INFLUENCE OF SILVICULTURAL REGIMES ON NATIONAL AND REGIONAL WOOD SUPPLY PLANNING

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ABSTRACT

Economic rationalisation of silvicultural regimes has enabled national and regional wood supply planning to be revised on a more realistic basis.

INTRODUCTION

The past decade has seen something of a revolution in the approach to silvicultural practice in New Zealand plantation forestry. One influence in this change of attitude has been the demonstration by researchers that management prescriptions calling for commercial thinnings were in many cases not adhered to because of difficult operating conditions and lack of markets for the produce. A further main influence was a series of profitability studies carried out by the Forest Research Institute, Rotorua, which advanced a methodology for rationalising economic decisions on forest management and silviculture. These studies demonstrated that a case existed, on the grounds of forest profitability, for the abandonment in many forests of the widely prescribed multiple commercial thinning regimes in favour of short rotations incorporating non-commercial thinnings. This "silvicultural revolution" has been a strong influence in revised national wood supply planning and is a major reason for the higher estimates of future wood availability expressed in subsequent national forestry planning models. The techniques for comparative analysis of silvicultural regimes have been adapted to regional forestry development planning to test the effects of alternative management approaches on social net return.

NATIONAL FORESTRY PLANNING MODELS

The technique adopted in the preparation of national wood supply estimates for New Zealand has been to simulate management of existing plantation resources at the current silvicultural regimes, adopting a feasible planting rate and allocating the planting to tree species according to the proportional species use in the then current annual new planting. Having simulated the prevailing situation, models then expressed one or more variations of planting rate and silvicultural regime in order to demonstrate their effects on the wood supply estimates. Models of supply were built up on a regional basis, using local variations in management and planting, with aggregate supply balanced against estimated demand at the national level.

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The first national forestry planning model (Familton, 1969) was prepared for the 1969 Forestry Development Conference, and it was used by a number of the conference working parties as a basis for estimates of industry development, manpower needs, etc. The model, in simulating then current management and planting rates, generally assumed silvicultural regimes for radiata pine which prescribed 35-40 year minimum rotations, with almost invariably one or two commercial thinnings at 25 and/or 30 years. In addition to the basic simulation, this model noted the possibility of making more rapid progress in clear felling the first-crop depression-planted forests of the central North Island, with additional planting, to be managed on shorter rotations in order to fill the supply deficit thus created. The estimates of exotic roundwood supply expressed in the first model are given below. The planting target of 23 100 ha/year recommended in this model was adopted by the 1969 conference.

By 1972, such had been the changes in plantation management and marketing in the intervening period, in part generated by the 1969 conference itself, that it was apparent that the supply estimates of the 1969 model were no longer relevant. The estimates of national exotic roundwood supply (M m^3/year) from a new model prepared that year (Hosking, 1972) for a National Development Conference are given below. They consist of a basic model in which the planting rate assumed in the 1969 model is repeated, and a model based on 28 300 ha annual new planting:

Planning Period	1969 Model	1972 Model	
	23 100 ha* Planting	23 100 ha Planting	28 300 ha Planting
1971-75	6.9	7.8	8.6
1976-80	7.9	9.0	9.9
1981-85	8.6	10.0	11.1
1986-90	9.6	11.0	12.4
1991-95	10.3	13.0	14.4
1996-00	12.3	16.0	17.5
2001-05	14.5	18.7	21.9
2006-10	16.2	20.5	23.7

* Planting in the 1969 model consists of 21 000 ha/year basic planting programme plus 2 100 ha/year crash planting programme 1971-75 to alleviate slowing in export growth late in the century.

The 1972 basic model demonstrated the alteration to expected wood supply brought about by the changed management emphasis since 1969. The main areas of change were:

(a) The greater usage of minor species (believed in 1969 to be unmerchantable) for pulping and log and chip exports. These gains were small, but the re-establishment of these unthrifty stands with radiata pine affects the longer term yield.

(b) The greater proportion of radiata pine in national new planting (increase from 75% in 1969 to 90% in 1972), which generates higher yields in the longer term.

The increase in the use of this species was due not only to its economic advantages through more rapid growth but also the serious effects of the needle blight disease *Dothistroma pini* on other pines.

(c) The change in silvicultural emphasis for radiata pine from predominantly 35-40 year rotations incorporating commercial thinnings, to 30 or even 25 year rotations, generally without commercial thinnings. Changes in yield tables were necessary for the new regimes, but generally yield estimation followed the same basis as the 1969 model. Simulation of these shorter rotations indicated that supplies of roundwood from new planting would be available earlier and would thus release old age-class resources for earlier utilisation. One of the management advantages in the shorter rotations was the fact that old crop, depression-planted stands in the central North Island would not have to be held as long as previous planning had indicated, thereby lessening the risk of windblow and other disasters in these overmature stands. The change in silvicultural emphasis had arisen because of a greater awareness of the economic implications of investment in forestry, particularly the compound interest effects of long rotations.

In addition to the basic 1972 model, a simulation incorporating a planting rate of 28 300 ha/year was prepared, with the extra planting above the 23 100 ha basic annual programme assumed to be entirely radiata pine managed on 25-year rotations incorporating thinnings to waste. The extra planting was theoretically located in areas where older age-classes could be released for earlier utilisation. This simulation (above, r.h. column) indicated even further potential wood availability in the short and long term as a result of this approach. A planting target of 28 300 ha/year was adopted by the National Development Conference in 1972, and subsequently by Cabinet.

Broad estimates of exotic roundwood supply were prepared during 1974 (Hume and Felton, 1974) for the Forestry Development Council, as a basis for consideration of even higher new planting targets. A number of different planting rates and management alternatives were examined, and three (including the basic 1972 model, with planting of 40 000 ha) are expressed below (estimates of wood supply are in M m^3/year).

Planning Period	40 000 ha Planting	55 000 ha Planting	Short-Rotation Alternative
1971-75			
1976-80	8.5	8.5	8.4
1981-85	9.6	9.6	9.3
1986-90	10.7	10.7	11.0
1991-95	11.9	11.9	13.2
1996-00	16.4	18.5	19.4
2001-05	24.8	30.8	28.9
2006-10	28.8	36.1	33.1

In the short-rotation alternative there is 55 000 ha/year of new planting but with 10% of both existing and new forest clear-felled at age 15, and 10% clear-felled at age 20.

These new simulations again embodied management regimes current regionally at the time. Yield tables employed in the 1972 model tended to overstate the potential of the old-age-class central North Island stands, hence the new estimates show generally lower yields in the short term than the 1972 model. The basic approach to radiata pine management in the simulations was to assume 25-year rotations for North Island stands and 30-year rotations in the South Island, without commercial thinnings. Allowing for the altered yield tables, the new estimates essentially confirm the 1972 estimates and demonstrate, not surprisingly, the very much higher production potential in the longer term as a result of increased planting (40 000 ha/year, similar to the present national achievement, and 55 000 ha/year, believed to be the maximum attainable with present resources). In addition a further simulation (short-rotation alternative, above) indicates the effects of cutting 10% of existing forests and new forests at age 15 and a further 10% at age 20. Compared with the basic approach, the effect of this strategy is to reduce yields slightly in the first 10 years, increase yields for the following 15 years but thereafter sustained yields would be approximately 2.8 M m^3/year lower.

The principal influences which have modified estimates of exotic production potential over the past decade may be summarised as:

(a) Increased new planting

(b) Increased use of radiata pine in new planting

(c) Revised silvicultural regimes incorporating fewer commercial thinnings and shorter rotations for economic and management reasons.

The effects of more planting and more radiata pine in new plantings are obvious but are longer term considerations. The possible increase in short term supply has been almost entirely caused by the planting of shorter rotations for immature stands, therefore allowing existing mature and over-mature stands to be clear felled more rapidly. The situation has been reached where any further shortening of rotations, as in the 1974 short-rotation alternative above, will mean an increase in pulpwood production at the expense of saw logs from new plantings.

REGIONAL FORESTRY DEVELOPMENT PLANNING

Successively higher estimates of aggregate national exotic roundwood supply suggest greater opportunities for limiting the cutting of indigenous forests and for forest industries to expand, satisfy domestic wood requirements, increase export earnings and further diversify New Zealand's overseas trade. While the benefits of forestry are considerable, it is equally obvious that regard must be had for the massive resources of land, labour, and capital required to achieve the simulated wood availability, to determine whether the use of such national resources is justifiable.

The evaluation of forestry development must be made within the context of the economic and social objectives of forestry. The prime objective of production forestry in New Zealand is enhancement of national welfare. This means forestry must be demonstrated as profitable commercially, and thus justify a share of national resources, and also "socially" implying that its development either enhances or does not detract from social welfare. This criterion is termed "social net return", which is measured by a cost/benefit analysis, with adjustments for social and economic considerations not reflected in a conventional discounted cash return calculation.

The approach to national forestry development planning in New Zealand is to produce a series of indicative regional development plans which, by aggregation, will give national wood supply estimates. It is therefore at the regional level that the social net return of forestry development is calculated.

The initial approach in preparing a regional development plan is to simulate wood supply from existing forest resources, based on existing forest management intentions and current afforestation plans. From the estimates of production potential over time it is possible to postulate the development of new forest industries or the expansion of those already existing. A number of alternatives for forest management, planting rate, and industry type and capacity are also likely to be studied. Economic analyses then determine the social net return from the project, taking into account the commercial profitability of the regimes and planting rates suggested and any off-site economic and social costs and benefits.

A recent regional plan, prepared for Otago Planning District (N.Z. Forest Service, 1975), indicates that existing and future resources in the south Otago region could allow the establishment of an integrated sawmill-refiner-groundwood-pulp plant by 1985, and thereafter expansion at a defined rate. The economic studies indicated that the internal rates of return for the saw log regimes (designed to supply domestic industry rather than for exports in unprocessed form) postulated in the supply models were less than 10%, but the future off-site economic benefits related to retention of population in the Otago area and the export orientation of the potential industries, when discounted to the present day increased the rates of return to 13-20%.

In postulating development of a certain industry in any region, the type, size, and timing of commencement and expansion will be important. In general, the observation from the Otago study was that the larger and more labour intensive the industry, the greater will be the economic benefits arising from provision of employment and retention of the work force in areas experiencing depopulation or slower-than-average development. Timing of establishment and expansion of industry is important because the value of the benefits obtained from the development will be discounted to the present in the calculation of social net return—hence the earlier the development of a certain size, the greater will be the present value (other things being equal).

ROLE OF COMMERCIAL THINNING REGIMES IN DEVELOPMENT PLANNING

In considering the needs of various industries, wood requirements are basically of two types:

(a) *Saw logs* — logs of reasonably large dimensions for efficient sawing, the highest quality of which can be utilised as peelers for plywood manufacture. With heavy early thinnings radiata pine saw logs of acceptable dimensions can be grown in 20-25 years in New Zealand;

(b) *Pulpwood* — for particle board, fibreboard, and paper pulp manufacture. A variety of material can be used, depending on the process and product type, and includes sawmill residues (offcuts and sawdust), planer shavings, and small roundwood. Pulp roundwood is obtained from top logs from clear felling saw log stands, from thinnings, or from pulpwood regimes which could incorporate 12-15 year rotations, depending mainly on site quality and the economic practicability of harvesting.

Table 1 outlines two saw log regimes, used in Forest Research Institute studies of the profitability of forestry on the Maraetai blocks in the western Bay of Plenty (Fenton *et al.*, 1968a; 1968b), and a pulpwood-only regime derived for the same site (J. R. Tustin, pers. comm.). Obviously there are many other variations in silvicultural regime depending on forest management and location, but the three may be regarded as representative. In determining management strategy for production of a suitable balance of saw logs and pulpwood for an integrated wood-using industry, it appears more logical to consider the satisfaction of plywood requirements from the top logs associated with saw log production in the "direct saw log" regime, and/or by the use of pulpwood regimes. This appears, on grounds of timing and flexibility, to be preferable to producing both pulpwood and saw logs from the same site under a "commercial thinning" type of regime. The approach to growing trees for the two types of produce are basically different. For saw logs, the aim is large dimension logs with few defects, achieved by thinning and pruning. For pulpwood, dimension and straightness of log are important but, linked with appropriate harvesting systems, volume per unit area is of major concern. Production of wood for these two main products would appear to be optimised better on separate sites than in combination on the same site under a commercial thinning regime. In the latter situation the early concern for a pulpwood thinning conflicts with the desire in saw log production to maximise diameter growth on final crop trees. From a wood supply planning viewpoint, therefore, saw log production is delayed 10 years compared with the "direct" approach, with consequent delays in realising the monetary and other socio-economic benefits associated with wood utilisation and industry development.

TABLE 1—Silvicultural regimes for radiata pine on the Maraetai Blocks, Bay of Plenty (Site Index 29 m).

Regime Type	Approximate Age	Treatment	Yield Saw logs (m^3/ha)	Yield Pulpwood (m^3/ha)
Commercial Thinning	0	Plant 2240 stems/ha		
(Fenton *et al.* 1968a)	10	Thin to waste to 445 stems/ha	—	—
	20	Thin to 200 stems/ha	—	160
	36	Clear fell	490	140
Direct Saw Log	0	Plant 1530 stems/ha		
(Fenton *et al.* 1968b)	9	Thin to waste to 370 stems/ha	—	—
	13	Thin to waste to 200 stems/ha	—	—
	25	Clear fell	470	110
Pulpwood	0	Plant 1500 stems/ha		
(J. R. Tustin pers. comm.)	16	Clear fell	—	330

CONCLUSIONS

The direct economic disadvantages of production thinnings for radiata pine in New Zealand have been well studied and reported (e.g. Fenton, 1972a; 1972b). Other comparisons between commercial thinning regimes and direct saw log regimes (Fenton, 1972c) have noted the true opportunity costs of extraction thinnings and the higher managerial, fire, and marketing risks associated with the longer commercial thinning approach. While the use of commercial thinnings as a deliberate management ploy in forestry development planning should not be ruled out entirely, it is difficult to envisage any situation in which this approach should be used in considering the management of new forests. While the profitability of commercial thinnings has not been demonstrated to be higher than a direct management approach to saw log production it is also apparent that the development or expansion of industries based on the use of wood from such commercial thinning regimes for new forests will be delayed, with attendant delays in realising the positive regional economic and social employment effects noted in recent studies.

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