IMPACT OF UNCERTAIN END-USE ON WOOD COSTS AND ITS IMPLICATIONS FOR FOREST PLANNING

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Abstract
Planning the utilisation of future forests requires different techniques from those used to plan the utilisation of an existing forest resource. If the end-use of a forest is defined well before utilisation, management for a specific crop can be undertaken and this can have a significant effect on wood cost, particularly pulpwood. Consequently, considerable attention should be given to a desirable structure for the future forest processing industry.

INTRODUCTION
There is widespread satisfaction with the manner in which New Zealand's present forest industries have developed from the planting boom of the 1920s. It is variously held that the present industry is a valuable net earner and saver of foreign exchange (Reserve Bank of New Zealand, 1974; National Development Council, 1969); that it creates opportunities for raising the level of skill in the work force, plays an essential role in decentralising the economy, and leads to other industrial growth; that in providing an integrated industry it is an efficient user of wood resources; that it operates under low levels of protection (Forestry Development Council, 1969); that it is sufficiently profitable to attract its own capital (National Development Council, 1969); and that the New Zealand pulp and paper industry enjoys a comparative advantage over pulp and paper industries in other countries (Reserve Bank of New Zealand, 1974).

The State forest expansion programme makes provision for major utilisation plants at several locations throughout the country within the next 20 years (Hosking, 1972). Because belief in the beneficial effects of pulp and papermaking has been widely held, these locations are already commonly regarded as sites for pulp mills. In fact, the establishment of pulp and/or papermaking facilities at these locations is being vigorously pursued by both the administrative and executive arms of local and national government, as well as by individuals and commercial organisations.

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In addition, the present rapid expansion in the rate of new planting promises a massive increase in the volume of wood available for export after 1995. Given sufficient capital, labour, water, and energy, this additional resource could support 15 to 20 paper mills (O'Neill, 1974).

This paper examines the role that forest planning should play in the development of the forest processing industries which will be based on the recent expansion in forest planting.

THE GROWTH IN AFFORESTATION

During 1925 and 1926, predictions that the indigenous wood supply would be insufficient to meet future demand, improvements in nursery and planting techniques leading to a 75% reduction in the cost of establishment (Allsop, 1973), and availability of labour on relief work, led to rapid expansion in the rate of forest planting. By 1935 most of the exotic forests, which are now the basis of our forest industries, were already established. After that only nominal planting was undertaken, until a review of wood resources in 1961 (New Zealand Forest Service, 1962) indicated that the current levels of planting would be unable to meet future demand.

The consequent reappraisal of afforestation led to the establishment of a planting policy designed to make New Zealand self-sufficient in wood and to allow an annual surplus of 4.25 million m³ for export as pulp, paper, and timber by the year 2000 (New Zealand Forest Service, 1962). By 1969, after several changes in the estimates of future domestic consumption, and a decision to increase the size of the exportable surplus, a basic planting rate of 21,000 ha/yr was established, of which half was to be State planting.

The new planting rate enabled predictions of high growth rates in forest-products processing and forest-based exports to be made at a series of development conferences in 1969. Combined with rising prices for log exports, this highlighted the role of the forest-products industry both in diversifying the New Zealand economy and as a source of foreign exchange, at a time when the terms of trade had fallen sharply.

Concurrently, research into the silviculture of radiata pine showed that, under certain assumptions, forest growing was a viable investment. The adoption of different silvicultural practices gave returns of up to 12% on capital invested in afforestation for 25 years (Fenton, 1972a; Fenton and Dick, 1972).

These factors led to a considerable change in the financial assessment of forestry from "an implicit assumption, amounting almost to a social philosophy, underlying discussions of land use in this country, that if land is capable of development
for farming it should not be used for forestry” (Ward et al., 1966, p. 143), to a situation in 1969 where the Forest Service was embarrassed by requests for increased planting from Maori land owners, local and regional authorities, and other interest-groups (New Zealand Forest Service, 1970).

This change in the social attitude led to an increase in private planting from 1970 and, with the availability of labour for relief work during the 1967-69 recession, to an immediate increase in State planting. Table 1 illustrates the dramatic increase in the annual additions to net stocked area, and shows the similarity between the planting “boom” of the 1925-35 era and the current explosion in forest planting.

### TABLE 1: NEW AREA PLANTED IN EXOTIC FORESTS

(Thousand hectares)

<table>
<thead>
<tr>
<th>Period</th>
<th>State</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1923-25</td>
<td>....</td>
<td>....</td>
<td>9</td>
</tr>
<tr>
<td>1926-30</td>
<td>....</td>
<td>....</td>
<td>74</td>
</tr>
<tr>
<td>1931-35</td>
<td>....</td>
<td>....</td>
<td>62</td>
</tr>
<tr>
<td>1936-40</td>
<td>....</td>
<td>....</td>
<td>13</td>
</tr>
<tr>
<td>1941-45</td>
<td>....</td>
<td>....</td>
<td>7</td>
</tr>
<tr>
<td>1946-50</td>
<td>....</td>
<td>....</td>
<td>6</td>
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<tr>
<td>1951-55</td>
<td>....</td>
<td>....</td>
<td>10</td>
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<tr>
<td>1956-60</td>
<td>....</td>
<td>....</td>
<td>16</td>
</tr>
<tr>
<td>1961-65</td>
<td>....</td>
<td>....</td>
<td>31</td>
</tr>
<tr>
<td>1966-70</td>
<td>....</td>
<td>....</td>
<td>55</td>
</tr>
<tr>
<td>1971-75</td>
<td>....</td>
<td>....</td>
<td>91</td>
</tr>
<tr>
<td>1976-80*</td>
<td>....</td>
<td>....</td>
<td>120</td>
</tr>
</tbody>
</table>

*Based on an annual planting rate of 55,000 ha and a net gain in stocked area of 87% of new planting (Hosking, 1972).

In many ways the exotic forest resource created in the 1920s and 1930s was regarded as a natural resource when its utilisation was planned. The costs of establishment were, quite properly, regarded as sunken costs and therefore irrelevant. Probably because of the satisfaction with the development of the existing industry, the forest planner has a similar approach to the establishment of future processing plants.

However, creating a general forest resource with a variety of end-uses without considering the impact this has on the cost of growing is not justified when planning future forests. If both the forest and the industries that present planting will support are to be economically viable, and the industries are to be able to compete in world markets, considerable attention should be paid to the delivered wood cost.
THE IMPACT OF UNCERTAIN END-USE

The undertaking of new planting on such a scale necessitates the making of some assumptions about the end-products of the forest output and the markets in which they will be sold.

First, since the existing forest resource is more than capable of meeting the domestic demand for forest products at least until the year 2005, new planting is necessarily for export (Hosking, 1972). Further, the volume of additional wood available by the year 2005 would be sufficient for pulp production to be 10 to 12 times greater than at present. Quite apart from the difficulties of marketing 6 million tonnes of pulp per annum, the capital required to construct the necessary pulp mills would be in excess of $4000 million (Uprichard, 1974). Even at that date the economy is unlikely to be able to absorb capital expenditure of this magnitude without considerable disruption. The expansion in forest output will be so great, and will occur over such a short time, that it is unlikely that the total forest output could be absorbed by sawmills and particleboard, plywood, and fibreboard plants. Consequently, for some time at least, log exports will be a necessity. Thus the production of the forests will have to include logs for export, logs for pulping, sawlogs and veneer logs. Whatever the goods produced, they will have to be sold on a world market in competition with the major world producers at a time when many of the countries in the south-east Asian and Pacific regions will be undertaking domestic production of processed forest products.

For this reason, the profitability studies (Fenton, op. cit.) which helped to change the social attitude to forestry have a special significance in that they also showed that the cost of growing could be reduced considerably if the end-use of the forest was specified at the time of the first thinning to waste (at height 11 metres, or at age 9 on site index 29 m).

The growing costs given in Table 2 demonstrate that growing sawlogs or export logs as a source of pulpwood is considerably more costly than growing pulpwood as such. For example, the increased cost involved in using logs from an export log regime for pulpwood is between $4.52 and $3.84/tonne of paper*, depending on whether the social costs of growing are included or not. The additional wood cost involved in using logs from a sawlog regime for pulpwood amounts to between $15.42 and $19.92/tonne, and when a production thinning regime is used as a source of pulpwood the cost of the pulpwood rises by between $66.54 and $81.55/tonne of paper.

*Based on an average conversion of 4.18 m³ pulpwood/tonne of paper.
TABLE 2: BREAK-EVEN GROWING COSTS OF SELECTED FOREST PRODUCTS, EXCLUDING THE COST OF LAND
(1967 costs and prices; interest rate 10%; site index 29 m)

<table>
<thead>
<tr>
<th>Product</th>
<th>Rotation (yr)</th>
<th>Mean Diameter (cm)</th>
<th>MAI (m³/ha)</th>
<th>Including Social Costs ($/m³)</th>
<th>Excluding Social Costs ($/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawlogs¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 pruning lifts</td>
<td>26</td>
<td>61.7</td>
<td>22</td>
<td>8.88</td>
<td>6.85</td>
</tr>
<tr>
<td>5 pruning lifts</td>
<td>26</td>
<td>61.7</td>
<td>22</td>
<td>9.58</td>
<td>7.56</td>
</tr>
<tr>
<td>Export logs²</td>
<td>23</td>
<td>48.5</td>
<td>25</td>
<td>5.21</td>
<td>4.08</td>
</tr>
<tr>
<td>Pulpwood³</td>
<td>19</td>
<td>31.8</td>
<td>26</td>
<td>4.13</td>
<td>3.16</td>
</tr>
<tr>
<td>Production thinning regime⁴</td>
<td>36</td>
<td>59.7</td>
<td>22</td>
<td>23.64</td>
<td>19.08</td>
</tr>
</tbody>
</table>

Sources: ¹Fenton, R. (1972a).
²Fenton, R. and Dick, M. Merle (1972).
³Bunn, E. H. (1974) Table 1 gives rotation and yield for pulpwood on site index 113 ft. This is reduced to site index 95 ft by Lewis (1954), increasing rotation length from 16 to 19 years. The costs of growing are assumed to be the same as for Fentons’ export log regime (op. cit.) apart from the difference in rotation.
⁴Fenton, R. (1972b) The break-even costs are for the final crop only. Thinning revenue has been assumed to be equal to the cost of extraction.

Alternatively, it is sometimes suggested that pulpwood requirements can be met by pulping some of the logs from a sawlog regime. In deciding the wood cost when pulping a sawlog, the average break-even growing cost is not as important a consideration as the net realisation of the log as a sawlog (Table 3). This is called the opportunity-cost of the log and need not be greater than the average cost of growing. Indeed, the opportunity-cost of pulping (i.e., the net realisations from sawing) the third log of the short-rotation sawlog regime is less than the break-even growing cost when an interest rate of 10% is used.

Costs derived in this way demonstrate the superiority of a pulpwood regime over the practice of extracting for pulpwood some of the final crop from sawlog regimes. Table 3 shows that the cost of such pulpwood is at least 60% dearer than the cost of deliberately grown pulpwood crops, and the wood cost/tonne of paper is increased by a factor of 2 or more.

The adoption of a pulpwood regime offers a number of advantages which are not related to the cost of growing the wood. Most important, it enables the starting dates of new pulp mills, and the expansion of existing plants, to be brought...
TABLE 3: COST OF PULPWOOD PRODUCTION, EXCLUDING THE COST OF LAND
(site index 29 m; 1967 costs and prices; interest rate 10%)

<table>
<thead>
<tr>
<th>Production Method</th>
<th>Rotation (yr)</th>
<th>MAI(^e) (m(^3)/ha)</th>
<th>Cost ($/m(^3)) Including Social Costs</th>
<th>Excluding Social Costs</th>
<th>Cost of Wood/ Tonne of Paper(^f) Including Social Costs</th>
<th>Excluding Social Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulpwood regime(^1)</td>
<td>19</td>
<td>26.0</td>
<td>4.13</td>
<td>3.16</td>
<td>17.27</td>
<td>13.21</td>
</tr>
<tr>
<td>Opportunity cost of short rotation sawlog regime</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>— pulping third log(^2)</td>
<td>26</td>
<td>4.3</td>
<td>5.17</td>
<td>21.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— pulping second log(^2)</td>
<td>26</td>
<td>6.2</td>
<td>11.81</td>
<td>49.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity cost of thinnings from a production thinning regime(^2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>4.1</td>
<td>80.07</td>
<td>334.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^e\)Mean annual increments for the second and third log are low because they are only part of the crop.

\(^f\)Based on an average conversion factor of 4.18 m\(^3\) of pulpwood/tonne of industrial papers. Because the volume of wood required/tonne of newsprint is lower, the cost of wood/tonne of paper should be reduced by about 25% if newsprint is being considered.

\(^1\)The difference between the average growing costs of the final crop of the production thinning regime and the short rotation sawing regime divided by the volume from thinnings.


2 Fenton, R. (1972a) — opportunity cost given is the net realisation obtainable from sawing the log. The basis is that the price for the log as pulpwood must be equal to the value of the sawlog if the profitability of the regime is to remain unchanged. If the indirect cost of logging reduces pro rata with volume logged, these costs would be reduced by up to $0.10/m\(^3\).

forward. Growing for pulpwood produces a relatively high volume of wood per hectare in a considerably shorter time than growing for other forest products (see Table 3), yet the stumpages that must be received to make growing it as profitable as growing other forest products are feasible. Consequently there is a good chance that, if pulpwood prices begin to reflect the cost of growing, this will attract additional land to forestry. Further, because pulpwood crops have a narrower range of diameters and smaller trees than crops intended for other purposes, they offer greater scope for increasing mechanisation during clearfelling operations (C. Terlesk, pers. comm.). At the same time felling costs under pre-
sent motor/manual methods for the pulpwood regime cited here are comparable with those for clearfelling mature radiata (Terlesk, 1972).

However, some top logs will inevitably be left as a by-product of sawlog production, and as a by-product they need bear none of the growing costs. In addition, slabs from sawlogs provide a source of chipwood at the sawmill. Consequently, these need bear neither growing nor initial collection costs. The cost of these resources as a source of pulpwood is dependent on the cost of collection and transportation from the sawmill to the pulp mill, and it is a simple matter to calculate the maximum distance it is worth transporting them before a pulpwood crop closer to the mill becomes a more economic proposition.

Because the top logs provide low volume per hectare (83.2 m³) they may be difficult to sell in some circumstances. In such situations it would pay the forest grower to tempt buyers by offering the additional 112 m³/ha in the third log as long as the total return is greater than the return from sawing the third log. For this to be so the average stumpage per cubic metre for the total volume must be greater than $2.97. As a source of pulpwood this arrangement competes with the pulpwood regime if the top logs can be sold no other way. Ignoring differences in the transport cost, a top log stumpage of $0.45/m³ would be needed to eliminate the cost advantage of such a scheme to the pulp mill.

**IMPLICATIONS**

The conclusion of the financial analysis is that specialised tree crops for given final products offer considerable cost advantages over a policy of growing a general resource. This is in contrast to previous practice (Williams, 1965) and forecast development (Thomson, 1973) in which it was envisaged that the cheapest pulpwood would come from the thinnings and top logs of a general purpose regime.

The Asian and Pacific area, which will provide the major markets for New Zealand’s wood products, is already highly competitive (Mason, 1973) and the competition is likely to become more intense as some of the countries in the region create their own forest industries. It is possible that the rise in wood costs due to the ineffectiveness of forest planning will be sufficient to endanger the economic viability of New Zealand forest industries exporting to the region.

For these reasons it is appropriate to consider the structure that New Zealand’s forest industries should assume. By defining a compatible set of objectives for afforestation and forest-products processing, by considering the likely markets
for forest products, and by studying — as far as is relevant — the performance of the existing industry against these standards, it should be possible to define the characteristics of a desirable forest-products industry. By studying the requirements of the various forest industries for resources, energy, water, labour, and capital in relation to the economy's ability to supply them, it should be possible to allocate at least 50% of the wood exports to specific forest-management regimes; to either export log, pulpwood, sawlog, or veneer log production. Concomitant with this there should be designation of the areas in which each product is to be grown, and the timing and scale of the operations in these areas.

The advent of specialised crops, the increasing number of forest growers, and the need to define the end-use of the crop by the time of the first thinning to waste, will also place more emphasis on co-operation between State and private growers. In addition to the problems arising out of the unbalanced distribution of age classes between the State forests and those of the private sector (Henry, 1974), it will be necessary in many cases to agree on a regional utilisation plan if both the forests and the industry are to be viable. Since this plan should be agreed on 10 to 15 years before utilisation commences, the co-operation will most probably have to take place under the aegis of bodies similar to the Regional Forest Bodies of Scandinavia (Allsop, 1964). These bodies could have a constitution similar to that proposed for the meat and wool growers (Zanetti, 1975) with the emphasis on regional co-ordination rather than price stabilisation.

One of the most important implications of the introduction of specialised regimes for particular crops is the shorter rotations that are possible. With the present management regimes, selection of the type of final crop required does not have to be made until the time of thinning to waste (age 7 to 9 years). Consequently the lead time (the time between planning and fruition) in forest management is 10 years for pulpwood, 12 years for export logs, and 15 years for sawlogs. These lead times are not significantly longer than the lead times in power generation — 10 years; in port development — 10 to 15 years; in roads — 5 to 15 years.*

*The lead times quoted here are based on the necessary works being incorporated into the activities of organisations concerned. In many cases the facilities can be created in a shorter time but only at the expense of disruption to other services. The supply of electricity to the Whirinaki pulp mill in March 1973 is an example. It provided an unforeseen demand for electricity, equivalent to slightly more than 10% of New Zealand's industrial power consumption, at a time when there was insufficient generating capacity to meet the country's needs under adverse weather conditions.
Consequently, in order to create the infrastructure necessary for a forest to be utilised as soon as a sustainable volume of wood becomes available, end-use predictions are required at about the same time as the thinning to waste decision is being made.

CONCLUSIONS

The silvicultural regimes discussed in this paper do not encompass all forest produce, nor are they necessarily the best way of producing a particular crop in any situation. Nevertheless it is apparent from the analysis that on some sites single-purpose crops provide a far less expensive source of a given type of wood than the extraction of wood types from a general-purpose crop.

If New Zealand is to have both a viable exporting forest industry and profitable forestry on the scale suggested by recent annual plantings, single-crop forestry must play an important part. In these circumstances, defining the end-uses of afforestation by the time of thinning to waste should have the highest priority.

For this reason, an analysis of the types of forest-processing this country should adopt deserves urgent consideration. By studying the efficiency of our present forest industries, it may be possible to define areas of production in which New Zealand has a comparative advantage. From studying the development of our resources — land, labour, energy, and water — and their use by different types of forest industries, and by studying the markets for alternative forest products, it should be possible to define permissible limits to the development of various forest industries.

Such an analysis should enable end-use predictions for considerably more than 50% of the wood surplus available for export. It would ensure that the quality of forest management would not be the factor preventing New Zealand from having an energetic, competitive, and exporting forest-processing industry. That the research would also highlight some of the difficulties in establishing such industries in New Zealand serves to emphasise its importance.

No attempt has been made to assess the profitability of the different types of crop. This is dependent on the differences between the break-even cost of growing and the market price. It is possible that, for some forest-processing organisations, the variation in wood costs may be small compared with other costs. This does not make the costs less real, nor would it justify a new afforestation programme involving a totally general resource. If some flexibility is required, it may be best provided by managing part of an afforestation effort (generally less than 30%) as a general resource, while dedicating the remainder.
UNCERTAIN END-USE AND PLANNING

REFERENCES


