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and auxiliary levelling, making a total for the season of 1,345 miles. In connection with this section of the work of the Department it may be mentioned that a new pattern aluminium staff has been designed, and will be experimentally tried. The magnetic survey work was continued and the usual tables prepared. The Reproducing offices continued to do good work, records showing that the photo-litho office is turning out work more cheaply and at a greater speed than it had done in the two previous years.

Reafforestation of Depleted Hardwood Areas in the Coast Districts of New South Wales.

Some Practical Notes upon the Work necessary to Encourage, Assist, and Protect New Forest Growth upon Worn-out Forest Areas in the Coastal Districts.

BY C. J. CLULEE, *District Forester.*

The present condition of the coastal hardwood areas may be summarised as follows :—

- (1) Virgin forests in inaccessible places and in localities which are beyond the reach of timber-getters under present conditions of market values and cost of transport.
- (2) Areas from which only the more valuable trees have been removed owing to the cost of transport being prohibitive, except in the case of timber suitable for special purposes, and commanding a high price.
- (3) Areas partly depleted, which are being heavily drawn upon for present supplies.
- (4) Areas from which the best timber of all classes has been removed, but which still contain quantities of timber of some economic value.

The ideal of forest management is to insist upon the thorough working out of forest areas before operators are permitted to break fresh ground. There are, however, many circumstances which render the achievement of this ideal impracticable. Timber-getting is a commercial pursuit, and is governed entirely by commercial considerations. The work of opening up the country with railways, and the construction of harbour and other national works, has the effect of maintaining a constant demand for heavy timber of good quality which can only be obtained from the best trees. To this may be added the large and constant demand for timber of good quality for building

purposes. The demand for timber for minor purposes is not nearly so great as that for timber of fine quality, while the supply of timber for such minor or secondary purposes is, at the present time, and under existing conditions, illimitable. In the densely populated countries of the old world, timber-getting operations may be conducted with a minimum of waste, as, owing to the demand for small sections of wood for conversion by turnery into articles of every-day use, every portion of the trees felled may be turned to account. Conditions in New South Wales, however, are entirely different, and much of the so-called waste of timber which occurs during forest operations arises from the fact that, under present conditions, and taking into account the questions of locality and accessibility or cost of transport, timber below a certain standard has no commercial value. The term hardwood, is applicable to, and includes, many varieties and species, some of which, although yielding valuable and lasting timber, have not yet been accorded a place in the favour of timber users, and are therefore at the present time practically unsaleable. In general terms, therefore, it may be safely estimated that of the present-day demand for timber, more than 60 per cent. is for timber of prime quality, and that, in the coastal forests, not more than 25 per cent. of the trees contain timber of quality suitable to satisfy such demand.

In undertaking reafforestation work it is difficult, therefore, to find any extensive areas in the coastal districts which have been depleted of all useful timber. Fortunately, however, there exists the necessity for leaving, during forest cleaning operations, a proportion of the existing matured trees for seeding purposes, and in deciding what to leave and what to destroy, trees which, in the opinion of the workman (who should be an expert bushman), contain timber which may eventually be of value, should be preserved for the purpose of producing seed, only the absolutely useless trees of the best species and the whole of the inferior species being destroyed. Of the fourth class in the above summary, viz., areas from which all the best timber and the timber of present market value has been removed, large tracts exist, and to this class of forest country operation for the encouragement of new growths should be confined. Accepting as indisputable the axiom that worn-out forest areas require treatment by ringbarking and the felling of scrub and weeds, as a preliminary to the firing of the areas to clear the forest floor, the question as to what season is most suitable for carrying out this operation requires consideration.

Season for Ringbarking.

The experience gained by the ringbarking of millions of acres during the progress of settlement affords no reliable guide upon this question. Settlers ringbark to destroy timber absolutely, and endeavour to ascertain the particular time of year when the trees will be least likely to throw out sucker and root growth. For forestry purposes it is desirable that young growths upon prepared areas should be dense and thicket-like in the preliminary stage, in order that, fighting for light and life, the more vigorous saplings may shoot upwards as nearly branchless as Nature will permit.

In order of value, growth as the result of ringbarking operations may be placed as follows :—

- (a) Seedling growths.
- (b) Growths from the root system.
- (c) Sucker growths from young but defective trees which have been ringbarked close to the ground.

Useless growths comprise—

- (d) Growths of inferior species.
- (e) Sucker growths from the stumps of large trees.
- (f) Forest weeds and scrub.

During the preliminary stage, until thinning should be necessary, all useful growths, however dense, should be encouraged, to assist in choking out those which are inferior and useless. Apparently, therefore, the season, most suitable for ringbarking for reafforestation will be the period when sucker and root growth is most likely to be produced. Settlers ringbark "when the sap is up," that is, at the close of a period of active growth, when the root system is exhausted, and, therefore, unlikely to produce aftergrowth. For forestry purposes, therefore, ringbarking should be undertaken after the dormant period and when the root system is ready to supply nourishment during the period of active growth, *i.e.*, in the spring.

Effect of Ringbarking on Trees.

Trees that have been merely ringbarked die slowly. Trees that have been ringbarked and sapped die more rapidly, referring, of course, to the portion of the trees above the ringbarking level. Trees ringbarked and sapped during the dormant period (or, as bushmen say, "when the sap is down") take longer to die than trees ringbarked and sapped when in active growth and full of sap for during the latter period the formation of new leaves and the expansion of the trees is dependent upon a continuous supply of nourishment and moisture being furnished by the root system. As the trees die, the leaves wither and fall, the twigs and smaller branches become brittle and are wrenched off by the wind. The bark shrinks, cracks, and becomes loose, and falls off in great sheets. Finally, many large, decayed branches fall, and the forest floor, which, previous to ringbarking, is probably cluttered with the heads of trees felled during operations since the last bush fire, become a veritable litter of highly inflammable material.

Effect of Bush Fires.

Bush fires do damage in proportion to their severity, and they are severe in proportion to the amount of inflammable debris on the forest floor. Irrespective of the litter left by timber-getters, large matured trees throw down more leaves, branches, and decayed limbs than do young, growing and healthy trees, and it is consequently those areas which contain a large proportion of matured trees which

usually suffer most damage from bush fires. Several bush fires among matured or partly matured hardwoods have a damaging effect, by inducing a lateral growth from the trunks, to the detriment of the timber, but the vitality of the various species of hardwood is so great that rarely, and only under exceptional circumstances, does a bush fire cause the death of a hardwood tree.

To the hardwood sapling, during the early stages of growth, and to all seedlings, the bush fire is disastrous, and all possible precautions are necessary to prevent its occurrence. Dense stands of saplings in a healthy condition, however, throw down only leaves and small discarded branchlets. These soon decay, and do not at any time afford much fuel for bush fires, and where there are no matured trees, the risk of damage by bush fires is inconsiderable.

When to Burn after Operations.

After a fire runs over the forest floor, as soon as conditions are favourable, seedlings and root suckers appear. Should a second fire sweep over the area before these are established, it will destroy the whole growth. Bearing in mind the effect of bush fires upon areas in different stages of maturity, it is obvious that, to ensure the safety of the future crop by making the occurrence of a second fire impossible, it is imperative that the fire used for the purpose of clearing the forest floor should consume the whole of the debris resulting from timber-getting, ringbarking, and scrubbing operations. Apart altogether from reforestation operations, the frequent use of fire during the cooler months to keep the forest floor clear of inflammable accumulations is probably the most efficacious method of preventing the occurrence or the spread of bush fires during the hot summer months. Fire used to consume a light mulch of debris at a period when the land is moist and the trees are full of sap, is known as light firing. Fire, under such circumstances, does not burn fiercely, does practically no harm to the forest, and prevents the heavy accumulations of forest debris which otherwise, during hot spells, greatly increase the severity of bush fires. Light firing, however, is neither possible nor desirable where the accumulations of debris are heavy, as must certainly be the case when a treated area is in a condition for firing. It being essential to future safety that the whole of the inflammable material should be consumed in one operation, fire should not be used upon any treated area until the stage is reached in which the leaves and minor branches have fallen, and the bark has loosened upon the dead trees.

Firing should then be effected, preferably in the spring, when the seed in the ground will to a considerable extent be protected by the soil moisture, but at a time when the rubbish is sufficiently dry to ensure its complete destruction. The result will be an apparently disastrous conflagration, but no harm to the area will result. A severe fire upon an untreated area, by scorching the green foliage and causing it to wither and fall, results in a further littering of the forest floor with debris enough to carry a fresh fire in a few weeks' time. No such effects need be anticipated in the case of an effective fire used to clean an area treated for reforestation. The utmost

harm it can do is to destroy a small proportion of the trees left for seed-producing purposes, and to scorch the foliage of the remainder; the leaves from these comparatively few trees will not cause any litter worth considering.

As already explained, young healthy forest growths do not throw down much waste to litter the forest floor, and the crop produced upon a treated area that, previous to regeneration, has been thoroughly cleared of inflammable rubbish, may reasonably be expected to be safe from damage by fire during the early stages of growth, when the effects of fire are most disastrous. A further element of safety will be provided by the density of the prospective crop, which will protect the forest floor from the drying effects of the sun during the summer months, and prevent such slight accumulations of waste as may be present from becoming a source of danger. A practical illustration, showing that a severe fire will not harm, but may assist, aftergrowth, is available on Forest Reserve No. 14,927, near Ourimbah, in the Wyong Forest District. During 1903 or 1904 a number of large blackbutt trees were felled by sleeper-cutters on a small area near the boundary of Portion 95. These trees were felled so close together that the heads made a solid mass of litter. During the memorable heat wave early in January, 1909, a bush fire swept over the reserve, and the fire on this little patch of land was so severe that almost the whole of the great tree heads was consumed, and the ground was burned to a reddish tint, giving it the appearance of a brick kiln. To-day, only four years after the fire, a dense stand of splendid blackbutt saplings, up to 30 feet in height, occupies the spot where the fire had apparently baked the soil into absolute barrenness.

Seed Available for Regenerative Purposes.

Areas which have been ringbarked by settlers and afterwards abandoned or neglected produce dense crops of seedling hardwoods, and this may be taken as an indication that sufficient seed is available in the soil of areas upon which the timber has been destroyed to bring about natural reafforestation. Upon the question whether seed falling and becoming buried in the soil retains its vitality for any length of time, or whether only freshly fallen seed is capable of germination, a diversity of opinion may exist. Nature, however, provides for the perpetuation of species. A wattle tree, if the bark is entirely stripped from its trunk before the blossoming period, will not die until it has blossomed and produced a crop of seed; when trees, owing to injury or decay, are dying, they produce and shed large quantities of seed before death. The ringbarked trees, upon any area treated for reafforestation, may, therefore, be expected to produce, ripen, and shed ample quantities of seed upon the areas before dying as the result of ring-barking, and to this may be added the seed shed annually by the trees specially left for the purpose. The supply of seed available may, therefore, be regarded as ample.

Points to be observed in Conducting Operations.

To ensure success, care in conducting operations is necessary. The workmen should be men skilled in bushcraft, who are able to

form a reliable opinion as to whether any tree should be destroyed or saved. The trees should be ringbarked and not sapped, in order that death may not result so rapidly as to destroy the probability of a crop of seed being produced. The scrub should not be felled at the time the ringbarking is done, but should be left until a few months before the ringbarked timber is ready for firing as when scrub is felled for any length of time before the area is burned trouble is likely to be experienced with a fresh growth of scrub, which, being green, interferes with the complete success of the firing operation.

Care of Areas after Firing.

After an area has been thoroughly cleaned with fire, all browsing animals should be excluded therefrom. Should patches be discerned upon which no seedlings appear after a reasonable length of time, it may be advisable to broadcast seed of suitable species. Where the growth of weeds and vines appears likely to choke out or hinder the crop of seedlings, the noxious growths should be destroyed before they attain any size, in order that the operation will not leave any appreciable amount of inflammable material on the area. All operations on the area should be absolutely prohibited, and care exercised to guard against wanton destruction. Upon areas which were, previous to denudation, clothed with a mixed forest growth, it is inevitable that the inferior species will reproduce themselves as readily as will those of commercial value. Where large patches of inferior species make their appearances, to the exclusion of the more valuable kinds, it may be found advisable to root up the young growth and to seed the patches with such of the better classes of hardwoods as are known to thrive in the locality. With the exception of this work, and the destruction of weeds and of vines which, growing rapidly, tangle the young saplings in a meshwork and destroy their symmetrical growth, no interference with the crop should be attempted until the growth reaches such a stage that thinning becomes advisable. It may then be found desirable to afford space by destroying defective growth and those of inferior species. The first thinning should be upon a moderate scale only, the leafy portions of the thinnings being placed in small piles and fired under careful supervision.

Eventually an even aged forest will be produced, which, from time to time, may be judiciously thinned out, the thinnings being available for—

Mining props and small poles,
Telegraph poles, scaffold poles, etc.,
Piles and small girders,

until the quantity of timber remaining has sufficient space to develop and mature into milling timber.

Thorough Clearing Expensive and Unnecessary.

The presence of stumps, standing dead trees, and waste logs upon areas prepared for reafforestation need not be taken into account. If their removal were necessary the cost would be prohibitive. Such logs as are left after an effective fire has swept the area treated are not readily inflammable, and their presence does not increase the risk

of the young timber being damaged by subsequent fires. Standing dead trees will eventually fall as the result of decay, and may cause some destruction, but where the clearing fire has been effective most of the heads will have been burned off, and the damage to be apprehended from this source is not sufficient to justify the expense which would be incurred in removing the trees.

Probable Cost of Operations.

The cost of ringbarking, scrubbing, and firing should not, on the average, and at a liberal estimate, exceed £1 per acre. The cost involved in seeding blank patches and in caring for the young crop cannot be estimated with any degree of accuracy, as the amount of such work required will vary with conditions and circumstances. The whole cost, however, as compared with the cost of producing similar results by planting, is infinitesimal, and ultimately, as the success of this method of assisting Nature to renew worn-out forest areas in the coastal districts becomes apparent, it is to be hoped that the wisdom of allocating a portion of the annual forestry revenues for reafforestation purposes will be recognised.

Correspondence.

Mr. Rygate has kindly communicated the following letter, which he has received from Mr. J. E. Sears, M.A. (Cantab.) Assoc. M.Inst.C.E., Metrologist of the National Physical Laboratory, in reply to inquiries he made there during his recent trip abroad.

THE NATIONAL PHYSICAL LABORATORY,
TEDDINGTON, MIDDLESEX,

30TH JANUARY, 1914.

P. W. RYGATE, ESQ.,
CITY BANK CHAMBERS,
164 PITT STREET,
SYDNEY (NEW SOUTH WALES.)

DEAR MR. RYGATE,

I think the following notes will answer the queries in your letter.

(1) As regards the fundamental standard: the "Comité International des Poids et Mesures" was formed in 1875, for the purpose of setting up international standards of weights and measures. Its first work was the setting up of a new *international* prototype standard,