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Forestry in Canterbury 100 Years Hence

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Abstract

Using as a basis the known facts and recognisable trends of today, an attempt is made to describe forestry in Canterbury in the year 2062.

Tentative forecasts are made of the probable geographical distribution of the forests of the future, of what probably they will look like, and of how probably they will serve the varying needs of the then community. In order to do this, certain basic human economic, technical and climatic assumptions have necessarily been made.

Introduction

Some while ago, the well-known scientific commentator, Nigel Calder, had occasion to criticise the British Association for the Advancement of Science for the over-specialisation evident in papers presented at its meetings and for the failure of scientists to stress the implications of their work on human and social values. He had this to say: " What I look for from B.A. is generally a reading of the signs, a giving of hints and indications of what science has in store for us, [an appreciation] of the ramifications which are tangled under the heading ' Social Implications '. In much of what the scientists reported at the last B.A. meeting, there was evidence of striking progress in scientific technique, but the consequences seemed remote ".

It is this suggestion that a proper function of a Scientific Congress is to interpret the probable future in the light of the known present, and to interpret it in terms of human needs and values, which prompts me to select the topic " Forestry in Canterbury One Hundred Years Hence " as the subject of my Presidential Address. I do so with some diffidence, since it would be a brave man indeed who would presume to foretell with any assurance what technological and social changes the next century will bring; and since also I make no claims to be well qualified to read all the present signs and indications in the various

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disciplines connected with forestry. But my diffidence is perhaps lessened by the fact that in all probability none of you here today will be alive in the year 2062 to prove me wrong.

Assumptions

In approaching this subject I have to make certain assumptions, or rather acts of faith, and these I do make with some confidence. The first such act of faith is a human one. It is that Canterbury will still be peopled by human beings in the year 2062; in other words, that the human race, with the means now at its disposal, will not meanwhile commit genocide. I think that all of us make this act of faith, otherwise we would not, as we do, plan for the future; and in particular we would not, as some of us do, assure that there is a future by begetting children. Perhaps this act of faith may come easier to foresters than to most other people. As a professional group, we commonly think of and plan for the needs of the community 30, 50, 100 years hence, or for even longer periods. By nature of our calling we are and always have been accustomed to this extremely long-term forward thinking. We could not practice our profession unless we had faith in it, and in the future of the human race. You do not plant trees for posterity without assuming that there will be one.

The second act of faith is an economic one. It is that the future population of Canterbury will enjoy at least as high a standard of living as do its occupants today. In this context, it is not of great importance, though it is of some, whether future Cantabrians are New Zealanders in the sense we know—i.e., primarily of British descent, or whether they are admixed either with European or with Asian races. It is the standard of living which is the important point, and hence the level of the demand which the community will make on products from the forests.

This leads up to the major or technological act of faith, that the diverse benefits which forests confer will be as much in demand in the future as they are today. There can be no doubt that the group of benefits sometimes termed forest influences will be even more necessary. We will require a greatly extended area of primarily protection forest, forests to control soil erosion, to regulate run-off, to ameliorate flooding; in short to ensure the very existence of the farms and cities and communications of the lowlands beneath them. I repeat, there can be no doubt about this.

But it may be asked if the physical yields of forests and wood and its derivatives will still be needed by the communities a hundred years hence. It may be thought that we are entering into an era of such technological change and scientific ingenuity that cheaper and more efficient substitutes may be found and that large scale production forests may no longer be necessary. I believe the reverse to be true. I will confidently prophesy that wood will continue to be, as it is today, one of the indispensable raw materials on which civilisation is based. The reasons for this are twofold. Firstly, unlike coal, oil, natural gas or minerals, forests are a readily renewable raw material resource. So, of course, is any product based on the utilisation of solar energy; in fact, there are few renewable forms of either raw materials or energy which do not derive directly from the sun. This brings me to the second reason, which is that through the photosynthetic process, forests or at least exotic forests in New Zealand, are a singularly efficient way of transforming solar energy. The annual dry-weight production per acre from a *Pinus radiata* forest in New Zealand is one of the highest of any form of vegetation in the world. I emphasise that the lasting importance of wood is that it is a readily renewable resource, and that the lasting importance of production forests is that they are one of the most efficient means of converting the major renewable source of energy, sunlight.

The Nature of Wood

One could spend a long time discussing the nature and properties of wood itself, and its probable future uses, but I will endeavour to be brief. Basically three things can be done with wood. It can be used as such (i.e., with its structure intact); it can be broken down by mechanical or chemical processes into its constituent fibres and reconstituted in the form of paper or other fibre products; or by hydrolysis it can form the base for a wide range of chemical products.

Wood in its raw state is a remarkable substance. The English author, C. E. Montague, once wrote "how he loved the stuff, as strong as iron, as carvable as cheese. What genius could have conceived so delicious a union of opposites, if by some disaster, it had not been fashioned by nature". He was speaking of ice, not wood, but his remarks are still apposite. What genius could have conceived the opposites of lightness and strength, of ease of working and rigidity, of general utility and beauty? Wood has all of these properties and others as well: good heat and sound insulation, low electrical conductivity, resilience, physical durability, great compressive strength and stiffness. It has, of course, some major defects, but most of these are susceptible to correction; thus, durability in the face of biological hazards can be imparted by chemical means, as can fire resistance; dimensional instability can be reduced or eliminated by such techniques as kiln drying, the application of protective coats and cross banding in the reassembly of wood pieces. The latter principle can be adopted in the manufacture of products such as plywood, particle board and glued laminations to overcome the other main disadvantage of wood, the fact that its strength is largely unidirectional. Careful design will also minimise this disadvantage.

Processed Wood

Furthermore, wood can be impregnated with resins, with or without pressure, or can be compressed with or without impregnation, to impart a further wide range of desirable properties and to enable its use, singly or in combination with other materials, for a further wide range of structural and commodity purposes. Wood in its natural or semi-natural state, i.e., with its oriented strength unimpaired, is likely to survive on sheer merit as a basic raw material. The peoples of 2062 will use it and will need large quantities of it.

They will need even larger quantities of wood in the second major type of use as fibre board, container board and paper in its various forms. We are entering into an era of pulp and paper products—newsprint and other printing papers, wrapping paper and multi-wall paper bags, cardboard and corrugated boards for the packaging industry, tissues, writing papers, wood textiles, and a host of others. In civilisation as we know it today, there is a strong positive correlation between standard of living and per capita consumption of pulp and paper; and there is no reason to assume that this correlation will not hold good in the future. Certainly paper can be made from other materials, notably from bamboo and from rice straw, bagasse and other agricultural residues; but for the reason already indicated wood is likely to remain its basic source. There can be no doubt that future generations will need pulp and paper products and will need them to an increasing degree, and there can be no doubt also that coniferous forests will continue to be by far the largest source of supply.

The quantities required in the future will be phenomenal. I will not attempt to prophesy them but will merely ask you to consider the facts; that whereas the annual per capita consumption of paper in U.S.A. is 403lb, in Japan it is 87lb, and in India it is only 2.4lb; that as the Asian races become literate and become industrialised their consumption of paper will rocket, as it did in Japan when these events occurred; and that well before the year 2062 the population of the

Asia-Pacific region is likely to be over three thousand million people. When one considers combined, the implications of these facts, one can have no doubt as to the magnitude of the future demand for pulp and paper products; the only doubt is where in the region will there be a sufficient area of suitable land to grow the necessary forests.

Wood as a Raw Material

Finally, wood will still be required as a major raw material for a wide range of organic chemicals. The cellulose molecule is readily convertible to sugars and hence to alcohols and aldehydes; and these compounds will become even more important than they are today as the base for many essential chemical industries. Other products will be solvents, explosives, synthetic rubber additives, plastics, and jet and rocket fuels. Today the conversion of woods through sugars to alcohols is economic only on a very large scale. Whether or not this will still be true in the future, world usage of wood as a source for industrial chemicals must continue to increase. A further understanding of lignin chemistry will open up still new fields for the chemical utilisation of wood. Lignin, which constitutes between 25% and 30% of wood weight, is today largely a waste product in both chemical pulping and hydrolysis processes. It would be safe to assume that the necessary scientific break-throughs will have been made by 2062, and that by then lignin will have joined cellulose as a cheap base for large scale and diversified chemical industries.

Climatic Change

So much for the three basic acts of faith. A further assumption must be made and that is that there will be no major climatic change during the next 100 years. You will all be aware (and none more than Canterbury skiers) that we appear recently to have gone through a period of low precipitation at high levels in the mountains, resulting in lighter or more infrequent snowfalls and in spectacular glacial retreats. However, I am given to understand that at all lower altitudes, including the zones in which forests would be grown, there is no evidence from climatic records of any consistent or significant trend in either mean temperatures or mean rainfall. As far as meteorologists can tell us, the climate has not changed over the last fifty years and is not in the process of changing; one can only assume, therefore, that this state of affairs will continue and that forests maturing in the year 2062 will have grown under much the same climatic conditions as they experience today. If this assumption is incorrect it would invalidate some of the conclusions which I will be drawing. Thus, if the climate becomes significantly colder it could affect the suitability of some of the main exotic tree species, particularly at the upper altitudinal limits of the foot-hill zone, and it certainly would affect the altitudes up to which forests could be grown for soil conservation purposes in the mountain lands themselves. If the climate becomes significantly warmer, it could likewise affect the choice of species for both production and protection forestry. In either case, in the year 2062 we would be in the process of converting the existing forests to other species or genera or to different provenances of the same species. However, the possibility of such major changes seems remote.

Having made these assumptions or taken these acts of faith, the major questions which then arise are—what place will forestry have in the Canterbury of 100 years hence, where will the forests be, and how will they differ from the forests of today? I have already given an indication of the role which I think the forests of the future will play in general, and I will be further referring to particular Canterbury applications in some of the remarks to follow.

LOCATION OF FUTURE FORESTS

Indigenous Forests

In discussing the probable location of future forests it is necessary first to make mention of the indigenous forest estate. At present, in round figures, this totals a mere half million acres, only 3.5% of the national total and only 5% of the land area of Canterbury. Since so much of Canterbury is in a true non-forest climate, it is not at all surprising that these percentages are so low. What is perhaps surprising is that Canterbury has almost exactly the same proportion of the original (pre-European) indigenous forest area as New Zealand has as a whole. In both cases the figure is approximately 50%. Canterbury is fortunate in this since in no other province are the indigenous forests of the foothills and mountains of more importance to the lowlands which they help to protect.

I would like to be able to suggest that the area of indigenous forest will be increased during the next 100 years, but the possibilities are remote. The other half million acres has gone and gone forever, for the simple reason that the conditions under which the forests developed have changed irrevocably. Locally and in the absence of animals, mountain beech forests may spread out from forest margins or re-develop through a nurse crop of scrub. But in general they constitute a residue which is incapable of major expansion.

Unfortunately, it is probable that the trend will be towards reduction rather than expansion. It is not that they will be further cleared for grassland or subjected to destructive exploitation; we have learnt too many lessons to repeat these mistakes. Nor, I hope, will they be destroyed by fire, although the risks of large uncontrolled fires will always be present, and some smaller fires are bound to encroach into them and gradually erode away the margins.

The threat to their existence is a different one and arises from the presence of browsing animals, of which the main culprit is red deer. As long as large numbers of deer use the forests for winter range and destroy the annual or periodic crop of forest tree seedlings, the forests are inevitably doomed. Their life will be no more than the life of the existing canopy trees. If they are not replaced by younger age classes, the forests as such must ultimately disappear. Later, I will suggest that in time we will gain sufficient control of deer to ensure forest regeneration, but I fear that before this state of affairs is reached much forest degradation may take place and some small isolated forests may disappear. Succeeding generations no doubt will prevent this by every means possible. They will do well if they do no more than keep intact the already precariously small residue and at the same time improve its condition and its effectiveness as a protective vegetative cover.

Exotic Forests

So much for the indigenous protection forest; where and how extensive will the exotic production forests be? I am not going to indulge in detailed and hypothetical forecasts, to prophesy the population for the year 2062, the likely per capita consumption of unconverted wood, the average rate at which forests will produce this wood, and hence the area of forest necessary to supply the estimated requirements. The assumptions are too great. We can make them with some precision for 20–25 years, less accurately for 40–50 years; it would be a pointless exercise to do so for as far ahead as 100 years. Rather I will suggest that by the year 2062 and, in fact, well before then, rational and sensible land use considerations will prevail. Further, I suggest that they will prevail not only in Canterbury and in New Zealand, but in the whole geo-political region of which New Zealand is already, and will then be even more, an integral and integrated part.

Land Use

Foresters of today have a popular and rather over-worked catch word called multiple-use. The best definition I know is: "The accommodation of the maximum of other compatible uses with the highest possible use of the land." This probably cannot be bettered as a prescription for land use generally, but it does beg the question of what is the highest possible use. The author of the definition begged no question; in his context it was that use which best met the wishes of the owner. In the wider context in which I have chosen to employ it, the highest use of any piece of land is that which most efficiently utilises its particular soil and climatic characteristics to supply the most important needs of the broad region in which the land is situated. The emphasis is on the words "most efficiently", and foresters will want to adhere to this emphasis. They will agree with the rest of the community that the population explosion in the Asia-Pacific region is going to demand that all land suitable for efficient and economical food production must be put to that primary purpose. They will be most careful before they will suggest that because the same population explosion will create an almost insatiable demand for pulp and pulp products, land with a highly efficient food producing potential should be diverted to growing cellulose. Again the emphasis will be on the word "efficient", and I would illustrate the point this way. By certain chemical processes, wood fibres can be converted to pure cellulose, and by taking this process a stage further they can be converted to sugars. But this is a relatively inefficient way to produce food. One can almost certainly say that in most of Canterbury the chain of sun-photosynthesis-food crops—or more usually the chain of sun-photosynthesis-grass-animal foods—will be far more efficient than the chain of sun-photosynthesis-wood-fibres-sugars. But the real question is—considering the total and not only the food requirements of the Asia-Pacific region, where will the chain of sun-photosynthesis-trees-forest produce be more efficient than the chain of sun-photosynthesis-grass-animals? It is the resolution of this question which will determine land use between agriculture and forestry. I believe that it will be resolved, if not perfectly, then far better than it has been to date.

Land for Forests

Accepting, then, this concept of optimum or highest land use, can we visualise where the future exotic forests are likely to be? The biggest change will certainly be away from the plains and on to the foothills. Of the 130,000 acres of exotic forests in Canterbury today, about half are on the gravel soils of the plains—i.e., the yellow-grey earths of the Waimakariri, Lismore, Eyre and Balmoral series. These soils are marginal for forestry; they have produced reasonable forest crops but not very efficiently; expressed in terms of mean annual increment, their growth capacity is only a third to a half of most other sites in New Zealand. They are not particularly good agricultural soils either, but I believe that it will be easier to improve them for agricultural purposes than for forest purposes. The techniques of irrigation and of dry-land farming are likely to upgrade their agricultural value far more than any known techniques could improve them for forestry. The plains forests therefore will tend to dwindle and to be replaced by improved grassland. I am not here suggesting that the forests of Balmoral, Eyrewell and the Selwyn Plantation Board will entirely disappear; rather that Balmoral and Eyrewell will be converted more to the Selwyn Plantation Board pattern of strips, belts and smaller blocks, interspersed between farm lands, and giving some protection to them, but still managed in perpetuity for forest production. In other words, we will return to the type of pattern originally designed for the Selwyn Plantation Board.

By contrast to the gravel soils of the plains, some of the downlands soils, in particular the Makerikeri, Okuku, Oxford and Kakahu hill soils are marginal for agriculture but are excellent for forestry. In 2062 we are likely to see a near-continuous belt between the 1,000ft and 2,500ft contours around all the foot-hills of the frontal ranges. Ashley Forest already occupies part of this zone; it will be extended to the north and west and will nearly join up with similar forests in the head waters of the Selwyn River. The same sort of pattern will develop in South Canterbury.

Dual-purpose Forests

The use of this foothill zone will be justifiable purely on the grounds of efficient cellulose and lignin production, particularly because of its favourable location in respect of markets and communications. But it will be doubly justifiable because they will be dual purpose forests. This foothill zone includes either the main streams or the tributary catchments of several of the short rivers of Canterbury, namely, the rivers which do not go back to the main divide but flood badly following heavy south-west rains. A coniferous forest in this zone can do a great deal to reduce total run-off and to regulate its flow. Indeed, the pressure for afforestation will come even more for protection than for production reasons. Forest management will, of course, take this vital protection role into account and will so proceed as to avoid large clear felled coupes and any undue disturbance and prolonged baring of the soil. Management will be made more complicated and logging more expensive; but with care it will be possible to have one's cake and eat it—i.e., to maintain the protective values of the forest and at the same time to harvest the physical products. It will be possible even without helicopter logging, which well before 2062 will assuredly be a practicable and economic technique.

Just as we will have production cum water regulation forests in the foothills, so we will have dual purpose forests in other types of unploughable hill country, the dual purpose here being production and weed control. *Nassella* is probably the best example of how this will come about. At present, the intention is to control *Nassella* almost entirely by agricultural means. We do not know how successful they will be, nor at what cost. I suggest, however, that in the years to come, it will be accepted that all possible means must be used to deal with this particular problem and that afforestation on a not inconsiderable scale will be one of these means. Before then, foresters may be able to make a better economic case for trees than for grass on some of the land in question, but I would guess that the deciding factor will not be comparative economics, but will be the continued presence of *Nassella* itself. I prophesy that in the year 2062 there will be many thousand acres of high production, high value exotic forests occupying the worst of the *Nassella* infested hill country. Again, it will be a matter of rational land use prevailing.

The prophecy just made about *Nassella,* like others in this paper, involves a good deal of crystal gazing and is subject to the usual risks attendant on that occupation. One prophecy and perhaps only one can be made with complete certainty. It is the self-evident proposition that during the next century each of the main problem rivers of Canterbury will have its 100 year flood. We do not know of course whether any of them during the period will have their 200 or their 500 year flood; just as we do not know whether the worst floods over the last 100 years may well have been the worst floods over a much longer period. Unfortunately though, there is one good reason to assume that flooding both in frequency and in intensity is going to get worse. The reason is that during the 100 years or so of human occupation (though not so much over the last 10 years) we have so mismanaged the mountain lands as to create near optimum conditions for rapid run-off. If, therefore, we ever experience the same pattern, duration and intensity of rainfalls which gave rise to the biggest flood over the last 100 years, then it is certain that when this happens again the floods will be bigger still. By bigger I do not necessarily mean that the total run-off will be greater, but that the peaks of the flood waters will be higher; this will be brought about by two factors, the quicker run-off already referred to, and the fact that the deteriorating condition in the mountain lands is likely to be reflected, to an increasing degree, in altered river profiles and aggraded river beds.

I believe, therefore, that when comparable climatic conditions recur, we will probably be faced with, to quote three examples, the waters of the Waimakariri, the Selwyn and the Ashley, out of the reasonable control which engineers are planning to impose on them. When this happens it will undoubtedly trigger off an irresistible public demand for remedial measures in the catchments themselves; and in some catchments and for parts of others these remedial measures will be forest ones.

Perhaps we will not need disaster and tragedy for this to happen. Perhaps there will merely be, as there is already at present, a growing realisation of the importance of an adequate vegetative cover in the catchments and of the role which forests can play in providing this mantle of vegetation. But whatever happens, the year 2062 will see a large exotic forest area beyond the foothill zone and on the mid-slopes of the main mountain ranges, the main river valleys, and the inter-montane basins, in other words, on the Class VII country of present "Land Capability" classification. I am not here suggesting that the whole or even a large proportion of the tussock grassland or run country will be clothed in trees. Despite the indications that we can grow certain exotics at higher altitudes than we can native species, and that similarly we can grow them in lower rainfall zones, it is a fact that much of the tussock grassland country is in a non-forest climate or at best in a climate quite unsuitable for healthy tree growth; the solution to its problems will therefore be a grassland solution rather than a forest one. Further, we cannot expect to establish a forest cover of any consequence at altitudes above 5,000ft, and we must therefore look for some other solution to cure the ills of much of the Class VIII country. Again, the problems of some of the Class VII and much of the Class VI land, even when it is within a forest climate zone, will be capable of solution or amelioration by remedies other than forest ones. But out of the several million acres of run country, there will still be some hundreds of thousands of acres of unstable deteriorating or already deteriorated mountain land on which the highest form of land use will undoubtedly be forest. This land will not grow quality forests, and it will make little contribution to saw log or peeler log requirements. But it can and will grow a huge volume of cellulose, maybe of indifferent and ungainly shapes, but still capable of being harvested and of being converted into a usable and saleable product. And as I have indicated earlier, the market potential will be enormous.

I will not attempt to prophesy what species will be grown in the mountain-land protection forest, but on present knowledge it appears that *Pinus murrayana* must be one of the major ones. The present fears that this species is potentially a dangerous weed will I believe disappear. *P. murrayana* will not spread into and colonise a close sward of improved grasses, and it is reasonable to assume that the grass cover over most of the Class VI land will be so improved. Furthermore, it is possible to select and breed a race of murrayana with cones that are truly serotinous, and which therefore never open except during a fire. This race of murrayana will undoubtedly be bred and where necessary will almost certainly be used. I say where necessary advisedly, because in areas from which murrayana cannot spread and colonise agricultural land, the over-riding need for a cheap method of establishment will force us to take advantage of one of the particular attributes of murrayana as we know it now—i.e., its ability to throw viable seed at an early age.

Farm Forestry

Before leaving this section, I must return from the hills and mountains to the plains, where indeed forestry in Canterbury began. Again, I am back to dual or multiple use. I believe that on the Canterbury plains farm forestry in all its aspects will reach its highest expression. The shelter aspect of farm forestry is all-important in Canterbury—high and low shelter for stock, crops and grass; shade trees to give shelter from the sun; shelter for homesteads and other buildings. Before long, we should be able to plan farm shelter more scientifically than we can today. We will know exactly the best trees and shrubs to use and in what combination, the optimum heights and widths of shelter belts, the optimum distance between them, in fact, the optimum pattern of trees to give maximum agricultural production. As this knowledge becomes available, so will the nature of the countryside change, and I believe become more beautiful.

In no parts will the change be greater than on the plains of the inter-montane basins. Here, there are large treeless expanses of unimproved tussock grassland on flat or easy country. I cannot believe that in the face of an expanding world population we can afford to leave land of this type in such an inefficient form of production. Hardy strains of grasses will be developed, the nutrient problems of the soils will be solved, and land use will become much more intensive. Shelter will be needed to make this possible, and I therefore visualise the MacKenzie Plains of the future criss-crossed with belts of trees. Here, I think, we will lose rather than gain beauty, but the pressure on land will demand it.

Because the distances are relatively short and transport is relatively easy, the production aspect of farm forestry in Canterbury will also increase in importance. I have no doubt that the forest industries of 2062, be they sawmills, plywood factories or pulp and paper plants, will secure a not insignificant part of their raw material requirements from shelter belts and from farm wood lots grown specifically for this purpose.

LOOK OF FUTURE FORESTS

We turn now to how the forests will differ from those of today. In some respects they will be less different than one would at first think. In most fields of science and technology, research is likely to bring about changes which may be far beyond the wildest imagination of even the most imaginative of those present today. But forests are relatively immutable. They are formed and moulded by factors over which we do not have, nor are ever likely to have, any real control. We cannot change geological structure, which determines topography and, in conjunction with other factors, soil; we cannot change the climate; and we cannot change some of the more important features of the soil and subsoil, particularly its depth and its efficiency as a rooting medium. We can perhaps influence the changes occurring in the structure and fertility of the upper soil horizons, and we can and certainly will change the nature of the vegetation itself. Science then will not work wonders in making possible new and radically different forests, nor has it in the past. The art of silviculture is itself subject to immutable natural laws; for this reason a correctly sited, well tended and perfectly managed forest in Europe today would not look very different from its counterpart of 100 years ago.

As I have said, the main differences which will come about will be by manipulating the nature of the vegetation itself; and by nature in this context I mean specifically its genetical constitution.

Improved Strains

I think we must assume that we will be dealing mainly with the same species as we have today. Radiata has been growing in Canterbury for almost 100 years; I see no reason to be pessimistic and to think that it will not be with us 100 years hence. We will doubtless add a few more species to the staple list of radiata, Corsican, ponderosa and lodgepole pines, Douglas fir, larch and macrocarpa. I would guess that certain poplars, cypresses and eucalypts will be the most likely additions. We may also lose a few due to insect or fungal epidemics or to market difficulties. It takes many decades to prove an exotic, the proof needed being both biological over the life cycle of the species, and commercial over the period of market establishment. For this reason, any change in species composition must necessarily be slow.

Within a species, however, the possibilities of change and improvement are immense, and the groundwork for these changes is now being laid. It consists of selecting individual elite trees with particularly desirable characteristics, propagating them vegetatively in seed orchards, conducting progeny tests of the results of both open and controlled pollination, and establishing further seed orchards of the selected progenies. These seed orchards will have to be isolated from other trees of the same species and there may well be several dotted around Canterbury in remote locations. In 15–20 years' time they will provide sufficient elite seed for all further de novo planting. Stock grown from elite seed will be used to enrich stands originating from natural regeneration, either by planting or by grafting. In 60-70 years' time (I am speaking here only of radiata), the full effects of this improvement programme will be evident. In 100 years' time, all but a few of the radiata trees in Canterbury forests will be of improved strains. They will be straight, lightly and horizontally branched, free from stem cones over most of the boles, and entirely without forking and other malformations. In addition, they will have desirable and improved levels of wood density and fibre length. Finally, growth rates will be increased by some 10% and overall quality to a very much greater degree.

The same sort of improvements will be made to other species with particular reference to the breeding of vigorous, frost-hardy, drought resistant varieties of ponderosa, Corsican, lodgepole pines and of other species to be used in middle and high altitude planting. The vigour of radiata will be used on some of these sites, not by selection within the species, but by hybridisation with *P. attenuata*. The forester of 2062 will have available a wide range of strains or varieties all of high quality, but of varying characteristics, and he will therefore be able to grow successful forests over a much wider range of sites than is possible today.

Mixed Forests

As these forests mature and are opened up by thinning, they will be invaded by partly or wholly shade tolerant species, mainly native. The rate of this invasion will be in direct proportion to the proximity of indigenous forest remnants. In the Ashley group of forests the invasion will be rapid and complete, as it has been in some of the older exotic forests of the North Island central pumice plateau. (I am indebted to Mr J. T. Holloway for suggesting exactly what species will be present.) On most sites throughout the mature stands we can expect the following shrubs and tall trees:

Neopanax simplex, N. arboreum and *N. colensoi, Schefflera digitata, Melicytus ramiflorus, Aristotelia serrata* and *A. fruticosa, Pseudopanax crassifolium, Grisel-*

inia littoralis, Carpodetus serratus, Myrsine australis, Coprosma robusta, C. rhamnoides, C. linariifolia, C. parviflora and *C. propinqua*, etc., *Cyathodes fasciculatus, Gaultheria antipoda, Helichrysum glomeratum, Olearia arborescens.*

In the moister gullies there will be *Fuchsia excorticata, Coriaria sarmentosa, Phormium tenax, Cordyline australis, Muehlenbeckia australis.*

The ground floor will be occupied by the ferns: *Blechnum capense, B. minus, B. fluviatile* and *B. lanceolatum; Polystichum richardii* and *P. vestitum, Hypolepis millefolia, Histiopteris incisa, Asplenium bulbiferum, Polypodium diversifolium, Lycopodium fastigiatum,* and by other species such as astelias, *Microlaena avenacea, Lagenophora petiolata, Uncinia* spp., and *Helichrysum bellidioides.*

In unplanted gullies, indigenous tree species will tend to replace *Leptospermum ericoides* and *L. scoparium,* the main ones being *Neopanax* spp., *Griselinia, Nothofagus cliffortioides,* with local examples of *Weinmannia, Nothofagus fusca* and *Sophora microphylla.*

It will be seen that the forests will be floristically quite rich in indigenous species. They will, in fact, no longer be exotic forests but mixed exotic-indigenous. This will have several results. Only one will be unfavourable, which is that during the regeneration phase the indigenous species will, temporarily, become weeds. However, they will be readily controllable, again temporarily, by chemical means. In all other respects the indigenous understorey will be beneficial rather than deleterious. It will have an ameliorating effect on soil structure and perhaps soil fertility, and will tend to offset the acidifying and mor-forming process which in some soils is typical of pure coniferous stands. It will create a more diversified population of insects, fungi and birds, and thus will tend to produce a forest complex which should pathologically be more healthy and less susceptible to the ravages of any particular insect or fungal pest. Above all, it will create more beautiful forests. No longer will there be complaints of " the black serried ranks of ugly pine forests "; in their place will be light and shade, a many-tiered forest, a variety of colour, and the great beauty which always goes with ferns en masse. For this and other reasons, Ashley Forest will become one of the scenic resorts of Canterbury. Foresters will no longer be able to maintain " keep out " notices and, on the pretext of fire risk, to exclude the public and to deny them the recreational benefits which forests can confer. There will be picnic grounds, scenic drives, scenic walks and lookout points, and the population of Canterbury will flock to use them. The ridge road around the western margin of Ashley, commanding as it does, a view over Loburn, the Ashley River and the plains to the Port Hills in one direction and of the mountains in the other, will become a major tourist attraction for visitors to the province.

Recreational Uses

I believe strongly that this aspect of future forestry should not be underestimated. As civilisation becomes more complex and above all, more artificial, there will be a deep-seated psychological need to retreat from it and to spend leisure hours in natural surroundings. Already this tendency is evident in New Zealand and more so in the highly industrialised Northern Hemisphere countries: it finds its expression in nature and bird societies, in hiking and tramping clubs, in the national park movement and in wilderness area enthusiasts. If the psychological need for such " back to nature " relaxation and recreation exists today, how much greater will the need be in 100 years' time? Forests will be able to cater for some of these needs and it will be no small part of the job of future foresters to see that they are met.

I have mentioned that the forests will maintain a larger and more diverse bird population. It is insufficiently realised that even today the exotic forests in New Zealand have created a new and favourable habitat for many native birds, and that the bird population in them is large and is increasing in both numbers and diversity. This unexpected development has occurred even before the invasion of native tree species, but it is, of course, greatly accelerated when the indigenous understorey develops and provides a more diverse food supply. Already Ashley Forest supports kingfishers, fantails, tomtits, warblers, bell-birds, white-eyes and shining cuckoos. (I am indebted to Mr Peter Bull for providing this list and the others to follow.) Before long it is certain that we will have brown creepers, riflemen, moreporks, tuis, bush hawks, long-tailed cuckoos and a few pigeons. In 100 years' time it is probable that there will be robins, yellowheads, wekas and kiwis, although some deliberate introductions may be necessary to establish them so far from their present known stations. There will also be a considerable population of introduced birds, including possibly species not yet in Canterbury but which are likely to become established over the intervening years. This varied bird population will itself be another recreational and aesthetic attraction.

Other Considerations

Earlier, I said that all but a few of the trees in future forests will be of improved strains. We will always grow some stands of unimproved and genetically diverse trees as a reservoir for further breeding material. We will also keep a few remnants of early plantings for other reasons. Thus, in a few sheltered gullies at Ashley Forest we will in 2062, I hope, have some radiata exactly 123 years old. They will be flat topped and deteriorating, but their heights will be between 170ft and 190ft, and their diameters up to 4ft or 5ft. They will be "grand old gentlemen" indeed, and preserved as such. Nearby will be some Douglas fir only a few years younger, possibly taller, and probably still putting on height and diameter growth. Although barely past the prime of life, they will still be magnificent specimens. The public will flock to see them and to see the stately old radiata just as they now flock to see the largest and most famous kauri trees.

Industrial Aspects

I have already said enough to indicate that these forests will undoubtedly support more sophisticated industries than they do today, particularly in the form of pulp and paper and in the field of chemical utilisation generally. Much has been written about the hazards to which forests in Canterbury are subject, and the suggestion has been made that the risks of total destruction are so great that no large scale industry can safely be based upon them. This argument ignores the fact that there is always one stage in the life of a forest at which it is most vulnerable to damage and that in all forests the degree of a hazard varies not only between age classes but also between species, and within species between different forms of silvicultural treatment and different standards of forest utilisation. Whether we are considering fire, wind or insect damage we can lessen the risk of any damage by correct silvicultural treatment and utilisation; and we can greatly reduce the hazard of total destruction by arranging the forests on the ground in an orderly series of age classes, distributed, as we already do with species and genera, in a patchwork quilt fashion. We will still have losses from fire, from wind and from insects, but they will be restricted to certain species and certain stages of development. Sound silvicultural practice and sound management planning will prevent them from being crippling and will give industry the reasonable assurance it will require in order to justify the capital investment necessary for large scale industries.

I have no doubt that in 2062 Canterbury will have its sawmills and plywood factories, its pulp and paper plants, its chemical industries based on wood; that these will be mainly in large integrated units; that they will diversify the economy and be an important factor in export earnings; and that they will create processed values which, translated back to the soil, will provide ample economic justification for the use of the land they occupy.

Noxious Animals

Finally, it is not possible to discuss the forests of Canterbury 100 years hence without making mention of the noxious animals then likely to be found in, around and above them. At present these animals consist of red deer, chamois, thar, goats, pigs, opossums, wallabies, rabbits, hares and wild sheep. One can be reasonably certain that the list will not be added to; there will assuredly be no approved liberations of other species, and any illegal liberations or invasions from other districts can and will be quickly dealt with.

On present indications thar, goats, pigs, opossums, wallabies, rabbits and wild sheep should present no great worry in the long distant future. These animals can be controlled, if perhaps never entirely eliminated, using known and proven techniques. The problem animals, in order of importance, are likely to be red deer, chamois and hares. Because red deer will almost certainly remain the most important of these, and because it is the one with which the public is particularly concerned, I will confine my few remarks to this species. They will be brief and are put forward with some timidity since there are few other fields in which it is more difficult to make confident prophecies.

All that can be said perhaps is that, if they continue to be applied with vigour and intelligence, and if sufficient monies are forthcoming to apply them on the scale required, then the known methods of deer control—shooting and poisoning—will result in the deer population being brought down to a level which will permit forests and other vegetation to regenerate and to be maintained in a reasonably healthy though greatly modified condition. These known methods will *not* enable deer to be exterminated, no matter how desirable this objective may be, and may continue to be. It is reasonable to assume that in the intervening years there will be marked improvements in poisoning techniques, not only in the poisons themselves, but also in their application and in the use of suitable, and we hope, irresistible lures. Even so, present methods of poisoning will in all probability be no more and no less successful than they have been with rabbits. One major break-through is possible and that is the development of a systematic poison which will be applied to vegetation, will be taken up into the living tissues of preferred plants, and which will be lethal to deer when these plants are browsed. Already work in U.S.A. with the compound Tetramine is showing promise in this direction. Even if successfully developed, however, I doubt if this sort of technique will ever result in the complete eradication of deer.

The only other possible technique which comes to mind is some form of biological control. It cannot be predatory control since animal predators are notoriously unselective and we will still have large numbers of domestic animals which must be protected. There is, however, the remote possibility that research (which as yet is barely started in this field) could produce a specific bacterial or virus disease which could be introduced into deer herds and could sound their death knell. The difficulty and perhaps the impossibility will be to get a purely specific one; as is the case with animal predators, unselective biological control would have disastrous results on domestic stock and its use therefore could not be countenanced.

For these reasons I believe the possibility is remote. In 100 years' time I would suggest that deer will still be with us, that they will be low in numbers, that they will be so controlled as to be in a reasonably acceptable though not ultimately desirable balance with the forest and alpine vegetation, that an enormous sum of money will have been spent to achieve this result, that sporting interests will play a large and increasing part in maintaining control, and that in the year 2062 we will still be looking for the magic wand to wave which will wipe deer out of our forests and off our mountains once and for all.

Conclusion

This, then, is how one forester in the year 1962 sees the future 100 years hence. If records are kept and anyone bothers to read them, he will no doubt think how unimaginative, how ignorant, how innocent! The prospects are so exciting, the possibilities are so great, my only wish is that I could be alive then to see how wrong I have been.

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