

have failed, whilst of seventeen species of other genera only seven have proved quite suitable for the locality. Of the failures, some have been unable to bear the frosts of winter; but the great majority have been injured or killed by late frosts. In this district, given a clear night and a light southerly wind, frost may occur at any time of the year; and if it is the spring or early summer, when the trees have much tender growth, the effects on many species are disastrous. Other species, uninjured by frosts, have proved unsuitable because they make very little progress for several years after planting out, and it is necessary, to prevent their being smothered, to keep the growth of fern and tutu cut back till the trees push their heads above it: this involves considerable expense, and therefore faster-growing species are more desirable.

In 1904 Whakarewarewa Plantation was enlarged by taking in an adjoining block of land, and a second prison camp was formed. Since then the work has been carried out steadily in both plantations—at Waiotapu chiefly by prison labour, and at Whakarewarewa by prisoners and free men; and an area of 11,000 acres has been planted with about twenty-nine million trees, the annual planting being now four or five million. With the exception of some small areas, which can be more conveniently planted by free labour, the selected area at Waiotapu is now planted up, and the camp is being removed to a new site on the Kaingaroa Plains, where some 30,000 acres are available for this work.

*Sylvicultural Systems.*—At first it was decided to grow the trees chiefly in mixed woods, and theoretically this would seem the correct system, as such woods suffer less from the attacks of insects and disease, and also produce a greater volume of timber, than pure woods. Under the first plans for Whakarewarewa Plantation the trees were planted at 5 ft. intervals, the mixture consisting of redwoods, 108 per acre; sycamore, 327; Austrian and Corsican pines, 1,307. On a second block the intervals between the trees was reduced to 4 ft., and the mixture consisted of redwood, 680 per acre; larch, 2,042.

On paper these plans were fairly correct. A. C. Forbes, Chief Forestry Inspector for Ireland, in his "Development of British Forestry" (1910), dealing with the subject, says, "An ideal mixture might be regarded as composed of four constituents—First, the species that will develop into the profitable crop at the end of the rotation adopted; second, the species that will aid in the development of the permanent crop, and create and maintain suitable soil-conditions, and protect the crop against wind; third, a species that will act as nurses, and yield some return in the shape of thinnings before the thirtieth or fortieth year; and fourth, trees that will suppress and kill out surface vegetation during the first ten or fifteen years after planting. The two former species may be regarded as permanent and indispensable; the two latter as temporary components of a forest crop which may or may not be regarded as necessary, according to circumstances."

In the pine mixture the intervals were too great, especially in the case of the Austrian pine, which is a shade-bearing species, developing strong side branches, and which must be planted very closely to produce clean timber; and in the second mixture, larch, being highly light-demanding, would not provide sufficient protection for the soil, one of the first rules for the formation of mixed woods being, "The ruling (more numerous) species must be soil-improving" (Schlich, "Manual of Forestry"). However, as the trees grew a more serious defect developed, and the plans failed because the nurse-trees outgrew the sycamore and redwood, and, with the exception of a few trees at the outer edges of the plantations, have suppressed them completely.

Later a mixture of larch and Douglas fir was planted on a third block, and this has proved more successful. The latter species is of very variable growth: a fair proportion hold their own with the larch, whilst others make comparatively poor growth, and will probably be suppressed, but this would occur also in pure woods of the species.

In the season 1907-8 a mixture of Douglas fir, larch, and redwood was planted in a more elevated position; but, so far as can be judged by present growth, the results will be very similar to those of the former experiments—the bulk of the redwood will be suppressed, and only a portion of the Douglas fir will keep pace with the larch.

In the season 1910-11 Douglas fir and larch were planted in alternate rows, also white-cedar and larch. No indication as to how these mixtures will succeed can be expected for some years, as the trees make little height-growth for some time after transplanting.

Eucalypti have usually been planted pure at intervals of 6 ft. On some blocks various species have been mixed without apparent effect, good or bad.

Waiotapu Plantation being exposed to very severe frosts, pines have been more extensively planted than at Whakarewarewa. Mixed planting has been largely adopted, Austrian, Corsican, Weymouth, and heavy pines being the predominant species. It seems doubtful, however, if much is to be gained by planting mixtures of pines. The chief recommendation of mixed woods is their comparative immunity from attack by insects or disease; but when the species mixed are so closely allied it is probable that they will have common enemies.

Austrian pine has proved too slow-growing to form a satisfactory mixture with any of the other species; being a shade-bearer, it has not as yet suffered from being outgrown, but may be affected as the other species increase in size, and the latter, having too much space, will maintain their side branches longer than is desirable.

Heavy pine planted in mixture assumes the lead from the first, recovering from the effects of transplanting more rapidly than other species, and increases this lead about the sixth or seventh year.

Corsican and Weymouth occupy a middle place in respect to height-growth, and should form a fairly satisfactory mixture; but this combination was first tried in 1909, and therefore a decided opinion cannot be formed at present.

Douglas fir and Corsican pine were planted in mixture in the season 1903-4. Apart from the defect of the uneven growth of the former, this seems a good combination.