality may seem to be unduly large, but it must be remembered that this nursery was specially set aside for experimenting with Australian hardwoods, and therefore a large number of failures was only to be expected before the most suitable species to grow could be determined.

For the six months of 1910 ended 30th September the expenditure amounted to £260 14s. 9d., £19 7s. 1d. of this amount being expended in grass-seed for sowing down 22 acres of the nursery prior to closing. This was done with the object of keeping down the growth of weeds and gorse which was likely to follow if the land was left vacant.

The average number of men employed during the six months was 2·36.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Tree-planting and maintenance—		
Tree-growing	75 4 3	3,309 11 7
General maintenance and repairs	96 15 2	845 4 7
Tree-seeds	..	226 1 0
Manures	14 6 0	78 11 1
Horse-feed, purchased and grown	51 4 9	743 0 4
Miscellaneous works	3 17 6	150 17 10
Stock and material—Tools, implements	..	411 15 2
Permanent works—		
Buildings	..	637 7 8
Nursery-formation	19 7 1	1,173 4 2
Fencing	..	85 1 11
Water-supply	..	76 17 6
Seed-frames	..	173 12 9
Supervision and clerical—		
Proportion of Superintending Nurseryman's salary	25 0 0	732 6 0
Proportion of Nurseryman's salary	85 0 0	
Clerical assistance	20 16 8	64 16 8
	£391 11 5	£8,708 8 3

H. A. Goudie,
Superintending Nurseryman.

Puhipuhi Plantation.

(Approximate area, 1,200 acres; altitude, 1,000 ft.)

Owing to the closing-down of the Ruatangata Nursery on the 30th September, 1910, trees to the number of 319,950 only were received from the nursery, and these were all used in replacing failures in the previous years' plantings. Since work commenced at this plantation, 1,933,313 trees have been planted on a new area. This plantation was supplied with trees from the Ruatangata Nursery, and like that station, a very large amount of experimental planting was done. Species tried were: totara, Hall's totara, white-pine, puriri, hardy catalpa, American ash, Californian redwood, black walnut, hickory, red cedar, tideland spruce, Douglas fir, Tasmanian blackwood, and twelve species of eucalypti. Of the coniferous trees, the only one that has succeeded is *Pinus muricata*. Very few of the eucalypti were suitable, and all have died with the exception of *Eucalyptus Stuartiana*, *E. rostrata*, and *E. resinifera*. The best portions of the plantation have been reserved, and this amounts to about 1,200 acres. It is difficult, owing to the number of failures, to arrive at an estimate of the number of trees actually on the plantation, but this can safely be put down at 1,000,000, composed principally of the three above-mentioned species of eucalypti.

Since the 1st October two men only have been employed to keep the fire-breaks in order, clear the growth amongst the trees, &c., and their time has been fully occupied up to the present time in attending to these works. As the fire-breaks are now all in thorough order, it has been decided to get a settler close at hand to act as caretaker of the plantation.

Unfortunately, in February last a fire occurred in the plantation, and before it was extinguished 23 acres of eucalypti and 6 acres of totara were burnt over. The totara were totally destroyed, but by cutting the eucalypti off level with the ground a large number of them will throw up young shoots and thus form new trees. The roots of these trees have not been very badly damaged, and it is hoped by this means to lessen the extent of the damage considerably. Up to the present it has not been ascertained whether the fire was the result of an accident or wilfully caused.

The following is a record of the rainfall and temperature for the year :—

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature. Maximum.	Temperature. Minimum.	Number of Days Frosts occurred.
1910.	Inches.		Degrees.	Degrees.	
April	1·66	15	65	42	..
May	13·38	20	62	38	..
June	9·99	21	64	35	..
July	13·03	25	60	40	..
August	8·55	18	64	36	..
September	4·55	11	64	40	..
October	7·97	18	66	44	..
November	8·28	17	79	44	..
December	7·04	9	83	44	..
1911.					
January	3·35	11	87	46	..
February	7·82	11	81	48	..
March	2·90	18	78	48	..
Totals	88·52	194	..	..	..

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	26 16 11	1,106 1 11
Pitting	54 3 0	1,552 14 0
Clearing	77 4 0	963 17 0
Cartage of trees	10 12 10	179 13 3
General upkeep of plantation	642 7 1	2,997 13 0
General repairs	5 10 3	138 11 7
Horse-feed	3 18 3	33 16 3
Permanent works—		
Fencing	26 9 8	471 0 3
Purchase of land	..	10 4 3
Formation	..	36 13 0
Buildings	..	355 4 9
Stock, implements, &c.—Tools, implements ..	..	322 1 7
Supervision and clerical—		
Salaries—		
Supervision of free labour	85 0 0	
,, prison labour	..	932 9 7
Nurseryman's proportion of clerical assistance	46 0 0	
	£978 2 0	£9,100 0 5

Schedule III.—Trees Account.

	Number.
Trees received during year	319,950
Less, to replace blanks	319,950
Planted on new area	Nil.
Previously planted	1,000,000
Total number planted on 1,200 acres (average age, two years) ..	1,000,000

Schedule IV.—Property Account.

	£ s. d.
Land (1,200 acres); Crown land, not charged to Forestry Account ..	..
Buildings	300 0 0
Stock	Nil.
Improvements	32 0 0
Fencing	450 0 0
Stores in hand	73 6 11
	£855 6 11

Balance-sheet.

	£	s.	d.
Total expenditure	9,100	0	5
Less Property Account	855	6	11
Cost of operations	8,244	13	6
1,200 acres planted (average age, two years)	£4	10	3
Estimated value of plantation per acre	£8	12	0

H. A. GOUDIE,
Superintending Nurseryman.

APPENDIX B.

REPORT ON TREE-GROWING OPERATIONS IN SOUTH ISLAND.

[By the Superintending Nurseryman, Tapanui.]

CLIMATIC INFLUENCES.

In reviewing operations conducted over the South Island section during the past twelve months special notice might be directed upon the most trying conditions under which the work had to be performed. Each officer makes forcible references to the prevalence of a partial drought experienced during the spring months—a period when a moderate amount of moisture is essential to successful seed-germination and tree-planting results. The position, however, was somewhat improved with the advent of summer, and it is interesting to note that the average precipitation of 4·55 in. of rain registered in December had a most reviving effect upon semi-dormant trees on both nurseries and plantations.

A perusal of the detailed reports will disclose the attainment, generally, of a very reasonable measure of success, although it is fortunate that each tree-raising station was well stocked with seedlings, otherwise the increased number of deaths, through failures in transplanting and intensified ravages of the grass-grubs, would have taxed our resources to such an extent as to seriously interfere with the ensuing year's output. The importance of possessing a few hundred thousand young trees in excess of immediate requirements is thus impressed upon one, and further facilities will accordingly be given officers in future in creating a more liberal margin between the desired year's output and trees available by lightly supplementing the seed-supply.

OUTPUT OF TREES AND ACREAGE PLANTED.

The number of trees transferred to nurseries and plantations, domains, and other public institutions is 3,121,570, being a considerably increased output on any previous season. Of this number, 2,966,810 were utilized in extending the State forests, where active preparations are now being made for the reception of an approximate three million trees during the coming planting period.

With each succeeding year the requests for distribution of trees to public bodies become more numerous, but as the adherence to a systematic planting scheme arranged well in advance of the transporting season is necessary, it is not possible to comply with these outside needs without affecting the afforestation operations generally; and, moreover, the Department has, up to the present, adopted the prudent attitude of only supplying trees to domains, &c., after plantation requirements have been fulfilled.

The year's planting was carried on over 1,025¾ acres, which has increased the total area planted to 4,637¾ acres, containing 12,732,915 trees (as per table submitted in an accompanying special report). Due allowances have been conceded for the deaths resulting from the deplorable fire experienced at the abandoned Dumgree Plantation some months ago.

Comprehensive summaries of all works undertaken have been compiled, and under the plantation statements various concentrated items of interest hitherto omitted are displayed. It will be noticed that since the initiation of the work no less than 2,512,115 trees have either been destroyed by the agency of fire or failed to succeed where planted, thus necessitating the replanting of blanks with a more suitable variety. The fact of much experimental work being conducted, and consequent high death-rate, must not be overlooked. Moreover, by a critical observance annually of the conditions under which the various trees may be associated and grown advantageously, it is only rationable to believe that, given normal climatic conditions, this high death-rate will be speedily lessened.

TREES RAISED AND EXPENDITURE INCURRED.

Some 5,634,795 seedlings were raised during the year, at an average cost of 2s. 4½d. per thousand. At Hanmer Springs and Tapanui Nurseries a corresponding rate (1s. 6d.) in tree-raising is recorded, and the increased cost at Ranfurly can only be attributed to the small quantity of seeds dealt with, together with the undesirable presence in seed-beds of the small thread-like worms alluded to elsewhere. In comparing the rates at which any item of labour is carried out, it may be pointed out that the greater the magnitude of the undertaking the more favourable should be the results disclosed; hence we cannot reasonably expect the smaller station at Ranfurly, with its almost similar upkeep-cost, to furnish such comparable records as those obtainable from larger nurseries.

The three nurseries now contain 12,823,010 trees, of ages ranging from one to four years, representing a value (as per schedule), of £20,636 17s. 1d., and from this number will be drawn the coming winter's anticipated output of slightly over three million trees.

An expenditure of £3,964 15s. 11d. was incurred in the combined nurseries, which, with the inclusion of amounts recorded against the abandoned Starborough and Kurow Stations, increases the total expenditure to date to £53,280 6s. 10d. On the plantations £7,067 17s. 7d. was expended during the year, inclusive of prison labour, and the total amount to date apportioned to areas in the South Island where afforestation has been carried on, reaches £60,794 18s. 9d.

Brief References to Tree-growth.

Although each officer has detailed at some length the individual progress of trees connected with his station, it may not be out of place to again allude to the subject from a general point of view. By reason of its fast-growing capabilities and recognized timber-value *Larix europaea* has generally been looked upon as being, perhaps, the most meritorious tree for extensive planting; but recent developments must surely shake the confidence of those holding this opinion. The dryness of the past two seasons has prominently brought to light the extreme sensitiveness of our European larch to drought, whilst, on the other hand, such pines as *Pinus Laricio*, *P. ponderosa*, and *P. austriaca* have exhibited their customary vigour, and adapted themselves to the temporary altered conditions without an apparent cessation of progress.

At Dusky Hill Plantation symptoms of the leaf-shedding fungus *Sphroella laricina* were at one time prominent; but towards the latter part of the summer bounteous rainfalls had the desired effect of freshening up the whole plantation to such an extent that no traces of any disease are now apparent; and this opinion is shared by Mr. A. H. Cockayne, Biologist to the Agricultural Department, who visited the plantation recently, but did not detect larch-disease in any form.

The question of curtailing to some extent the output of larch, and replacing the deficiency thus created with pines, is worthy of earnest consideration.

Revision of Records and Subdivisional Plans.

Much clerical work has been devoted to the rearrangement of statements for displaying annual records in a comprehensive form.

Every effort has been directed towards tabulating all items of expenditure for rapid comparison, and in framing the table relating to trees growing on plantations it has been quite impossible to adhere to the preceding returns.

The presentation of subdivisional working-plans was also aimed at, but as circumstances did not permit of their completion in time, the whole matter will be omitted here, and given special consideration in the subsequent annual reports.

Correspondence Class on Forestry.

The idea outlined in last report of instituting a correspondence class with an associated library for the benefit of officers of the Department was successfully launched, and much enthusiasm has been shown throughout the term by those connected. A syllabus embracing all practical subjects was drafted, and each officer prepared and submitted his monthly composition. In transmitting replies, a review of each officer's paper preceded my own remarks and instructions, and in this way the blending of practical knowledge with the advanced literary efforts of the most modern continental writers had a decidedly beneficial effect upon the staff generally. The volume of work (some 400 pages of writing) inseparable from the undertaking was rather in excess of expectations, and had to be attended to during the evenings. To incite further interest, the Hon. the Minister of Lands offered a prize of two guineas for competition for the best paper, which, after an exceedingly close contest, was won by Mr. W. T. Morrison. For sustained excellence throughout the term a trophy donated by myself was awarded to Mr. W. T. Morrison.

The library on forestry literature has been brought up to a very high standard, and officers are now able, on application, to secure any of the works of recognized writers on the various branches of sylviculture.

Fire-breaks.

Provision against the spread of fire as at present being adopted is perhaps one of our most costly recurring items of labour, and during the past year much deliberation has been applied in formulating a practical, economical, and effective scheme to supersede the present cultivation-work. Some thirty-six miles of fire-barriers, averaging an approximate 50 ft. in width, were ploughed, cultivated, disced, and harrowed last year. This horse-work necessitated an outlay of £115 10s., besides greatly depreciating (through the rough nature of the ground) the value of the implements used. Probably the most judicious means of decreasing the maintenance-cost without impairing the efficiency of the fire-lines would be to erect cheap sheep-proof fences along each side of the main fire-breaks, and after sowing down in grass, keep the area well stocked with sheep during the spring and summer periods. It is just possible, however, that these grassed barriers would eventually become overgrown with tussocks and other undesirable vegetation from seed maturing in the immediate vicinity; but this knowledge can only be gained by experimenting.

At Dusky Hill and Conical Hills Plantations fires are most likely to originate from the fringing Pomahaka Reserve, and there is no doubt that an immense amount of benefit would be derived from the presence of any stock there, provided the animals were not permitted to wander over the planted areas.

Free and Prison Labour.

The amount of free labour absorbed by the nursery and plantation work was 69·5 men, which is somewhat in excess of former years. This was not unforseen, as the numerical strength of the prison camp became unavoidably curtailed through more urgent work requiring to be attended to elsewhere. After due allowance for domestic and other camp duties, 7·31 prisoners have been available for plantation-labour, and the annual value of their work is computed at £56 14s. 2d. per man.

It cannot be claimed that the ground being operated upon at Hanmer Springs is eminently suitable for the utilization of prison labour, as the gravelly nature of the surface forbids the rapid preparation of pits, so noticeable amongst gangs operating on the light pumice lands. The former high quality of the work performed, however, has been maintained, and the success achieved is in a great measure due to the officers of the Justice Department, who are keen to accomplish favourable records.

The difficulty heretofore experienced in securing suitable tree-planters was not repeated this season, but probably the adoption of contract-work, when practicable, makes the labour more attractive to workers.

Advisory Work to Public Bodies.

The increasing solicitations from Domain Boards and private persons for advice relative to tree-growing generally have been attended to with despatch. Every effort is made to transmit information to applicants, whose desires for demonstration of the methods adopted by the Department are acceded to when possible.

Much interest and capability were displayed by the Burnham Industrial School boys during the progress of the preliminary seed-sowing and "lining-out" work. Under departmental supervision, very fair results were attained, and, by adhering to the system advocated, the institution should be easily able to produce the desired number of trees for the proposed plantation extension.

About a thousand appropriate native trees and shrubs were planted on Pudding Island, in Otago Harbour, and have succeeded beyond expectation. As may be expected, the greater proportion of the failures is attributable to "wind shaking"; but the isolation of the planted area forbade the almost constant attention in the way of "firming," so essential in the creation of well-grown shrubberies or plantations occupying highly exposed positions.

General.

Computing on the present planting basis, sufficient ground is available at both Naseby and Conical Hills Plantations for some three or four years; at Hanmer Springs, however, the ground enclosed will only meet requirements for another year, and the early resumption of an additional area for extension purposes is advisable.

The correspondence was somewhat larger than usual, some 2,818 inward and outward letters and reports being recorded, and necessitating the usage of postage-stamps to the value of £16 6s. 2d.

Beyond the retirement of Mr. L. B. Archibald, and the engagement of Mr. J. Hetherton as clerical assistant, no changes in the staff have been necessary, and I have to express my thanks to all officers for the efficient manner in which they have carried out their duties.

R. G. Robinson,
Superintending Nurseryman, South Island.

Tapanui Nursery, Otago.

(Area, 120 acres; altitude, 500 ft.)

Our tree-raising work is influenced largely by climatic conditions, which during the past few years have been so changeable that it has been quite necessary at times to ignore previously recognized principles in conducting operations.

Rain fell on 159 days, with a total precipitation of 28·29 in. This record is about 9 in. below the annual average for the past eleven years, whilst over the same period an average of 146 wet days were experienced annually. Fortunately, no unseasonable frosts have had to be contended with; and to the extreme mildness of the winter months, during which only twenty-five frosts were registered, may be partially attributed the unusual measure of success attained generally. The highest shade temperature (90°) was recorded in February, and the lowest (25°) in July.

Seedlings.—It is gratifying to be able to state that exceptionally fine results have been achieved this season in each branch of our nursery-work. The initial seed-sowing labour was unavoidably delayed until the second week in October, when timely showers converted the arid surface-soil into a desirable state for the reception of seeds. Irregular germination resulted, owing to the consequent dry spell; but after a duration of about six weeks the seedlings were found to be evenly distributed throughout the beds, and now number close on three millions. The success of the *Larix europaea* is perhaps most noteworthy, as from 250 lb. of seed 2,000,000 trees were raised. A comparatively small sowing of 48 lb. of *Pinus Laricio* resulted in 320,000 sturdy plants; and this number, supplemented by surplus two-year-old seedlings of the same variety, will be ample to meet the next year's requirements.

After a liberal trial of the much-favoured shelter-tree *Pinus muricata* it has been decided to revert to the formerly used *Pinus radiata* for creating shelter-barriers, as although the latter pine is more brittle, susceptible to frosts, and apt to break off near the top during the prevalence of high winds, the former species, owing to its faulty lateral-rooting system, is persistently being blown over, and consequently cannot be expected to form a durable wind-break. From 6 lb. of *Pinus radiata* seeds 27,000 plants were raised, and have developed strongly. We were fortunate in obtaining what appears to be true *Pinus ponderosa* seed, and from 39 lb. sown, some 210,000 plants were realized. Smaller sowings of other pines were equally satisfactory.

Perhaps the *Picea sitchensis* crop of 130,000 seedlings from 3 lb. of seed is the most productive issue for some years, and *Pseudo-tsuga taxifolia*, although scarcely up to the average in germination, have grown with unusual vigor. Small quantites of *Acacia dealbata* and *A. decurrens*, *Cupressus Lawsoniana*, *C. macrocarpa*, and various species of the eucalypti family were experimented with favourably, as a perusal of the associated tree-schedule will disclose.

Notwithstanding the dryness, water was only applied artificially to seed-beds on two occasions, but care was taken to retain the scrim covering on frames until March, so that seedlings would benefit by the increased humidity thus fostered.

Tree-growth.—Tree-growth throughout is much above the average, particularly in the larch-breaks, where scarcely a transplantation failure is noticeable. A minute inspection, however, will show that the grass-grubs have destroyed a small percentage.

Almost equally well-rooted pines are available for permanent planting, although only medium success attended the lining-out of some thousands of small one-year-old *P. Laricio*.

Some 1,600,000 trees have developed sufficiently for permanent planting during the coming winter. This anticipated output would be materially increased by including small-sized two-year-old trees, but the fallacy of transferring undergrown stock to exposed positions is usually exemplified by subsequent heavy plantation losses.

"Wrenching" was deferred until late in March, when heavy rain, thoroughly saturating the ground, permitted this operation to be conducted with every degree of safety.

Lining-out was commenced on the 6th August, and during the following eight weeks some 2,100,000 one- and two-year-old seedlings were removed from beds to nursery lines, at 1s. 7d. per thousand. An approximate 89,000 smaller plants were also lined in closely at 1s. 1d. per thousand, but wherever possible this method should be discountenanced, as "drawn-up" weakly specimens are generally produced in this way, and rarely succeed even when placed in the most favoured situations on plantations.

Buildings, Improvements.—No accommodation being available locally, it was decided to erect a small cottage within the grounds for the horseman, whose duties necessitate his almost constant presence at the nursery. The building is now almost completed, and will be tenanted before the transporting season is far advanced.

To permit of all implements being systematically arranged under cover when not in use, an additional open shed was constructed. This building will also be brought into requisition for packing and sizing trees during unsuitable weather for outdoor labour.

Two flood-gates and protecting concrete walls in Whisky Creek, over which our boundary-fence lines cross, were completed, and, judging by the present stability of the structures, they should be entirely effective in reducing to a minimum the future scouring of the creek-bed.

All shelter and ornamental plantations attached to this station have made remarkable growth, and as trees were well established and each succeeding year the weeds were becoming more troublesome, the whole of the area planted was sown down in grass, with good effect.

Well-grown specimens of trees in stock, together with a few more rare varieties received in exchange, were utilized in creating an ornamental fringe in the vicinity of the lower sizing-shed, whilst an undrained piece of ground, also conspicuous, was planted with English ash for working under the coppice system. The somewhat neglected appearance of another small area has also been relieved by flax-planting, and, being adjacent to the bundling-shed, ties will thus be conveniently procured from this source.

Horse-feed.—About 17 tons of prime oaten sheaves were harvested from 12 acres, and the double cutting of 4 acres of rye and clover yielded close on 7 tons of this winter feed. The carrot-crop proved to be exceedingly slow in beginning, but having since made a good recovery, probably 6 tons of this produce will be duly lifted and pitted.

Water-supply.—During the springtime the absence of water in horse-paddocks and Whisky Creek demanded attention, and immediate steps were taken to convey water by means of ¾ in. pipes from the small upper reservoir to the extension nursery, a distance of some 60 chains. Standpipes were erected at horse-paddocks and sizing-shed, and also at convenient positions adjacent to the seed-beds. Sufficient pressure was obtained to allow of one hose being used, and the result has fully justified the expenditure incurred.

The annual expenditure amounts to £1,749 12s. 7d., providing employment for 11·16 men, and expenditure to date is £20,821 2s. 8d.

The year's output to plantations, public institutions, &c., is 1,565,300 trees, which are valued at £4,566 5s. 1d. (as per schedule), and the transportation of a similar number is anticipated during the coming season.

Revised statements of expenditure, Property Account, Trees Account, and meteorological records are appended.

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature.		Number of Days Frosts occurred.
			Maximum.	Minimum.	
1910.	Inches.		Degrees.	Degrees.	
April	3·26	14	69	28	1
May	1·37	14	71	35	..
June	2·55	20	62	30	4
July	2·52	18	52	25	10
August	1·91	13	65	31	5
September	2·03	11	70	31	3
October	3·32	13	73	32	2
November	1·33	11	88	37	..
December	4·36	17	84	40	..
1911.					
January	2·31	8	82	42	..
February	0·83	7	90	41	..
March	2·50	13	81	34	..
Totals	28·29	159	..	..	25

Schedule II.—Statement of Expenditure.

	£ s. d.	£ s. d.
Tree-planting and maintenance—		
Tree-growing	791 7 7	10,893 13 11
General maintenance and repairs ..	363 8 11	1,959 18 11
Tree-seeds	117 16 1	956 4 5
Manures	18 10 6	189 4 5
Horse-feed, purchased and grown ..	68 10 3	1,080 4 9
Miscellaneous works	56 3 8	139 1 3
Stock and material—Tools, implements ..	35 0 6	935 11 3
Permanent works—		
Buildings	46 15 5	1,623 12 11
Nursery formation	4 19 4	496 1 0
Fencing	..	548 5 8
Water-supply	70 2 4	223 11 3
Supervision and clerical—		
Proportion of Superintending Nurseryman's salary	40 0 0	269 0 0
Proportion of Nurseryman's salary ..	70 0 0	1,369 14 11
Clerical assistance	66 18 0	136 18 0
	£1,749 12 7	£20,821 2 8

Schedule III.—Trees Account.

	During the Year.		Since 1896 to Date.		Estimated Value, as Schedule V.
	Number.	Cost of Raising.	Number.	Cost of Raising and Maintenance.	
		£ s. d.		£ s. d.	£ s. d.
Trees raised	2,821,245	210 13 10	19,886,145	20,821 2 8	..
Trees sent out	1,565,300	..	9,174,036	9,605 6 10	..
Trees, deaths	432,900	..	4,361,564	4,566 10 11	..
Balance in stock			6,350,545	..	9,594 10 1
Value of land, improvements, and stock (Property Account)				..	3,843 7 1
Total value				..	13,437 17 8

Schedule IV.—Property Account.

	£ s. d.
Land (120 acres); Crown land, not charged to Forestry Account ..	..
Buildings	1,623 12 11
Stock	199 0 0
Improvements	719 12 3
Fencing	548 5 8
Stores in hand	752 16 3
	£3,843 7 1

Schedule V.—Details of One-year-old Trees, sown 1910–11.

Name of Tree.	Number in Seed-beds.	Height in Inches.	Seed sown.	Value per thousand.	Total Value.	Remarks.
			lb.	£ s. d.	£ s. d.	
Larix europaea	2,000,000	2	250	1 0 0	2,000 0 0	Excellent crop.
Pinus austriaca	4,700	2	1	1 0 0	4 14 0	Well-grown plants.
„ Laricio	320,000	2	48	1 0 0	320 0 0	„
„ ponderosa	210,000	2½	39	1 0 0	210 0 0	„
„ Benthamiana	19,000	2½	15	1 5 0	23 15 0	„
„ maritima	3,500	4	0¾	1 0 0	3 10 0	Strong growth.
„ muricata	5,000	4	1	1 0 0	5 0 0	„
„ radiata	27,000	4	6	1 0 0	27 0 0	„
„ strobus	1,500	1½	1	1 0 0	1 10 0	Germinated poorly.
			oz.			
„ canariensis	200	5	1	1 0 0	0 4 0	Sturdy plants.
„ scopulorum	70	1½	1	1 0 0	0 1 4	„
			lb.			
Pseudo-tsuga taxifolia	75,000	2½	12	1 5 0	93 15 0	Thin crop.
Picea sitchensis	130,000	1	3	1 5 0	162 10 0	Fine even crop.
			oz.			
Abies Nordmanniana	75	1	1	1 10 0	0 2 3	Experimental.
			lb.			
Betula alba	700	2	2	1 0 0	0 14 0	Germinated poorly.
			oz.			
Cupressus macrocarpa	1,300	3	1	1 0 0	1 6 0	Experimental.
„ Lawsoniana	10,000	1	2	1 0 0	10 0 0	„
Acacia dealbata	2,000	6	2	1 0 0	2 0 0	„
„ decurrens	4,000	6	4	1 0 0	4 0 0	„
Eucalyptus Stuartiana	1,500	8	1	0 10 0	0 15 0	„
„ Amygdalina ..	1,500	5	1	0 10 0	0 15 0	„
„ coriacea	800	4	1	0 10 0	0 8 0	„
„ Gunnii	1,600	9	1	0 10 0	0 16 0	„
Cytisus proliferus	1,500	9	4	0 10 0	0 15 0	„
Various trees	300	2	..	1 0 0	0 6 0	
Totals	2,821,245	..	..	..	2,873 16 7	

Two-year-old Trees, sown 1909–10.

Name of Tree.	Number in Seed-beds.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Larix europaea	133,000	447,000	12	1 5 0 2 5 0	1,172 0 0	Well-grown trees.
Pinus Laricio	1,600,000	100,000	13	1 5 0 2 5 0	2,225 0 0	„
„ ponderosa	215,000	..	3	1 5 0	268 15 0	„
„ muricata ..	..	9,500	10	2 5 0	21 7 6	„
Fraxinus excelsior	18,800	..	4	1 5 0	23 10 0	Poor growth.
„ americana	..	3,700	6	2 0 0	7 8 0	„
Betula alba	6,000	4,000	14	1 5 0 2 5 0	16 10 0	Strong trees.
Alnus glutinosa	..	16,000	6	2 0 0	32 0 0	„
Pyrus aucuparia	..	100	18	3 0 0	0 6 0	„
Totals	1,972,800	580,300	..	..	3,766 16 6	
	2,553,100					

Three-year-old Trees, sown 1908–9.

Name of Tree.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
			£ s. d.	£ s. d.	
Larix europaea	163,400	15	3 0 0	490 4 0	These trees have developed into fine, fibrous-rooted stock.
Pinus austriaca	22,000	5	3 0 0	66 0 0	
„ Laricio	391,000	6	3 0 0	1,173 0 0	
„ ponderosa	264,200	4	3 0 0	792 12 0	
„ Benthamiana	100	18	3 5 0	0 6 6	
Picea excelsa	36,400	4	3 0 0	109 4 0	
„ sitchensis	27,700	4	3 5 0	90 0 6	
Pseudo-tsuga taxifolia	1,800	4	3 5 0	5 17 0	
Quercus pedunculata	100	40	3 0 0	0 6 0	
Fraxinus excelsior	22,700	9	3 0 0	68 2 0	
Betula alba	4,600	12	3 0 0	13 16 0	
Acer pseudo-platanus	500	12	2 15 0	1 7 6	
Alnus glutinosa	2,700	18	3 0 0	8 2 0	
Fagus sylvatica	100	24	3 5 0	0 6 6	
Thuja gigantea	35,500	5	3 10 0	124 5 0	
Tsuga canadensis	1,800	3	3 0 0	5 8 0	
Pyrus aucuparia	150	48	4 0 0	0 12 0	
Cytisus laburnum	150	30	3 10 0	0 10 6	
Various trees	1,300	12	3 0 0	3 18 0	
Totals	976,200	..	..	2,953 17 6	

Trees transferred from Nursery to Plantations, &c., 1910–11.

Where sent.	Name of Tree.	Number.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Conical Hills Plantation	Larix europaea	602,275	14	3 0 0	1,806 16 6	The partial drought experienced was mainly responsible for a slightly increased death-rate here.
	Pinus Laricio	625,350	12	3 0 0	1,876 1 0	
	„ austriaca	28,600	12	3 0 0	85 16 0	
	„ ponderosa	50,275	12	3 0 0	150 16 6	
	„ Benthamiana ..	8,050	14	3 5 0	26 3 3	
	Picea excelsa	56,475	10	3 0 0	169 8 6	
	„ sitchensis	15,050	12	3 0 0	45 3 0	
	Pseudo-tsuga taxifolia ..	16,600	10	3 5 0	53 19 0	
	Betula alba	18,625	15	3 0 0	37 5 0	
	Alnus glutinosa	7,900	14	3 0 0	23 14 0	
	Fraxinus excelsior ..	16,225	15	3 0 0	48 13 6	
	Quercus pedunculata ..	18,050	16	3 0 0	54 3 0	
	Acer pseudo-platanus ..	1,025	16	2 15 0	2 16 4	
	Fagus sylvatica	4,250	14	4 0 0	17 0 0	
	Sequoia sempervirens ..	200	15	4 0 0	0 16 0	
	Thuja plicata	25	12	4 0 0	0 2 0	
		1,468,975	..	..	4,398 13 7	
Dusky Hill Plantation	Larix europaea	2,000	14	3 0 0	6 0 0	These trees were used for replanting purposes.
	Pinus Laricio	19,000	12	3 0 0	57 0 0	
	Picea excelsa	2,000	10	3 0 0	6 0 0	
	Quercus pedunculata ..	1,630	16	3 0 0	4 17 9	
		24,630	..	..	73 17 9	
Conical Hills Plantation	As per details above ..	1,468,975	..	..	4,398 13 7	
Dusky Hill Plantation	„ ..	24,630	..	..	73 17 9	
Eweburn Nursery ..	Thuja plicata seedlings ..	1,000	..	..	1 0 0	
Clyde Domain Board	Assorted trees	165	..	..	0 11 4	
Pudding Island ..	Native trees and shrubs ..	216	..	..	2 2 9	
Education Department, Otekaike	Assorted trees	500	..	..	1 15 0	
Riverton Domain Board	Sycamore	275	..	..	0 13 9	
Industrial Schools, Burnham	Trees and seedlings ..	5,850	..	..	7 19 6	
Te Oranga Home ..	Assorted trees	734	..	..	2 11 5	
Rabbit Island Domain Board	„	750	..	..	3 0 0	
School Committee, Becks	„	200	..	..	0 14 0	
Recreation Grounds, Cromwell	„	550	..	..	1 18 6	
Swinburn Cemetery	„	200	..	..	0 14 0	
Dunedin Corporation	Pine and larch seedlings ..	60,000	..	..	60 0 0	
Acclimatization Society, Clinton	Assorted trees	900	..	..	1 16 0	
Sanatorium, Palmerston	„	355	..	..	8 17 6	
Totals ..	..	1,565,300	..	..	4,566 5 1	

R. G. Robinson,
Superintending Nurseryman.

Dusky Hill Plantation, Otago.

(Area, 845 acres; altitude, 400 ft. to 800 ft.)

Perhaps in no previous year have the trees growing throughout this plantation been taxed to such an extent through dearth of moisture during the spring and summer months. At one period the larch foliage assumed a most unhealthy tint, and fears were momentarily entertained that the trees had developed the leaf-shedding fungus (*Sphoerella laricina*). On investigating, however, the roots were found to be in a perfectly healthy state, although an almost entire absence of moisture in the ground for some 2 ft. from the surface was disclosed. This fact alone was sufficient to account for the premature shedding of needles from the lateral branches; but with the advancement of the season, and gradually increasing rainfalls, tree-growth became more vigorous, and foliage partially resumed its normal colour.

The outstanding feature of the review of annual progress made by the plantation is the exceedingly fine growth of the spruces—*Picea excelsa* and *P. sitchensis*—which have made an average increase in height of about 13 in. When allocated in exposed positions the spruces during their youth rarely escape having their leaders broken by the agency of either winds or hailstones; but the absence of such influences this season has permitted the trees to advance quite unmolested. No evidence of existing diseases of any kind is apparent amongst the *Picea* blocks, and it is reasonable to believe that as local conditions are so dissimilar from those in Canterbury, where the minute red spider is proving so

destructive to the *Picea sitchensis*, the growing of the tideland spruce in this district may be successfully accomplished. In sheltered situations the *Quercus pedunculata* continue to register an annual vertical growth of about 18 in., whilst even more rapid headway is discernible among the *Fraxinus excelsior* compartments.

The *Fraxinus americana* are decidedly more frail trees than the English variety; but, nevertheless, are now beginning to develop favourably. Although *Pinus austriaca* grew with greater rapidity in the early stages, *Pinus Laricio* is now gradually proving its superiority, both as a faster grower and more healthy forest tree. Isolated specimens of the former variety are at times literally covered with an aphis, which, however, does not appear to lessen the vigour of the tree to any extent, but certainly creates a disfigurement. It is now evident that the Japanese larch (*Larix leptolepis*) is no more able to withstand a partial drought than the European species; and of the two varieties, growing under precisely the same conditions, the latter one has certainly recovered more speedily and grown with greater uniformity.

Some six years ago an exceptionally severe frost accounted for the destruction of a natural broad-leaf bush, and the area thus deforested was eventually underplanted with walnuts and chestnuts. These trees have succeeded beyond expectations, and will now probably average 9 ft. in height; whilst from a number of specimens fully matured nuts were gathered this year.

Apart from the planting of some 24,630 trees (as per schedule), which were used purely for replanting purposes, the two employees engaged at this station have devoted their time to the general maintenance-work, and included in this labour may be mentioned tree-pruning, removing coarse growth from around young trees, repairing roads and water-tables, rabbiting, and caretaking.

Buildings.—A most satisfactory result attended the uniting of the unused huts, and quite a substantial dwellinghouse is now available for the foreman. A combined wash and coal house has also been erected by our own labour, besides sundry improvements effected to immediate surroundings.

Presence of Deer.—With the increase of shelter, and consequent difficulty in locating their whereabouts, the red-deer are causing rather more damage to young trees than formerly. The ravages of the destructive animals are chiefly confined to ash-saplings, which usually receive such extensive damage as to necessitate immediate cutting-back to ground-surface. Employees receive authority from time to time to destroy deer; but rarely get an opportunity to fire at the animals from an effective distance.

Rabbiting.—The ill effects arising from a dry season was again brought into prominence by the Pomahaka River failing to check the ingress of rabbits from opposite properties, which, of course, are not so free from the pest. Fortunately, no great difficulty is experienced in trapping, although some little time generally elapses ere the haunts of the intruders are known.

An expenditure of £457 11s. 4d. was incurred during the year, giving employment to two men, and the total to date reaches £12,459 1s. 7d.

The value attributed to buildings, fencing, &c., is recognized at £1,010 19s., whilst the total cost of tree-planting operations since initiation amounts to £11,439 2s. 7d.

Details of expenditure, Trees Account, Property Account, and balance-sheet are appended.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	..	3,094 16 2
Pitting	..	3,619 2 7
Clearing	..	496 5 11
Cartage of trees	..	216 12 8
General upkeep of plantation	157 7 7	2,410 14 7
General repairs	14 16 5	52 19 11
Horse-feed	6 14 6	112 8 11
Permanent works—		
Fencing	..	258 2 3
Formation	..	366 7 2
Buildings	103 12 10	368 18 6
Stock, implements, &c.—Tools, implements	..	145 8 9
Supervision and clerical—		
Salaries—		
Supervision of free labour	150 0 0	955 10 0
Nurseryman's proportion of clerical assistance	25 0 0	361 14 2
	£457 11 4	£12,459 1 7

Schedule III.—Trees Account.

	Number.
Trees received during year	24,630
Less to replace blanks	24,630
Planted on new area	..
Previously planted	2,180,837
Total number planted on 845 acres (average age, seven years)	2,180,837

Lifting and bundling Young Plants, Hanmer Nursery.

Prison Camp, Hanmer Springs, showing Area now being operated.

Face page 60.

Pinus ponderosa and *Pinus contorta*, Young Plantation

Tree planting with Spade and Planting-bar

Schedule IV.—Property Account.

	£	s.	d.
Land (845 acres); Crown land, not charged to Forestry Account			
Buildings	368	18	6
Stock			
Improvements	366	7	2
Fencing	258	2	3
Stores in hand	26	11	1
	£1,019	19	0

Balance-sheet.

	£	s.	d.
Total expenditure	12,459	1	7
Less Property Account	1,019	19	0
Cost of operations (845 acres planted; average age, seven years)	£11,439	2	7
Estimated value of plantation per acre	£11	0	0

F. BENFELL,
Plantation Foreman.
R. G. ROBINSON.
Superintending Nurseryman.

CONICAL HILLS PLANTATION, OTAGO.

(Area, 3,672 acres; altitude, 400 ft. to 1,050 ft.)

It is again possible to render a favourable review of tree-growth generally and amount of work performed at this station during the past year. The effect of intense dryness throughout almost the whole summer period has not been so conspicuous here as at the other local plantation, and perhaps premature fall of needles from the lower branches of larch occupying exposed westerly positions is the only indication that the absence of sufficient moisture has been keenly felt by plant-life.

The annual development of trees somewhat exceeded that of the previous year, although in either case vigorous headway cannot be claimed. It is not surprising that *Larix europaea* have again grown with greater uniformity and vigour than other trees planted; but where occupying stony surfaces, in company with pines, they have latterly assumed a somewhat parched appearance, whilst evergreen conifers appear to find the position to their liking. The variation in the progress of *Picea excelsa* is due principally to the amount of shelter provided. On the most elevated sites perhaps an annual vertical growth of 4 in. has been made by the spruces, whilst exceedingly fine specimens, increasing in height about 15 in. annually, are prominent throughout gullies and semi-sheltered flats. None of the pines appear to be influenced to any great extent by the dry weather, and particularly prominent in this respect is the *Pinus ponderosa*, which maintain a yearly growth of from 6 in. to 12 in.

On all occasions *P. Laricio* are allotted more favoured situations than the former species, both as regards shelter and soil, and probably this consideration is responsible for the more speedy headway being made by the Corsican pine.

The *Pseudo-tsuga taxifolia* have escaped injury from high winds, which, fortunately, were not prevalent during that period of greatest activity in growth, when Oregon pine leaders are very easily broken off. Fortunately, our projected hardwood-planting has not been adhered to, as neither ash, oak, nor sycamore have made the expected headway, even in the most select spots. We still retain the belief, however, that when shelter is made available by the faster-growing trees in the vicinity, the hardwoods will then respond to the altered conditions.

Our season's experimental work included a trial planting of *Sequoia sempervirens* and *Thuja plicata*. The result indicates that both varieties will undoubtedly succeed, and arrangements will accordingly be made to raise a limited number annually in the associated nursery.

About 200 *Fagus sylvatica* were also experimented with, and specimens put on 16 in. of growth. As one of the chief characteristics of this tree is its shade-enduring capabilities, it will be interesting to note its future progress, particularly as in the course of a few years a system of under-planting will require to be established.

Arrangements are now in hand to introduce *Cupressus macrocarpa* into plantations. Although strong lateral branches are usually connected with this tree, close planting—about 3 ft. apart—will have the desired effect of stimulating the upright growth at the expense of the side branches.

Tree-planting.—During the year 1,468,975 trees (over 506¾ acres), as enumerated in tree schedule, were planted, principally by contract, at 12s. 6d. per thousand. This price is slightly in excess of similar work at other stations, but the rough tussocky hills and abrupt fern-clad gullies now being operated upon make it impossible to conduct the work at reduced rates, although the proximity of the camp to the ensuing year's planting-ground may induce employees to arrange for an adjustment in contract prices in favour of the Department. Although on no previous occasion has contract planting been attempted, the excellence of the work, combined with the desired speed, justifies a repetition of the system. Notwithstanding the unfavourable season, probably 6 per cent. would cover the planting-losses. On No. 1 Block the small maintenance gang of three workers were fully occupied in replanting some 89,275 failures, which are mostly found amongst the ash and sycamore blocks.

Pitting.—The required number of grubber pits were prepared by contract at 12s. 6d. per thousand. This rate may be regarded with mutual satisfaction by both the Department and employees, who require to work steadily for fully eight hours daily to complete 700 pits up to the specified standard.

Several trials were made with the recently imported hole-borer, the working of which is briefly described in another portion of the report. On the cleared areas an operator can easily prepare 800 holes daily, and with practice this number should be increased fully 25 per cent. without overexertion on the part of the manipulator. Before the advent of the coming planting season an extended trial of the machine over an acre or two will be made, and it is more than likely that the result of same will influence our future planting-work.

Fire-breaks.—The yearly increasing labour essential in keeping our fire-breaks in an effective state may be gauged from the fact that two teams of horses were employed for about two months in ploughing, discing, and cultivating these intersecting fire-lines, which extend over an aggregate distance of about nine miles, and average about a chain in width.

The caretaking service was maintained on Sundays and holidays during the summer months, and it is gratifying to be able to report the entire absence of any outbreak of fire.

Rabbiting.—Since the acquirement of this property incessant warfare has been directed against the rabbit pest. Naturally, the rough nature of the ground makes effective work difficult, and it is improbable that we could have continued planting in safety had the divisional fencing scheme not been introduced. By this means we are able to eradicate the rabbits over an area large enough to contain one year's planting, after which the rabbiter, with his traps, dogs, ferrets, fumigator, and poison, devotes his energies in preparing another block for the ensuing season. It has been necessary this year to occasionally provide assistance to the rabbiter, who has accounted for close on five thousand of the destructive animals during the twelve months under review.

General Maintenance.—The increasing expenditure allocated under this heading was not unforeseen, as with each year's planting an additional 500 acres or more of trees require to be attended to in the form of pruning, removal of interfering grass-growth, replanting failures, &c. In arriving at the upkeep-cost (8s. 7½d. per acre) consideration has also been given to fire-break labour, horse-shoeing, and repairs.

Revision of Records.—In examining the concentrated statements herewith, it will be seen that credit to the extent of some 700,000 trees given for the previous planting has been withdrawn. In accounting for this, it might be explained that when the acorn-planting scheme was being applied each seed germinating was duly credited as a tree planted. The whole venture was not attended with success, as, although the acorns freely germinated and developed into sturdy yearling oaks, their consequent annual progress was so disappointing that replanting the whole area with more suitable varieties was unhesitatingly adopted, but up to the current year no deduction from the original totals was made for this wholesale replanting.

By a careful analysis of trees planted, and a liberal allowance for deaths since initiation, it was ascertained that at the present time there are, at this station, 5,164,862 forest trees, occupying an area of some 1,897 acres.

The expenditure for the year was £3,215 10s. 4d., which provided employment for 23·5 men.

Since the beginning of operations here £17,555 3s. 11d. has been expended, the details of which may be seen on reference to tables appended.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance		
Tree-planting	915 11 1	3,863 2 6
Pitting	1,042 0 3	5,453 14 10
Clearing	..	648 3 8
Cartage of trees	53 12 0	272 10 5
General upkeep of plantation	769 16 9	3,377 7 4
General repairs	23 1 10	342 16 9
Horse-feed	27 1 6	78 12 5
Permanent works—		
Fencing	99 15 3	1,105 19 0
Formation	..	259 11 10
Buildings	20 17 7	244 5 4
Stock, implements, &c.—Tools, implements	8 14 1	255 10 6
Supervision and clerical—		
Salaries—		
Supervision of free labour	175 0 0	1,200 0 0
,, prison labour	..	..
Nurseryman's proportion of clerical assistance	80 0 0	453 9 4
	£3,215 10 4	£17,555 3 11

Schedule III.—Trees Account.

	Number.
Trees received during the year	1,468,975
Less to replace blanks	89,275
Planted on new area	1,379,700
Previously planted	3,785,162
Total number planted on 1,897 acres (average age, four years)	5,164,862

Schedule IV.—Property Account.

	£ s. d.
Land (3,672 acres); Crown land, not charged to Forestry Account	..
Buildings	244 5 4
Stock	..
Improvements	259 11 10
Fencing	1,105 19 0
Stores in hand	159 15 4
	£1,769 11 6

Balance-sheet.

	£ s. d.
Total expenditure	17,555 3 11
Less Property Account	1,769 11 6
Cost of operations	£15,785 12 5

1,897 acres planted (average age, four years).

Estimated value of plantation per acre £9 10 0

H. Howe,
Plantation Foreman.

R. G. Robinson,
Superintending Nurseryman.

Waitahuna Plantation, Otago.

(Dredged area, 11 acres; altitude, 331 ft.)

It is very evident by the continued vigorous headway being made by trees growing here that abandoned dredged areas may be speedily converted into flourishing plantations of forest trees.

Of the fifteen varieties introduced for experimental purposes, *Fraxinus excelsior*, *Fraxinus americana*, *Acer saccharum*, *Acer pseudo-platanus*, and *Robinia pseudo-acacia* have failed to succeed, whilst *Quercus pedunculata* and *Picea excelsa* thrive only when occupying positions where large proportion of clay and fine silt is incorporated with the dredged tailings.

The growth of each of the other varieties planted is decidedly satisfactory, and compares quite favourably with that recorded at our most progressive stations. Planting began four years ago, and European larch, English birch, and alder have now attained a height of from 10 ft. to 12 ft.; although somewhat slower, *Pseudo-tsuga taxifolia*, *Pinus austriaca*, *Pinus Laricio*, *Pinus ponderosa*, and *Pinus muricata* are making from 15 in. to 18 in. of vertical growth annually, and possess a most healthy appearance.

Immediately on ascertaining the relative values of the trees being experimented with, all unsuitable kinds were replaced by either larch, pines, or birch, and, notwithstanding the present irregular look of the plantation generally, each succeeding year's growth should create greater uniformity.

An expenditure of £6 7s. 10d. was incurred in maintenance-work during the year, and, contrary to expectations, little trouble is now being experienced in keeping gorse and broom in check.

After an additional two year's growth, no danger to "tree-leaders" should accrue from the presence of a few clumps of the noxious plants, which will be gradually killed outright by growing trees.

Detailed statements of expenditure, &c., are appended.

Schedule II.—Statement of Expenditure.

	Per Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	..	20 2 0
Pitting	..	27 6 0
Clearing	..	23 0 3
Cartage of trees	..	3 0 0
General upkeep of plantation	5 7 10	37 2 3
General repairs	..	4 0 0
Horse-feed	..	..
Permanent works—		
Fencing	..	57 11 1
Formation	..	3 10 0
Buildings	..	..
Stock, implements, &c.—Tools, implements	..	..
Supervision and clerical—		
Salaries—		
Supervision of free labour	1 0 0	9 0 0
,, prison labour	..	..
Nurseryman's proportion of clerical assistance	..	18 9 0
	£6 7 10	£203 0 7

Schedule III.—Trees Account.

	Number.
Trees received during year	..
Less to replace blanks	..
Planted on new area	..
Previously planted	30,525
Total number planted on 11 acres (average age, three years)	30,525

Schedule IV.—Property Account.

	£	s.	d.
Land (11 acres); Crown land, not charged to Forestry Account ..	..		
Buildings	..		
Stock	..		
Improvements	3	10	0
Fencing	57	11	1
Stores in hand	..		
	£61	1	1

Balance-sheet.

	£	s.	d.
Total expenditure	203	0	7
Less Property Account	61	1	1
Cost of operations (11 acres planted; (average age, three years) ..	£141	19	6
Estimated value of plantation per acre	£9	2	0

R. G. ROBINSON,
Superintending Nurseryman.

EWEBURN NURSERY, NEAR NASEBY, OTAGO.

(Area, 49 acres; altitude, 1,400 ft.)

During the year the rainfall has been a little heavier than the previous one, the total being 15·61 in. on ninety-two days. The highest reading of the thermometer in the shade was 84° on the 10th and 16th November, and the lowest 10° (22° of frost) on the 25th September. The ground-temperature of the same date was 5° (27° of frost). Frost occurred on 137 nights in the screen and on 192 nights on the ground.

The weather this year, compared with last, has been very much warmer, and, although more rain has fallen, it has been drier in the months of February and March, and, in consequence, the drought became very serious. The average heat for the month of March last was 66·35°, and for the corresponding month of this year 72·22°, which with the scanty rainfall in February accounts in a measure for the drought.

The work of sowing seeds was commenced on the 20th October and finished on the 26th, but owing to the unfavourable season the crop has not been too satisfactory, especially amongst the larch. The latter came away very evenly in the first stages until the dry set in, and to make matters worse, large numbers were eaten off by a small white worm resembling a small eel.

Pinus Laricio are a very even crop, but not so thick as usual, yet, nevertheless, are a fair crop. Watering had to be resorted to day after day, owing to the want of rain during the latter part of the summer, which has greatly raised the cost of production.

The water-supply is not sufficient, and during the winter months I would recommend that a better supply be laid on by the use of a larger pipe at the intake of the dam.

The seedlings as a whole are very sturdy, and better results can be obtained from pines than larch.

The work of lining out was commenced on the 5th September, the weather being most unfavourable, owing to the high winds, which made the work irksome to the men, and harder on the trees. A total of 918,953 trees were lined out, at an average cost of 1s. 7d. per thousand, and, notwithstanding the depredations of the grass-grub and the drought combined, the average strike has been excellent. It is usually thought in this dry region that constant watering is carried out on the lined-out trees, but this has never been the practice, nor have we the water at hand to do so, and it is simply an evidence of what can be done by constant cultivation.

The probable number of trees that are sufficiently advanced for their removal to the plantation is 708,133.

The number of trees sent out to the Naseby Plantation was 326,300, and 1,065 to nurseries and public bodies, their value being £1,064 14s. 1d.

The number of trees in the nursery at the 31st March, 1911, is 1,750,265, and their value is £3,489 1s.

Taking the work as a whole, the year has been very satisfactory, and with a better supply of water and the shelter-breaks getting higher and thicker, good results should be accomplished in the future.

The expenditure for the year amounts to £825 1s. 6d., and the total to date £11,906 14s. 11d., which gave employment to 4·6 men.

All buildings, harness, tools, &c., have been kept in good repair; but the building will require to be painted during the incoming year.

Details of accounts are appended.

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature.		Number of Days Frosts occurred.
			Maximum.	Minimum.	
1910.	Inches.		Degrees.	Degrees.	
April	0·66	3	72	18	17
May	0·61	10	72	22	11
June	1·11	12	58	19	25
July	0·62	8	52	12	26
August	0·82	8	60	20	23
September	1·13	6	68	10	15
October	2·11	6	71	24	6
November	1·16	5	84	30	4
December	3·58	13	81	31	1
1911.					
January	2·08	9	83	30	3
February	0·32	4	84	29	2
March	1·41	8	82	29	4
Totals	15·61	92	..	..	137

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Tree-planting and maintenance—		
Tree-growing	400 6 2	4,817 10 7
General maintenance and repairs	156 0 7	2,269 19 7
Tree-seeds	37 8 0	446 9 3
Manures	..	40 15 3
Horse-feed, purchased and grown	43 16 7	456 0 11
Miscellaneous works	..	44 18 7
Stock and material—Tools, implements ..	5 11 6	787 7 8
Permanent works—		
Buildings	..	758 18 2
Nursery-formation	..	624 18 4
Fencing	..	340 1 0
Water-supply	21 18 8	268 6 7
Supervision and clerical—		
Proportion of Superintending Nurseryman's salary	25 0 0	421 7 4
Proportion of Nurseryman's salary ..	130 0 0	600 1 8
Clerical assistance	5 0 0	30 0 0
	£825 1 6	£11,906 14 11

Schedule II.—Tree Account.

	During the Year.		Since 1896 to Date.		Estimated Value, as Schedule V.
	Number.	Cost of Raising.	Number.	Cost of Raising and Maintenance.	
		£ s. d.		£ s. d.	£ s. d.
Trees raised	343,350	71 10 7	5,190,867	11,906 14 11	..
Trees sent out	327,365	..	1,986,107	4,555 13 9	..
Trees, deaths	157,370	..	..	..	..
Balance in stock			1,750,265	..	3,489 1 0
Value of land, improvements, and stock (Property Account)				..	2,476 4 7
Total value			..	..	5,965 5 7

Schedule IV.—Property Account.

	£	s.	d.
Land (50 acres); Crown land, not charged to Forestry Account.			
Buildings	787	7	8
Stock	109	7	5
Improvements	893	4	11
Fencing	340	1	0
Stores in hand	346	3	7
	£2,476	4	7

Schedule V.—Details of One-year-old Trees, sown 1910–11.

Name of Tree.	Number in Seed-beds.	Height in Inches.	Amount of Seed sown.	Value per Thousand.	Total Value.	Remarks.
			lb.	£ s. d.	£ s. d.	
Pinus Laricio	150,600	2	28	1 0 0	150 12 0	Even, thin crop.
„ ponderosa	62,750	2	23	1 0 0	62 15 0	„
Larix europaea	130,000	3	112	1 0 0	130 0 0	Germinated well, but badly attacked by grubs.
Totals	343,350	..	..	..	343 7 0	

Two-year-old Trees, sown 1909–10.

Name of Tree.	Number in Seed-beds.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Pinus Laricio	600,000	..	4	1 5 0	750 0 0	Strong plants.
„ ponderosa	98,800	..	4	1 5 0	123 10 0	„
Totals	698,800	..	..	..	873 10 0	

Three-year-old Trees, sown 1908–9.

Name of Tree.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
			£ s. d.	£ s. d.	
Pinus Laricio	503,500	7	3 0 0 3 10 0	1,642 17 6	These trees have all done very well, and will be transferred to Naseby Plantation during the coming winter.
„ ponderosa	110,125	7	3 0 0	330 7 6	
„ Benthamiana	62,040	7	3 5 0	201 12 6	
Larix europaea	32,450	10	3 0 0	97 7 0	
Totals	708,115	..	..	2,272 4 0	

Trees transferred from Nursery to Plantations, &c., 1910–11.

Where sent.	Name of Tree.	Number.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Naseby Plantation	Pinus Laricio	163,400	13	3 10 0	571 18 0	All good strong plants.
	„ ponderosa	27,375	10	3 0 0	82 14 6	
	„ Benthamiana	26,250	10	3 0 0	78 15 0	
	Larix europaea	109,075	15	3 0 0	327 4 6	
Clyde Domain	Pyrus aucuparia	50	24	4 10 0	0 4 6	
	Cytisus vulgaris	50	24	3 0 0	0 3 0	
Lauder School, Becks	Pinus Laricio	100	30	3 10 0	0 7 0	
	„ Benthamiana	50	10	3 0 0	0 3 0	
	Larix europaea	50	18	3 0 0	0 3 0	
Tapanui Nursery	Pyrus aucuparia	25	24	4 10 0	0 2 3	
	Cytisus vulgaris	25	24	3 0 0	0 1 6	
Hanmer Springs Nursery	Pyrus aucuparia	300	24	4 10 0	1 7 0	
	Cytisus vulgaris	215	24	3 0 0	0 12 10	
	Pyrus aucuparia	200	24	4 10 0	0 18 0	
Totals		327,365	..	..	1,064 14 1	

A. W. Roberts,
Nurseryman in Charge.

NASEBY PLANTATION.

(Area, 1,350 acres; altitude, 2,300 ft.)

During the year the removal of the fence from the commonage-site has been carried out, and an area of 1,200 acres been acquired from Run 219C, Naseby, and on which the fencing has been erected.

In order to facilitate the work, as the season was advancing, only a small portion was fenced, but the whole area is at present being enclosed in readiness for the coming spring.

Owing to there being so much haulage and dismantling, &c., of fencing material, the average cost of maintenance has been greatly increased, and is therefore hardly a fair average.

During last season 156,075 trees were transferred to Naseby Commonage site, and of these, 31,240 still remain in the trenches. Some 65,925 were used on the commonage-area, which was eventually abandoned, and the remainder, having died in the trenches, should not be put down as failures on the new or old area.

The remaining trees could not be removed owing to the lateness of the season, but will be transferred during the incoming spring. There were 326,300 trees removed to the new area from the nursery, and I am sorry to have to report that of these 24,550 had to be thrown out as they died in the trenches.

These were some of the first trees lifted and bundled in order to be sent to Conical Hills Plantation, but were retained here as the Government acquired the extension property later, and, consequently, the trees remained too long in the bundles before being planted out.

Pitting was commenced in July, but as the ground was too hard owing to the frost, good progress could not be made at first, but during the months of September and October better progress was made. The spot is an ideal one for trees, but, owing to the turfy nature of the ground, it requires to be all pitted before the winter, in order to pulverize the soil; and this is being done for the reception of the trees during the coming spring.

Trees planted out are doing very well, and from all appearances the percentage of deaths will be very small, the larch especially having done exceedingly well.

The trees on the old site are making excellent growth, and a plan of the area subdivided into blocks has been compiled.

The number of trees planted on the new area is 301,750, at an average cost of 11s. 8d. per thousand. The total number planted to date in the old and extension area is 682,204.

Some 360,750 grubber pits were made, at an average cost of 10s. 9d. per thousand, and of these 59,000 remain open for the trees during the next spring.

The expenditure for the year is £867 8s. 10d., and the expenditure to date is £3,644 17s. 11d.

A hut was erected during the year by the employees, and another removed from Gimmerburn. Two tents on frames were also erected on the ground.

The average number of men employed was 5·5, day-labour.

During the incoming year a thermometer and rain-gauge are to be installed at this station.

Details of accounts are appended.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	191 5 5	696 5 11
Pitting	193 18 4	764 10 3
Clearing	..	20 17 10
Cartage of trees	21 4 0	92 1 9
General upkeep of plantation	203 10 3	928 19 3
General repairs	7 18 6	7 18 6
Horse-feed	..	164 10 0
Permanent works—		
Fencing	112 10 1	480 2 9
Formation	..	5 0 0
Buildings	47 2 3	85 0 0
Stock, implements, &c.—Tools, implements	..	1 12 6
Supervision and clerical—		
Salaries—		
Supervision of free labour	60 0 0	248 10 11
Nurseryman's proportion of clerical assistance	30 0 0	149 8 3
	£867 8 10	£3,644 17 11

Schedule III.—Trees Account.

	Number.
Trees received during the year	326,300
Less to replace blanks	24,550
Planted on new area	301,750
Previously planted	380,454
Total number planted on 260 acres (average age, five years)	682,204

Schedule IV.—Property Account.

	£ s. d.
Land (1,350 acres); Crown land, not charged to Forestry Account	.. ..
Buildings	85 0 0
Stock	.. ..
Improvements	5 0 0
Fencing	480 2 9
Stores in hand	2 5 9
	£572 8 6

Balance-sheet.

	£ s. d.
Total expenditure	3,644 17 11
Less Property Account	572 8 6
Cost of operations (260 acres planted; average age, five years)	£3,072 9 5
Estimated value of plantation per acre	£10 0 0

T. SCREEN,
Plantation Foreman.

A. W. ROBERTS.
Nurseryman in Charge.

GIMMERBURN PLANTATION RESERVE.

(Area, 420 acres; altitude, 1,200 ft.)

Owing to this area being abandoned as far as further tree-planting is concerned, there has been no planting done during the year, but keeping the fire-breaks and fence in order has been attended to.

During the year account was made of the trees standing, and a sketch of same prepared, apportioning the various trees into blocks. The trees as a whole appear to be making better progress now that they are becoming more established, especially larch in places where the soil is suitable to their requirements. In some instances they have attained a height of 20 ft.; others again are not more than 3 ft. for the same period. The pines are slower, but are putting on more even growth than the former, and in places are beginning to cover the ground.

During the year 32 acres of land were broken up and sown down in oats for horse-feed, and yielded about 22 tons of chaff. This is not a very heavy yield as compared with other seasons, and no doubt the continued drought is accountable for the shortage. The sheaf is, however, very short and clean, and will make excellent chaff.

During the year 5 tons of chaff were transferred to Eweburn Nursery and 2 tons to Tapanui Nursery, valued at £28.

The expenditure for the year amounts to £92.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	..	857 4 3
Pitting	..	29 9 0
Clearing	..	..
Cartage of trees	..	97 10 9
General upkeep of plantation	13 12 1	379 8 5
General repairs	..	9 13 5
Horse-feed	46 8 11	420 4 0
Permanent works—		
Fencing	..	387 11 2
Formation	..	50 0 0
Buildings	..	57 3 9
Stock, implements, &c.—Tools, implements	7 19 0	19 19 0
Supervision and clerical—		
Salaries—		
Supervision of free labour	10 0 0	223 0 0
Nurseryman's proportion of clerical assistance	14 0 0	79 16 8
	£92 0 0	£2,611 0 5

Schedule III.—Trees Account.

	Number.
Trees received during the year	..
Less to replace blanks	..
Planted on new area	..
Previously planted	152,896
Total number planted on 173 acres (average age, five years)	152,896

Schedule IV.—Property Account.

	£ s. d.
Land (420 acres); Crown and, not charged to Forestry Account	..
Buildings	57 3 9
Stock	..
Improvements	50 0 0
Fencing	387 11 2
Stores in hand	19 19 0
	£514 13 11

Balance-sheet.

	£ s. d.
Total expenditure	2,611 0 5
Less Property Account	514 13 11
Cost of operations (173 acres planted; average age, five years)	£2,096 6 6
Estimated value of plantation per acre	£10 0 0

A. W. Roberts,
Nurseryman in Charge.

Hanmer Springs Nursery, Canterbury.

(Area, 40 acres; approximate altitude, 1,225 ft.)

Rain fell on 110 days, with a total precipitation of 44·68 in., the maximum monthly fall being 6·11 in., during the month of June. The highest shade temperature (85°) was registered on the 25th November, and the lowest (20°) on the 17th May and the 21st June. Although a heavier rainfall was experienced during the year by 0·94 in. than that of last year, the number of days on which rain fell was less by twenty-nine days, thus showing a very uneven distribution of moisture throughout the year. Extremely dry weather was experienced during the early spring and autumn, but the summer months were fairly moist, sufficient rain falling to maintain an even, and in the case of larch, a fairly rapid growth.

The spring drought was, however, severely felt, coming as it did during the latter part of and immediately subsequent to the completion of lining-out operations. The larch, being planted earlier in the season, did not suffer so greatly as the pines, as they were well established before the drought set in, and the death-rate could be put down at from 10 to 12 per cent. The pines, however, were very severely dealt with, as the drought had set in just before the completion of planting operations, and continued for some five or six weeks following. The death-rate was therefore very high, being from 25 to 30 per cent., and the growth of the trees throughout the rest of the season was poor. A number of alder cuttings was also planted, but a "strike" did not eventuate owing to the dryness of the season.

Lining-out was commenced on the 26th August and was completed on the 18th October, the latter part of the operation being carried out under most adverse circumstances. Two beds of *Pinus Laricio* were left for the following season, and the young plants have made excellent growth. These trees will now require to be left in the nursery lines for one year only. A total of 1,452,000 seedlings were dealt with, at a cost of 1s. 5d. per thousand.

Trees to the number of 1,146,905 were transferred to the plantation during the year, valued at £3,442 10s. 5d., and 82,000 seedling larch were sent to Tapanui Nursery, valued at £82; making a total of 1,228,905 for the year, and 4,867,705 to date.

The total number of trees raised since initiation is 12,198,800, and those raised during the year total 2,470,200. The estimated number at present on the nursery is 4,722,200, and the number available for the coming season's planting is 1,040,000.

Seed-sowing was commenced on the 25th October, and was completed on the 31st. The results have been fairly successful, a very sturdy crop eventuating, but the seeds germinated somewhat thinly especially larch, *Pinus Laricio*, *P. Benthamiana*, *P. austriaca*, *P. muricata*, and *Pseudo-tsuga taxifolia*. On the other hand, *P. ponderosa*, *P. insignis*, *Picea sitchensis*, and *Cupressus Lawsoniana* germinated excellently.

Growth has been good throughout the seed-beds.

Formation.—Before lining-out was commenced, a considerable amount of draining and levelling was necessary. All low-lying portions of the new nursery-area were thoroughly tile-drained, and this work was also carried out on the older area.

Water-supply.—The water-supply at the nursery continues to give satisfaction, although additional pressure would be most desirable in case of any outbreak of fire.

Buildings.—The additions to the nurseryman's house were completed during April, but the erection of a bathroom and woodhouse would be much appreciated. A roof of corrugated iron replaced the felt roofing of the office, as most of the latter material was blown off during a heavy gale. A substantial extension was attached to the workshop, and the accommodation now meets all requirements. A clay floor was put down in the smithy.

Horse-feed.—Good crops of clover and rye hay were harvested in good condition for winter feed. An autumn sowing of 12 acres of oats yielded a good crop, which was harvested during January.

Maintenance-work.—This work consisted principally in repainting building and vehicles. The repairing of tools, vehicles, and implements was also carried on.

Manures.—A sowing of 6 tons of lime was distributed over the vacant areas set aside for seed-sowing and lining-out, and was thoroughly worked in with harrows and cultivator.

Pests.—Hares and rabbits were not troublesome, and no damage was done to young trees. The grass-grub was again in evidence, however, and did very considerable damage to seedling larch. The estimated output was thus reduced by from 30 to 40 per cent.

The grubs have also made their appearance amongst this year's seedling larch, and it is feared that the loss from this source will be again a heavy one. The sowing of "aptorite" has been tried as a means of dealing with the pest, but sufficient time has not elapsed since its application to enable a decision to be arrived at as to results.

An average of 7·91 men were employed on the nursery throughout the year.

Statements of expenditure and values, together with records of rainfall for the year, are appended.

Schedule I.

Month.	Rainfall.	Number of Days Rain fell.	Temperature.		Number of Days Frosts occurred.
			Minimum.	Maximum.	
1910.	Inches.		Degrees.	Degrees.	
April	4·12	7	73	27	1
May	3·22	9	72	20	10
June	6·11	11	70	20	13
July	5·67	16	57	21	11
August	3·78	11	65	24	9
September	2·53	9	71	27	7
October	1·30	4	71	30	3
November	1·95	6	85	32	1
December	5·70	16	81	37	..
1911.					
January	4·08	9	82	32	1
February	5·93	9	85	36	..
March	0·29	3	81	38	..
Totals	44·68	110	..	..	56

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Tree-planting and maintenance—		
Tree-growing	596 18 0	3,499 7 4
General maintenance and repairs	98 3 9	437 6 4
Tree-seeds	85 16 6	477 0 3
Manures	10 15 7	48 19 8
Horse-feed, purchased and grown	69 7 9	409 6 1
Miscellaneous works	28 19 0	144 12 4
Stock and material—Tools, implements ..	31 16 3	531 18 1
Permanent works—		
Buildings	226 5 1	984 6 6
Nursery-formation	92 12 5	452 3 9
Fencing	1 17 6	55 18 5
Water-supply	..	440 0 10
Supervision and clerical—		
Proportion of Superintending Nurseryman's salary	35 0 0	115 0 0
Proportion of Nurseryman's salary ..	101 0 0	590 0 0
Clerical assistance	10 0 0	40 0 0
	£1,388 11 10	£8,225 19 7

Schedule III.—Trees Account:

	During the Year.		Since 1896 to Date.		Estimated Value, as Schedule V.
	Number.	Cost of Raising.	Number.	Cost of Raising and Maintenance.	
		£ s. d.		£ s. d.	£ s. d.
Trees raised	2,470,200	180 3 4	12,198,800	8,225 19 7	..
Trees sent out	1,228,905	709 17 3	4,867,705	3,282 7 6	..
Trees, deaths	2,121,775	..	..	..	..
Balance in stock, 4,722,200 trees					7,553 5 6
Value of land, improvements, and stock (Property Account)					2,710 0 6
Total value					10,263 6 0

Schedule IV.—Property Account.

	£ s. d.
Land (40 acres); Crown land, not charged to Forestry Account ..	..
Buildings	984 6 6
Stock	115 0 0
Improvements	892 4 7
Fencing	55 18 5
Stores in hand	662 11 0
	£2,710 0 6

Sehedule V.—Details of One-year-old Trees, sown 1910–11.

Name of Tree.	Number in Seed-beds.	Height in Inches.	Seed Sown.	Value per Thousand.	Total Value.	Remarks.
			lb.	£ s. d.	£ s. d.	
Larix europaea	1,300,000	4	168	1 0 0	1,300 0 0	Thin crop; sturdy plants; attacked by grub.
Pinus Laricio	900,000	2	140	1 0 0	900 0 0	
„ ponderosa	130,000	2	30	1 0 0	130 0 0	
„ Benthamiana	30,000	3	15	1 0 0	30 0 0	
„ muricata	5,000	5	0½	1 0 0	5 0 0	
„ insignis	22,000	5	3	1 0 0	22 0 0	Fine crop.
„ austriaca	3,000	2	1	1 0 0	3 0 0	Poor.
Picea sitchensis	30,000	1	1½	1 5 0	37 10 0	Good crop.
Pseudo-tsuga taxifolia	40,000	2	8	1 5 0	50 0 0	Thin crop; sturdy plants.
Cupressus Lawsoniana	10,000	1	1	1 10 0	15 0 0	Good crop.
Biota orientalis	200	1½	0⅛	2 0 0	0 8 0	Thin crop.
Totals	2,470,200	..	368⅛	..	2,492 18 0	

Two-year-old Trees, sown 1909–10.

Name of Tree.	Number in Seed-beds.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Larix europaea	..	400,000	18	2 5 0	900 0 0	Splendid growth.
Pinus Laricio	500,000	..	4	1 5 0	625 0 0	Fine crop.
„ „	..	550,000	3	2 5 0	1,237 10 0	Poor crop.
„ ponderosa	..	150,000	3	2 5 0	337 10 0	„
„ muricata	..	6,500	8	2 5 0	14 12 6	Good growth.
Cupressus Lawsoniana ..	..	400	10	2 0 0	0 16 0	„
Thuja gigantea	..	600	8	3 0 0	1 16 0	„
Pseudo-tsuga taxifolia ..	..	3,300	8	2 10 0	8 5 0	„
Alnus glutinosa	..	1,200	11	2 0 0	2 8 0	„
Totals	500,000	1,112,000	..	..	3,127 17 6	

Three-year-old Trees, sown 1908–9.

Name of Tree.	Number in Nursery-lines.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
			£ s. d.	£ s. d.	
Pinus austriaca	460,000	13	3 0 0	1,200 0 0	Very sturdy plants.
„ ponderosa	190,000	9	3 0 0	570 0 0	„
„ Benthamiana	50,000	9	3 5 0	162 10 0	„
Totals	640,000	..	..	1,932 10 0	

Trees transferred from Nursery to Plantations, &c., 1910–11.

Where Sent.	Name of Tree.	Number.	Height in Inches.	Value per Thousand.	Total Value.	Remarks.
				£ s. d.	£ s. d.	
Hanmer Springs Plantation	Larix europaea	586,575	16	3 0 0	1,759 14 6	Sturdy plants.
	Pinus Laricio	264,920	13	3 0 0	794 15 3	Strong plants.
	„ austriaca	226,470	13	3 0 0	679 8 3	„
	„ ponderosa	49,390	10	3 0 0	148 3 5	„
	„ muricata	4,350	14	3 0 0	13 1 0	„
	Pseudo-tsuga taxifolia ..	7,200	11	3 5 0	23 8 0	„
	Alnus glutinosa	8,000	12	3 0 0	24 0 0	Cuttings; very poor take.
Tapanui Nursery ..	Larix europaea	82,000	3	1 0 0	82 0 0	Strong plants.
Totals ..	..	1,228,905	..	..	3,524 10 5	

W. G MORRISON,
Nurseryman in Charge.

HANMER SPRINGS PLANTATION, CANTERBURY.

(Area, 2,568 acres; altitude, 1,225 ft.)

Although not quite successful a season as that of last year, which was a record one in the matter of tree-planting and tree-growth, the past season compares very favourably with it, considering the extreme dryness of the early spring months, when moisture was more needed than any other time.

Of the trees dealt with during the season, pines suffered only slightly from the dryness, and a small percentage of deaths is recorded; larch, however, were very severely interfered with, and the death-rate amongst them was considerably higher than in past seasons. Taking operations throughout, however, the percentage of deaths would not be above 12 or 15, which is comparatively low considering the difficulties met with.

Excellent growth has been made by all trees during the past year, with the exception of two varieties —*Picea sitchensis* and *Pseudo-tsuga taxifolia*—these two having made very little headway.

Larch has again demonstrated its adaptability to this locality by rapid progress. Trees of this variety planted last season have made a vertical growth of from 4 in. to 18 in., and those planted during previous years, and which have become established, have put on a growth of from 2 ft. to 4 ft. 6 in. All varieties of pines have done exceedingly well, and have increased in height to an average of about 10 in.

The total number of trees planted during the year was 1,146,905; of this number, 34,200 were used to replace failures in former planting, and 1,112,705 were planted on an area of 408¾ acres, making a total area of 1,451¾ acres now under forest, containing trees to the number of 3,951,951.

It was found necessary to do a large amount of clearing before pitting operations could be commenced, some 283 acres being dealt with. About three miles of rabbit-proof fencing were erected to enclose part of the new area recently acquired.

Free Labour.—An average of five men was employed on day-labour and 7·83 on contract-work. The cost of pitting was 15s. per thousand; tree-planting, 7s. 3d. per thousand; clearing, 14s. 6d. per acre; fencing, 4s. 4d. per chain.

Pitting.—Pits to the number of 866,880 were dug during the year. The number available for the coming season's planting is 144,500.

Tree-planting.—A total of 745,985 trees were planted out permanently on new area. A large proportion of the proposed planting-area was covered with heavy scrub, and of this, about 209 acres were cut and burned before pitting was commenced.

Type of Buildings used as Stable and Workshop, Tapanui Nursery

Pinus [illegible] at Eweburn Nursery

Face page [illegible]

Formation.—Under this heading the ploughing of fire-breaks was the principal work carried on, some four miles being broken up for the first time. The forming of road-cuttings and culverts also engaged attention in order to give access to planted areas. Grading operations were also carried out in several swampy areas.

General Upkeep.—Under this heading the reploughing of fire-breaks was one of the principal works carried on, some twelve miles of ground being turned over, thus providing an effectual barrier to fires.

The replanting of failures on No. 1 Plantation was pushed on. Pruning and cutting of double leaders were also carried on over the greater part of the same area.

A heavy north-west gale in the late autumn did damage to trees, a large number being blown over, and requiring immediate straightening and firming.

Buildings.—A camp was formed for the workmen at a spot convenient to the area being operated upon. All material required for the erection of the new huts at the prison camp was carted from Culverden by the nursery team of horses.

Pests.—Both rabbits and hares have been kept well in check by dogs and guns, and very few of either of these pests are now within the enclosed area. A green aphis appeared on the *Betula alba* during the summer, and, spreading rapidly from tree to tree, soon affected the whole of this variety. While dealing with some lightly, others were severely attacked, and in some instances entire defoliation ensued. A white blight has appeared on Austrian pine in isolated cases, but, with the exception of one or two trees, no damage has so far been done.

Prison Labour.—The number of prisoners available for forestry operations throughout the year was very small, a daily average of only 7·31 men being employed; consequently, the total value of this labour for the year is very much below that of former years, although the quality is up to the average. Accommodation is available for forty prisoners, but the number of men in camp during the year has usually been below twenty, thus necessitating the employment of additional free labour to cope with the work in hand.

Details and values of work are as follows: Pitting (129,230 pits), £96 18s. 6d.; tree-planting (366,120 trees), £183 0s. 8d.; formation, £20 18s. 6d.; clearing 74 acres, £62 12s. 9d.; general maintenance, £1 10s.; horse-feed, £1 7s.; fencing, 12s. Total value for the year, £396 19s. 5d., which works out at £56 14s. 2d. per man for the year.

Statements of values and expenditures are appended.

Schedule II.—Statement of Expenditure.

	For Year. £ s. d.	To Date. £ s. d.
Planting operations and maintenance—		
Tree-planting	459 15 2	2,388 15 6
Pitting	749 1 8	3,251 15 7
Clearing	214 19 3	1,078 1 11
Cartage of trees	23 16 6	59 19 6
General upkeep of plantation	276 10 0	1,926 14 3
General repairs	3 2 4	11 2 10
Horse-feed	30 9 9	123 17 3
Permanent works—		
Fencing	270 16 10	1,021 13 11
Formation	41 14 10	972 18 7
Buildings	43 8 10	722 0 9
Stock, implements, &c.—Tools, implements	30 4 1	360 13 5
Supervision and clerical—		
Salaries—		
Supervision of free labour	160 0 0	611 14 4
,, prison labour	80 0 0	342 16 8
Nurseryman's proportion of clerical assistance	45 0 0	327 7 0
	2,428 19 3	13,199 11 6
Estimated value of prison labour (apportioned in above items)	396 19 5	4,261 9 9
Actual expenditure	£2,031 19 10	£8,938 1 9

Schedule III.—Tree Account.

	Number.
Trees received during the year	1,146,905
Less to replace blanks	34,200
Planted on new area	1,112,705
Previously planted	2,839,246
Total number planted on 1,451¾ acres (average age, six years)	3,951,951

Schedule IV.—Property Account.

	£	s.	d.
Land (2,568 acres); Crown land, not charged to Forestry Account	..		
Buildings	722	0	9
Stock	..		
Improvements	2,051	0	6
Fencing	1,021	13	11
Stores in hand	123	18	7
	£3,918	13	9

Balance-sheet.

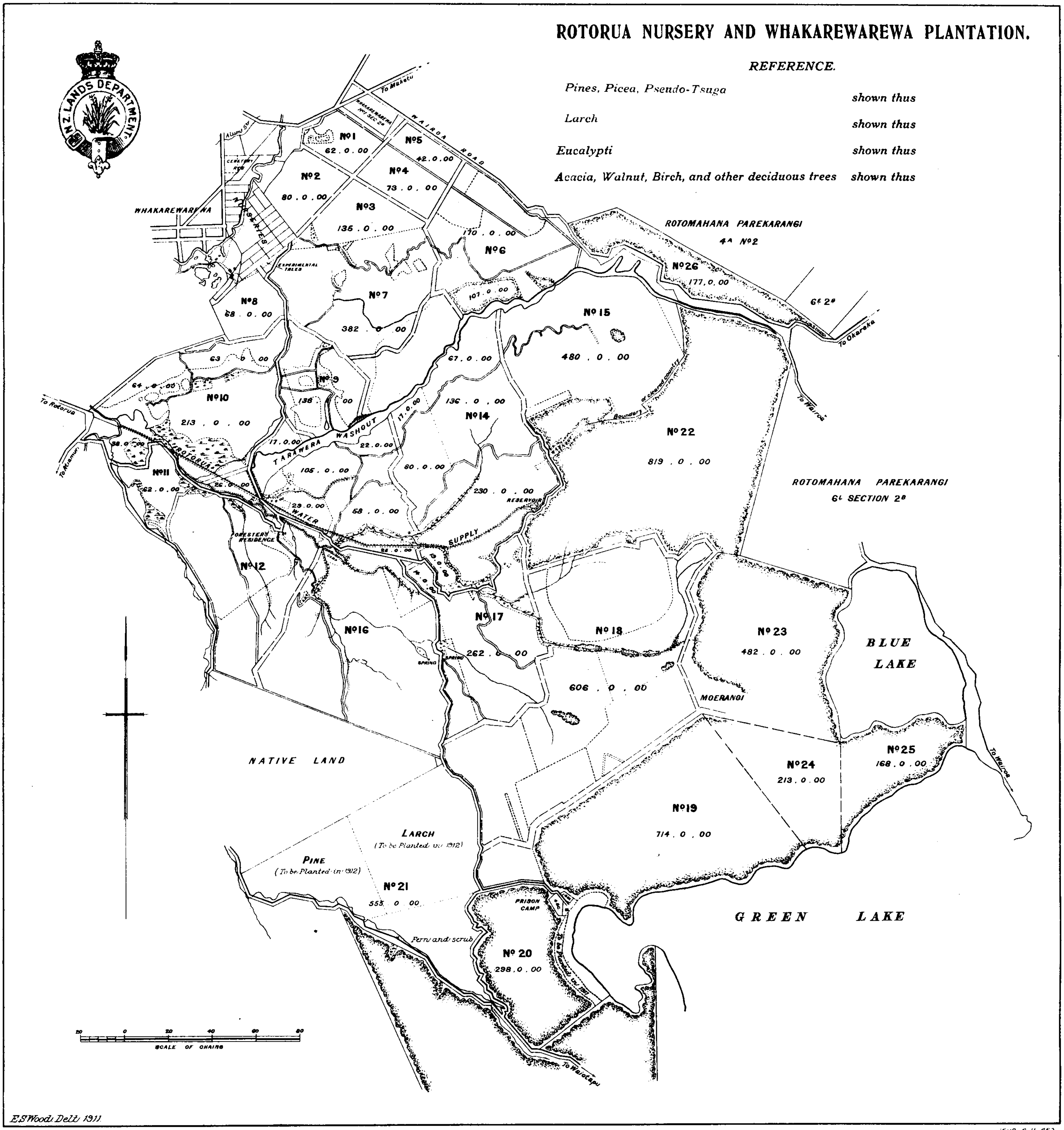
	£	s.	d.
Total expenditure	13,130	15	4
Less Property Account	3,918	13	9
Cost of operations (1,451¾ acres planted; average age, six years) ..	£9,212	1	7
Estimated value of plantation per acre	£10	10	0

A. J. BOYDELL,
Plantation Foreman.
W. G. MORRISON.
Nurseryman in Charge.

Approximate Cost of Paper.—Preparation not given; printing (1,600 copies, including illustrations and maps), £124.

By Authority: JOHN MACKAY, Government Printer, Wellington.—1911.

Price 2s. 3d.


ROTORUA NURSERY AND WHAKAREWAREWA PLANTATION.
REFERENCE.
Pines, Picea, Pseudo-Tsuga shown thus
Larch shown thus
Eucalypti shown thus
Acacia, Walnut, Birch, and other deciduous trees shown thus
N.Z. LANDS DEPARTMENT
WHAKAREWAREWA
WAIROA ROAD
To Mahotu
ROTOMAHANA PAREKARANGI 4A No2
No1 62.0.00
No2 80.0.00
No3 136.0.00
No4 73.0.00
No5 42.0.00
No6 170.0.00
No7 382.0.00
No8 68.0.00
No9 136.0.00
No10 213.0.00
No11 62.0.00
No12
No14 136.0.00
No15 480.0.00
No16
No17 262.0.00
No18 606.0.00
No19 714.0.00
No20 298.0.00
No21 553.0.00
No22 819.0.00
No23 482.0.00
No24 213.0.00
No25 168.0.00
No26 177.0.00
EXPERIMENTAL TREES
TARAWERA WASHOUT
WATER SUPPLY
RESERVOIR
FORESTERS RESIDENCE
To Rotorua
ROTOMAHANA PAREKARANGI 6L SECTION 2B
To Okareka
To Wairoa
MOERANGI
BLUE LAKE
GREEN LAKE
NATIVE LAND
LARCH (To be Planted in 1912)
PINE (To be Planted in 1912)
Fern and scrub
PRISON CAMP
To Waiotapu
SCALE OF CHAINS
E.S.Wood Delt 1911.

By Authority: John Mackay, Government Printer
1600-6/11-463

Plan of
WAI-O-TAPU STATE PLANTATION.

REFERENCE.

Larch, shown thus ....
Pines, „ ....
Eucalypti, „ ....
Birch, „ ....

20 10 0 20 40 60
SCALE OF CHAINS

N.Z. LANDS DEPARTMENT

GALATEA ROAD

PRISON CAMP

OLD CAMP

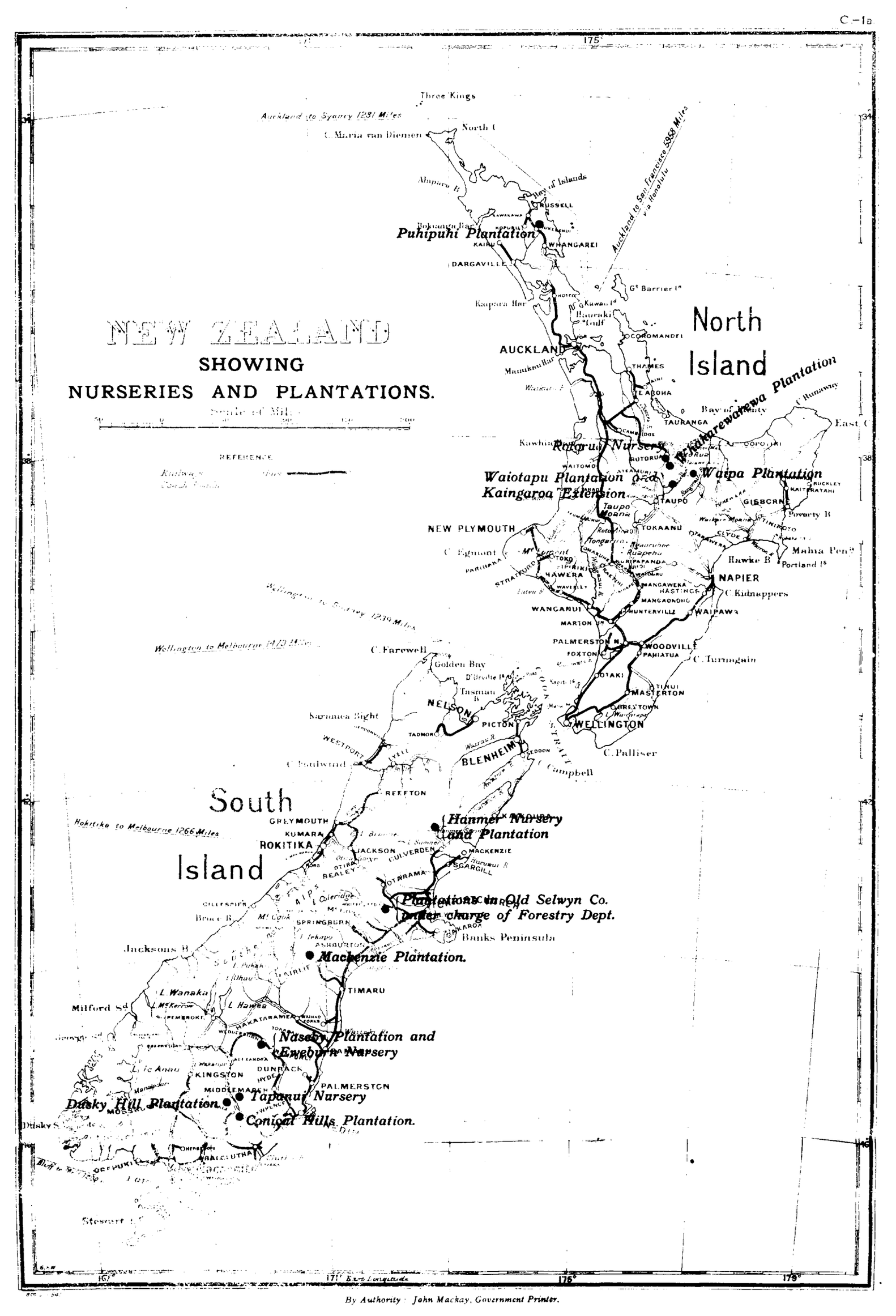
MAIRE ROAD

Nº1 88·2·0
Nº2 36·1·0
Nº3 37·3·0
Nº4
Nº5 71·2·0
Nº6 257·2·0
Nº7 24·2·0
Nº8 27·2·0
Nº9 285·1·0
Nº10 172·0·0
Nº11 191·2·0
Nº12 97·3·0
Nº13 298·0·0
Nº14 324·2·0
Nº15 203·2·0
Nº16 180·2·0
Nº17 73·2·0
Nº18 221·2·0
Nº19 121·3·0
Nº20 119·2·0

E.S.W. 1911

BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.

1600.7.11.17.


NEW ZEALAND
SHOWING
NURSERIES AND PLANTATIONS.
North Island
South Island
Puhipuhi Plantation
Waiotapu Plantation and Kaingaroa Extension
Rotorua Nursery
Whakarewarewa Plantation
Waipa Plantation
Hanmer Nursery and Plantation
Plantations in Old Selwyn Co. under charge of Forestry Dept.
Macenzie Plantation.
Naseby Plantation and Eweburn Nursery
Tapanui Nursery
Dusky Hill Plantation.
Conical Hills Plantation.
Auckland to Sydney 1281 Miles
Auckland to San Francisco 5958 Miles via Honolulu
Wellington to Sydney 1239 Miles
Wellington to Melbourne 1413 Miles
Hokitika to Melbourne 1266 Miles
Three Kings
North C
C. Maria van Diemen
Bay of Islands
RUSSELL
WHANGAREI
DARGAVILLE
Gt Barrier Id
AUCKLAND
THAMES
TEAROHA
TAURANGA
Bay of Plenty
East C
ROTORUA
TAUPO
GISBORN
NEW PLYMOUTH
TOKAANU
NAPIER
Hawke B
Portland Is
C Kidnappers
WANGANUI
HUNTERVILLE
WAIPAWA
PALMERSTON N
WOODVILLE
PAHIATUA
C Turnagain
MASTERTON
WELLINGTON
C Palliser
C Farewell
Golden Bay
Tasman B
NELSON
PICTON
Karamea Bight
WESTPORT
C Foulwind
BLENHEIM
Cook Strait
Campbell
REEFTON
GREYMOUTH
KUMARA
HOKITIKA
JACKSON
CULVERDEN
MACKENZIE
OSCARGILL
Banks Peninsula
Jacksons B
Bruce B
ASHBURTON
TIMARU
L Wanaka
Milford Sd
L Hawea
KINGSTON
DUNEDIN
PALMERSTON
MOSGIEL
OREPUKI
BALCLUTHA
Stewart I
Foveaux Strait
Dusky S
Auckland
Wellington
Christchurch
Dunedin
Invercargill
Bluff
Scale of Miles
REFERENCE
Railways
Roads
Rivers
Boundaries
By Authority: John Mackay, Government Printer.