IMPLICATIONS OF RADIATA PINE AFFORESTATION STUDIES

R. FENTON
Forest Research Institute, New Zealand Forest Service, Rotorua

(Received for publication 9 May 1972)

ABSTRACT

Interest rate is the dominant variable for evaluation of a given afforestation project.

The costs of producing export logs by simple silviculture, and of two sawlog regimes, assuming competent standards of management, are high compared with current stumpages. If export log type regimes are used to produce pulpwood, costs to mill will be as high, or higher than those in Scandinavia and North America. Costs are reduced by rapid establishment, and by concentrating on high quality sites.

New Zealand management has to decide whether the extra cost of producing high quality pruned logs, with versatile end uses and which are unlikely to be produced overseas, is warranted, when compared with export log type regimes. Production thinning regimes are expensive and incur high risks. The direct, quality log regime plus grazing could provide a likely source of comparative advantage to New Zealand.

The economics of pruning rather than production thinning, emerge as the significant study.

On current returns, the internal rates of return of both the export and direct log regimes are over 10%; that of the production thinning regime is 6.66%.

INTRODUCTION

A series of seven nominative afforestation models has been evaluated for some aspects of radiata pine (*Pinus radiata* D. Don) management. These are, in summary:

	Site index (Lewis, 1954):	80	95	110
Regime	*Management Tempo*			
Export log	Accelerated	X E(1, 2)	X E(3,2)	X E(4,2)
	Normal		X E(5,6)	X (5)
Direct sawlog	Normal		X E(7,6)	
Production thinning sawlog	Normal		X E(8,6)	

X signifies a completed study for full costs and returns, and E signifies a complementary analysis in terms of import costs and export returns. Relevant papers are:
(1) Fenton and Dick, 1972a
(2) Fenton and Dick, 1972b
(3) Fenton and Tustin, 1972
(4) Fenton and Dick, 1972c

(5) Fenton and Dick, 1972d
(6) Fenton, 1972a
(7) Fenton, 1972b
(8) Fenton, 1972c

This paper deals with the economic implications of these studies as they affect forestry in New Zealand and forest economics as a whole.

EFFECT OF THE INTEREST RATE

All studies show the overwhelming influence of interest rate on forest profitability, with land expectation values (LEV) declining steeply as interest rates rise, followed by a general flattening of the trend. If interest rates rise sufficiently, the negative LEV decrease in magnitude as the values of discounted future costs and returns tend towards zero; this is an arithmetical curiosity and it is stressed that negative LEV can be misleading in ranking projects.

Forest management has some flexibility in meeting a set internal rate of return (IRR), as the technical prescription may be altered to enable a project to meet it. An example is growing crops of 60-70 ft on site index 80 to produce one, instead of two 39 ft export crops (Fenton and Dick, 1972a). This was the only example offered in this particular series of models, but the principle has more important implications in considering pulpwood production.

The interest rate chosen affects the relative ranking of the projects; this is discussed under "Results" below.

The IRR within a given model is relatively insensitive and it usually requires major differences in cost or return parameters to affect IRR by more than 2%.

COSTS OF PRODUCTION

Costs of production are high compared with local exotic stumpages over the last 20 years. The accelerated rates of planting in the export log models reduce growing costs by about 1.2 to 1.5c per cu ft at 10% interest, when compared with "normal" rates. These reductions are of the order of 10-15%. If costs are to be reduced all indirect expenditure should be postponed, especially that on offices and buildings, roads and fire protection. Tree crop expenditure must not be curtailed as this is the only source of revenue. It is debatable how far such flexibility in allocating finance is within the power of a Government Department or of a large company. The constraints on where to allocate expenditure may be fundamental structural ones within any organisation. At present, it is doubtful if tree crop expenditure exceeds a third of the total in any but small scale enterprises here, but data on this are hard to find.

The difficulty in obtaining sawing costs has been stressed in the sawlog models, but details on costs are not recapitulated here.

The Forest Development Conference set targets on the basis of demand projections. Costs of production schedules were not prepared. The models represent a way in which national cost of production schedules for increasing volumes of different forest products (Hummel and Grayson, 1962) can be made. Such schedules would provide a complementary and equally valuable way of assessing the role of forestry in an economy.

Reasonable quality pulpwood can be produced by the accelerated export log regimes at costs of 10 to 20c per cu ft standing at 10% interest, on the site indexes of 110 to 80 respectively. But this is above the stumpages (not costs) for pulpwood in British Columbia of about 3 to 4c (Anon., 1971a), in Louisiana of 4.3c (Hair and Ulrich, 1970) and in Finland of about 6 to 8c (Heikinheimo *et al.,* 1969). The delivered costs at mill door are usually better measures of comparative advantage and these are:

Canada, 1968: 19c in British Columbia to 31c in Ontario (Bowland, 1971),
S.E. U.S.A. 1969: 20c (Hutchins, 1970).

(Recent accelerated inflation and exchange rate fluctuations, and conversions from cords to cu ft make absolute comparisons difficult). The delivered cost of pulpwood in New Zealand, if the export log management applied, would be 20 to 30c per cu ft depending on the log haul and site index concerned, at 10% interest. The World Bank Report stated "Fuel and power costs [in newsprint production] run twice that of the Canadian producers" (Anon., 1968), so it is difficult to see the comparative advantage of New Zealand here. Lower cost (and in some respects, lower quality) pulpwood can be produced by shorter rotations than the 20-29 years considered in the models, because interest rate will be the most important factor influencing the cost of production. The assumption that New Zealand has lower costs for reproducible forest resources is not the relevant criterion, as competition will be from countries where it is not necessary to reproduce raw material by plantation management. It is contended that the capital cost of plantations is high in relation to that of utilisation plants. The studies show New Zealand has no marked advantage in producing pulpwood (of the quality obtained from 110 ft, 20- to 29-yr-old trees) at a cost below the price being paid for pulpwood by overseas competitors.

The costs of growing are the most important of the findings of the study; the models assume high levels of management competence, so the costs are likely to be higher in practice.

RETURNS

The long time scales in forestry do not reduce the influence of returns on net results. Returns are likely to change faster than costs in the short term. The price for export logs will probably fluctuate with changes in the Japanese economy; the effects have been dealt with in the sensitivity analyses of the earlier papers.

The values of about 45c per cu ft for the butt logs in the sawlog models are high compared to current domestic sales. Overseas conifer sawlogs cost about 30c in Finland (Vaananen, 1971), and 29c in Great Britain (Anon., 1971b). In both overseas examples the quality and size is inferior (less than 1/3 the volume and with negligible clearwood) to these butt logs. Against this, prices for all logs in Canada appear to be little above those of pulpwood (Bowland, 1971). Stumpages have fluctuated so markedly in the Pacific N.W. of the U.S.A. since 1967 (Darr, 1971) that an average figure would be misleading. Analysis of log price/size gradients in three Australian States, Sweden, South Africa and the United Kingdom show considerable increases in value with size (Sutton, 1972). The price calculated for the quality pruned logs would have to be assessed against the price of similar logs delivered to mills elsewhere. Some conservative assumptions are made in deriving these values; conversion in current sawmills has been assumed, with cutting to one in. boards. This ignores both the possibility of more profitable sizes—either thicker or thinner—or of conversion by cutting veneer.

Price comparisons per cu ft are reasonably valid for pulpwood, but values by grade per unit of sawn outturn are more useful for sawtimber, as log grades are more difficult to compare. The export Factory grade produced from pruned logs would be superior to otherwise comparable Pacific N.W. No. 2 Shop (Western Wood Products Association, 1965) ponderosa pine (*Pinus ponderosa* Laws.). The proportion of clear-cuttings of one ft or more is nearly 80% in the export Factory grade (Fenton *et al.,* 1971) which is much higher than in the American grade (for which timber values are available). The price of $10.8 per 100 bd ft used in the models compares with a price in 1971 of $10.3 (Darr, 1971) for the North American timber.

The Clears grade produced is equal to the B and Better North American Clears (in all except rings/inch which is not mentioned in the American grading rules). Prices for B and Better ponderosa pine per 100 bd ft have ranged:
$21.1 (Newport and Amidon, 1961); $22.15 (Gaines, 1962); $22.4-$24.5 (Western Wood Products Association, 1966); $30 (Western Wood Products Association, 1970), and for C select (slightly inferior to B select and better) $22.8 (Benson and Kirkwald, 1967), against an export price of $14.56 allowed in the studies. (1972 exchange rates of $1NZ = $1.20 U.S.A. throughout). In some cases the American prices are for dry and surfaced lumber, but the comparisons show the prices obtained for high quality timber on an open market.

The price of timber is still affected by the assumption that mill profits should be 15% of production capital. It is surprising that this basis, a hangover from keeping indigenous mills in production during the Depression, still applies. The concept of plantation plus mill profitability needs clarification. Present procedure has the almost flippant result of improving returns when forest and mill are combined; because overall forest IRR must rise if it is below 15% before incorporating the sawmill results. Moreover, *all* sawmills must be profitable on the Treasury criterion of a 10% minimum IRR, hardly an intentional result.

ACTUAL RESULTS

Undue weight should not be given to the absolute values of the actual results, as these depend on the cost and return parameters used. The broad results are clear cut; and when social items are included the rankings are:

(a) For the export log models
Site index 110, accelerated > 110, normal > 95 accelerated > 95 normal > 80 accelerated.

(b) For the "normal" models on site index 95
Direct sawlog > export log > > production thinning sawlog

These rankings apply at all interest rates where LEV are still positive. It is not particularly appropriate to rank the seven projects together, but if they are (Table 1) there is a shift in ranking as interest rate rises.

The results of the export log models show the effects of faster rates of afforestation, which lift IRR by about 1-1½%. Site quality is very important and is quantified to some extent in the export log models. It is a safe inference that similar results would apply to sawlog models, apart from two technical limitations. The first limitation is that the crop has to be successfully established. On some sites of over 120 index, such as Tarawera in the Bay of Plenty, this is still straightforward as scrub growth is easily controlled; on other high site indexes it is extremely difficult and expensive—as on the

TABLE 1—Ranking of the seven models—based on LEV, including social items

Interest Rate %	MODEL 95DS	110LA	110LN	95LA	95LN	80LA	95TS
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	3	1	2	4	5	6	7
7	3	1	2	4	5	6	7
8	4	1	2	3	5	6	7
9	4	1	2	3	5	6	7
10	4	1	2	3	5	6	7
11	4	1	2	3	5	6	7
12	4	1	2	3	5	6	7
13	4	1	2	3	5	(6)	(7)
14	5	1	2	3	4	(6)	(7)

Code to models tabulated:

80,95,110 signify site index
N,A signify Normal or Accelerated rates of afforestation
L = export log regime
DS = direct sawlog (normal) regime
TS = 'Normal' sawlog regime, with production thinning
The broken line shows where the LEV became negative for each model

steep, indigenous forest-covered, finely dissected, papa country of North Taranaki. The second qualification is that sawlog economics, particularly pruning, are not known for site indexes of 80 and below; it may be uneconomic to prune on these sites. The effect of high interest rates will not be to push forestry back onto difficult, low site index country, but rather the reverse.

It is this influence that makes the combined grazing/quality log proposals so important; instead of competing with agriculture for land, high quality sites can be obtained for tree growing, while maintaining continuing (if diminishing) agricultural returns during the long non-productive period of tree growth. Such management *does* provide a solution to the problem ". . . New Zealand has become one of the most efficient plantation forest producers in the world. However . . . it takes about 25 to 30 years from planting before significant income can be derived from a new forest . . . this would provide no satisfactory solution to the pressing shorter-run problems facing the farmers and the nation" (New Zealand Economic Council, 1970). It would be interesting to know the basis for the statement that New Zealand is "one of the most efficient plantation forest producers", as comparative data other than those presented in these studies, are scarce.

When results are calculated in terms of export dollars earnt per import dollar (Anon., 1968) ranking is unaffected. This criterion is favourable to forestry (Fenton and Dick, 1972b; Fenton, 1972a). The effect of a 10% weighting of costs and returns on overall results does not affect the IRR, although it increases LEV at all interest rates.

ECONOMICS OF THINNING

The two sawlog models (Fenton, 1972a, 1972b) provide a comparison of the economics of production thinning for pulpwood, when the latter is reduced to its ultimate residual of one operation. Even these comparisons are complicated by the use of a stumpage for the pulp yield; results from sawing such logs show returns often lower than given by this pulp stumpage (Tustin, 1968; Tustin and Knowles, 1970; Sutton *et al.,* 1971a, 1971b). The indirect costs of the thinning are available in manuscript.

Comparative results between the two sawlog regimes are given in Table 2 for log volume and quality, in Table 3 for sawn grade, and by economics criteria in Table 4. The production thinning management regime is inferior in every respect to the direct regime; it costs more than twice as much per cu ft, produces lower grades, needs as much labour, has greater managerial, physical, fire and marketing risks. The contention that a pulp commitment must be met from such a regime is extravagant. It is much

TABLE 2—MAI by log quality and volume (cu ft/acre/ann.)

Log Height Class	Mean Annual Increment Production-Thinning*	Mean Annual Increment Direct Sawlog
A Final crop		
Butts — pruned	83.4	120.0
Seconds — pruned	0	89.2
— unpruned	62.0	0
Thirds — unpruned	42.8	61.5
Top logs — pulpwood	63.6	46.5
B Thinnings		
Pulpwood	64.4	0
C Totals		
Pruned sawlogs	83.4	209.2
Unpruned sawlogs	104.8	61.5
Pulplogs	128.0	46.5
Total	316.2	317.2

* Before correction for loss of final crop area caused by thinning

TABLE 3—MAI by timber quality from production-thinning and direct sawlog regimes, (bd ft per acre)

Grade	Production-Thinning*	Direct Sawlog
Clears	207	437
Superior Factory‡	179	420
Superior Dressing†	61	199
Ordinary Factory	28	44
Ordinary Dressing	20	26
Framing (1 & 2)	364	26
Merchantable	124	281
Box	236	320
Total	1219	1753

* Before correction for loss of final crop area caused by thinning
‡ Mean length of clear cuttings 4.5 ft
† Mean distance between defects 5 ft

TABLE 4—Relative results (including social costs) of production-thinning and direct sawlog regimes

	Production-Thinning	Direct Sawlog
LEV at 7% $ per acre	-5.7	99.4
10% $ per acre	-27.1	5.8
IRR %	6.66	10.5
Export $ earned per import $		
(a) At 7%		
Optimistic	6.9*	13.1
Medium	5.0*	11.0
Pessimistic	4.2*	10.2
(b) At 10%		
Optimistic	3.5*	8.4
Medium	2.7*	7.1
Pessimistic	2.1*	6.5
No. of men at "normality" per 1000 acres	4.16	4.20
Volume per man per year at "normality" (thousand cu ft)	62.6	62.8
Break-even growing costs (c per cu ft) At 7%	20.8‡	11.1
10%	54.0‡	21.4

* Excluding thinning costs
‡ Excluding thinning costs and yields

less costly to use a combination of direct plus export log regimes. If pulp commitment is so important (and no data on the relative efficiency and profitability of the local industry have been published), then it is difficult to see why more work on direct pulpwood regimes has not been attempted.

Results are so different that no such production thinning should be prescribed; it has no advantage to compensate for its disadvantages.

ECONOMICS OF PRUNING

The economics of pruning is not found by comparing pruned and unpruned logs of the same age and size, but by comparison of a pruned regime with the most profitable alternative. The export log and direct sawlog regime provide such a comparison. Again, the relative costs are of more fundamental importance than the actual results. The latter show, in these models, a superior result to the direct regime, which declines in magnitude as the interest rate increases; these results are highly sensitive to price changes. The direct regime aims at trees of 24.3 in. d.b.h. and it is feasible that later work will alter this target; it was adopted primarily as grade results were available for trees of this size.

Pruning turns out to be a far more important question than production thinning for local forestry. The fundamental policy question can now be framed from the cost-of-production data and results. It is:

How far should the additional investment in direct type schedules be favoured over the simpler export log management? The actual costs for site index 95 at 7% and 10% interest in c per cu ft are:

		Excluding social items	Including social items
7%	Export log	6.3	8.0
	Direct sawlog	11.1	13.8
10%	Export log	11.6	14.8
	Direct sawlog	21.4	27.1

(Lower figures would result from accelerated planting of higher site qualities).

The answer depends on the estimate of New Zealand's advantage in producing quality logs, with their versatility for whatever end-use emerges; basically it is a question of risk. The costs would be reduced if grazing revenue—not available from export log silviculture—offsets quality log production costs.

FUTURE INDUSTRIES

The underlying importance of the cost of production is the most significant gain from these models. Pulpwood production costs for 110 ft trees are going to be far higher than the industry is paying at present. There are several solutions to this, including investigation of cheaper pulp production methods. Another is to marginally price top logs and utilisation plant residues for sale to pulp plants. New Zealand may well have a larger pulp industry than at present, but its size should certainly be influenced by the likely cost of production of its raw material supplies. Demand projections are only one guide to decision making in forest management.

The results of the direct sawlog and export log regime pose the choice of the extra cost needed to build versatility into the standing crop. The export log regime produces logs of knotty quality, reasonable size (17.9 in. d.b.h. trees) and uniformity. The end uses for its products would be sawn timber of much the same quality as currently produced from older, untended first rotation stands, apart from potentially lower yields of framing grades and higher yields of board grades. Grade study results, however, while giving moderately improved yields of board grades, showed cutting framing from trees of this age was generally more profitable (Sutton *et al.,* 1971; Tustin, 1968; Tustin and Knowles, 1970). Overall log size would be equivalent to that available to the exotic sawmill industry in the early 1950s—when the first big mill expansions (at Maramarua, Conical Hill, Waipa, Tasman and Kinleith) occurred, with similar costs.

This would compete with similar material from other world softwood plantations, and with the much larger supplies of virgin and second-growth natural forests. Management risks would be low, marketing risks—apart from log sales—relatively high.

The direct (high quality) log/regime incurs the opposite risks—final marketing would be versatile, management risks are higher as silviculture has to be accurately timed, and costs of forest production are higher. These costs are offset to some extent by grazing returns.

The generally unexploited comparative advantage of a high rate of diameter increment, with or without added log quality through pruning, can be best utilised by development of export of peeler logs, veneers, or plywood. It is difficult to understand why New Zealand forest production targets have been based on pulpwood, in competition with resources elsewhere which still only bear the cost of exploitation, when veneer and plywood potential is available. The example of the development of the southern pine veneer in the U.S.A., competing in one of the fastest growing of all U.S. industries, is striking: "Veneer logs are high valued in comparison with other kinds of logs and bolts and considerable employment is generated and much value added in their manufacture. . . . The first southern pine plywood mill became operational in December 1963 . . . [when pine was] . . . a scant 2% of the mid-south's annual output. . . . Until 1963 . . . softwood veneer and plywood was centred in the coastal Douglas fir region. Of the locational factors that contributed to the development of the southern pine plywood industry, timber availability was decisive. . . . By the end of 1969 annual output had zoomed to 2.8 billion sq ft ($\frac{3}{8}$ in. basis) or 20% of the total United States softwood plywood output". (Sternitzke, 1971). In this same period softwood timber production there rose from 6.1 to 7.5 billion bd ft and softwood pulp wood from 20.7 to 30.8 million cords (Hair and Ulrich, 1970) so there was considerable competition for the resource. Ply and veneer would be a logical consequence of quality log production.

CONCLUSIONS

1. Interest rate is the dominant variable for economic evaluation of a given afforestation project.
2. Costs of production can be best reduced by restructuring forest enterprises to give first priority to the tree crop. It is debatable how far this is feasible in present large-scale organisations.
3. Costs of production of export logs are as high, or higher than major overseas pulpwood stumpages.
4. Costs of production schedules for major classes of forest products can now be prepared. The higher the site quality and the faster the rate of planting, the lower the cost; assuming successful establishment is achieved and a uniformly competent standard of management is maintained.
5. Production thinning is economically unacceptable in the case considered here; its economics generally have been misunderstood.
6. Pruning, rather than production thinning, economics emerge as the significant study. The fundamental question is how far are the additional cost and management risks

justified by the higher returns and increased versatility of the product, when compared with simple export log type regimes?

7. Quality log plus grazing production plus some freedom of thought provides a likely source of comparative advantage for New Zealand.

REFERENCES

ANON., 1968: "The World Bank Report on the New Zealand Economy 1968" Government Printer, Wellington.

——— 1971a: Annual Report 1970 British Columbia Forest Service, Department of Lands, Forest and Water Resources, Victoria, British Columbia.

——— 1971b: Standing softwood timber. **Timber Trades Journal,** p. 39, 5/6/71.

BENSON, R. E., and KIRKWOLD, L. L. 1967: Market trends for western white pine. **Intermountain Forest and Range Experiment Station, Research Note INT 65.**

BOWLAND, J. G. 1971: Economic indicators in forestry and forest based industries in Canada: 1961/69. **Department of the Environment, Canadian Forestry Service. Publication 1297.**

DARR, D. R. 1971: Production, prices, employment and trade in the north-west forest industries. First Quarter, 1971. Pacific Northwest Forest and Range Experiment Station.

FENTON, R. 1972a: Import costs and overseas earnings in sawlog and export log afforestation profitability. **New Zealand Journal of Forestry Science 2 (3) (this issue):** 369-77.

——— 1972b: Economics of radiata pine for sawlog production. **New Zealand Journal of Forestry Science 2 (3) (this issue):** 313-47.

——— 1972c: Economics of sawlog silviculture which includes production thinning. **New Zealand Journal of Forestry Science 2 (3) (this issue):** 348-68.

FENTON, R., and DICK, M. MERLE 1972a: Profitability of radiata pine afforestation for the export log trade—on site index 80. **New Zealand Journal of Forestry Science 2 (1):** 69-99.

——— 1972b: Import costs and overseas earnings of afforestation models for the export log trade. **New Zealand Journal of Forestry Science 2 (1):** 128-43.

——— 1972c: Profitability of radiata pine afforestation for the export log trade—on site index 110. **New Zealand Journal of Forestry Science 2 (1):** 100-27.

——— 1972d: Profitability of "normal" afforestation for the export log trade on site indexes 95 and 110. **New Zealand Journal of Forestry Science 2 (3) (this issue):** 289-312.

FENTON, R.; SUTTON, W. R. J., and TUSTIN, J. R. 1971: Clearwood yields from tended 26-year-old, second-crop, radiata pine. **New Zealand Journal of Forestry Science 1 (2):** 140-59.

FENTON, R., and TUSTIN, J. R. 1972: Profitability of radiata pine afforestation for the export log trade—on site index 95. **New Zealand Journal of Forestry Science 2 (1):** 7-68.

GAINES, E. M. 1962: Improved systems for grading ponderosa pine and sugar pine sawlogs in trees. **Pacific South West Forest and Range Experiment Station. Technical Paper 75.**

HAIR, D., and ULRICH, ALICE H. 1970: The demand and price situation for forest products 1969-70. **United States Department of Agriculture, Forest Service miscellaneous publication 1165.**

HEIKINHEIMO, L.; PAARANEN, S., and VEHVILAINEN, H. 1969: Stumpage and contract prices of pulpwood in Norway, Sweden and Finland in the felling season 1958/59-1968/69 and 1969/70. **Folia Forestalia 68.**

HUMMEL, F. C., and GRAYSON, A. J. 1962: "Production Goals in Forestry with Special Reference to Great Britain." (Paper to Eight British Commonwealth Forestry Conference.) Forestry Commission, London. 16pp.

HUTCHINS, C. C. 1970: Trends in pulpwood prices in the southeast, 1962-69. **United States Department of Agriculture, Forest Service Research Note SE-137.**

LEWIS, E. R. 1954: Yield of unthinned **Pinus radiata** in New Zealand. **New Zealand Forest Service, Forest Research Institute, Forest Research Note 1 (10).**

NEW ZEALAND ECONOMIC COUNCIL, 1970. New Zealand and an enlarged EEC. New Zealand Economic Council Report 19. Government Printer, Wellington.

NEWPORT, C. A., and AMIDON, E. L. 1961: Lumber grade and value performances of young growth ponderosa pine logs at the Challenge Experiment Station. **Pacific South West Forest and Range Experiment Station. Technical Paper 55.**

STERNITZKE, H. S. 1971: Midsouth veneer log production. **United States Department of Agriculture, Southern Forest Experiment Station, Forest Service Resource Bulletin SO-25.**

SUTTON, W. R. J. 1972: Price size gradients for sawlogs—a review. **New Zealand Forest Service, Forest Research Institute, Economics of Silviculture Branch Report 51** (unpublished).

SUTTON, W. R. J.; MACDONALD, D. S.; CHANDLER, K. C., and KEATING, B. 1971: A grade study of thinnings from moderately and heavily thinned **P. radiata** stands—Ngaumu Forest. **New Zealand Forest Service, Forest Research Institute, Economics of Silviculture Branch Report 2** (unpublished).

SUTTON, W. R. J.; MACDONALD, D. S.; CHANDLER, K. C., and TROTMAN, I. G. 1971: A grade study of radiata pine thinnings from Gwavas Forest. **New Zealand Forest Service, Forest Research Institute, Economics of Silviculture Branch Report 3** (unpublished).

TUSTIN, J. R. 1968: A review of first utilisation thinning for other than minor forest produce of tended radiata pine stands. **New Zealand Forest Service, Forest Research Institute, Silviculture Branch Report 101** (unpublished).

TUSTIN, J. R., and KNOWLES, R. L. 1970: Results of a grade study on 19-year-old thinnings from Patunamu Forest. **New Zealand Forest Service, Forest Research Institute, Economics of Silviculture Branch Report 20** (unpublished).

VAANANEN, S. 1971: Stumpage prices in private forests during cutting season 1969/70. **Folia Forestalia 102.**

WESTERN WOOD PRODUCTS ASSOCIATION 1965: Standard Grading Rules 1/1/1965.

——— 1966: Weekly F.O.B. price summary report 52.

——— 1970: Weekly F.O.B. price summary report 8.