FOREST RESEARCH INSTITUTE MEETING ON THINNING AND PRUNING

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INTRODUCTION

An informal meeting to discuss thinning and pruning was held at the Forest Research Institute, Rotorua, under the chairmanship of E. H. Bunn from July 16 to 19, 1963. The participants included research officers of the Institute, and (by invitation) a fairly representative group of conservancy foresters, foresters in private companies, forestry consultants, farm foresters, and specialists from the New Zealand Forest Service Head Office. It resulted in a comprehensive appraisal of the current state of knowledge, practice, and progress in development of thinning and pruning forests of exotic species in New Zealand, with particular reference to *Pinus radiata*.

The following condensation is about one-tenth as long as the discussions: inevitably a great deal has had to be left out in a summary of this length. The writer hopes that he has managed to retain the gist of what was said, and apologizes beforehand to any speakers who may feel that the errors and omissions are excessive or that they have been misrepresented in any way.

A full account is in course of preparation by officers of the Forest Research Institute and it is hoped that it will be available for limited distribution early in 1964.

MORNING SESSION, JULY 16

The meeting was opened at 9 a.m. on July 16, 1963, by H. R. Orman, Acting Director of Research. He stressed that the meeting was a gathering of people interested in pruning and thinning, for informal discussion of problems of common interest for the common benefit, and he added that it might provide some indication of possible useful lines of research. He introduced E. H. Bunn (FRI) as Chairman.

The Chairman said he proposed that the meeting should consider first the foreseeable future requirements in forest products, then the type of tree required to produce these products, and then how to grow these trees.

Future Requirements

R. W. M. Williams (Economics Division, N.Z.F.S.) presented a paper on "Forest Products Requirements of the Future". He

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estimated the annual average exotic-timber requirements for the period 2001 to 2005 in millions of cubic feet as:

Sawlogs:		
Finishing	56 (30%)	
Building	85 (46%)	
Rough	45 (24%)	
Total		186
Peelers		4
Other roundwood		9
Pulp logs		172
Total		371

He asked whether the Rotorua district could achieve a distribution of 50% in finishing grades, 25% in building grades and 25% in rough grades, on rotations of less than 40 years for radiata pine and less than 60 years for Douglas fir.

J. S. Reid (Utilization Development Division, N.Z.F.S.) in a paper on "Future Trends in Timber and Veneer Grading", discussed probable grade prices and usages. He forecast a decrease in demand for wooden containers, slight decreases in the proportionate demand for light framing and for knotty boards of machining quality, an increased demand for small-knotted Merchantable grade for lamination, an increased demand for a Factory grade of better quality than the present grade of that name, and a much increased demand for clear boards. He said we must rely largely on radiata pine to furnish the necessary higher grades.

J. Maddern Harris (FRI) introduced his paper on "Quality Requirements in Forest Products". He said that it might become advisable to select radiata pine separately for sawlogs and for pulp logs, selecting mainly on form for sawlogs and on vigour and fibre length for pulp logs. He considered that in the case of Douglas fir the coming of stress grading might make it increasingly important to avoid loss of quality from too rapid rates of growth.

In discussion of these subjects the impact of reconstituted wood (such as chipboard) and devices such as finger jointing on the demand for high grades of natural wood was considered. Neither Reid nor T. A. Foley (Utilization Development Division, N.Z.F.S.) thought that these processes could seriously affect the need for the production of clear timber through pruning. Reid held that pruning should aim mainly at production of clear wood, rather than at mere grade improvement, and he estimated the future requirement of the top grades of radiata pine as at least 25% of the total cut of sawn timber; he doubted if this could be produced on a rotation of about 35 years. Discussion of timber quality and rate of growth showed that few were worried about the effect of rapid growth on pines, but that some were concerned about its effect on Douglas fir. Reid was of the opinion that first-class timber could not be produced from Douglas fir planted at 8 × 8 ft, and Maddern Harris favoured a minimum of about six rings per inch as the rate to aim at. The consensus of opinion was that initial espacement was the vital factor in this regard, subsequent thinning being unlikely to produce fewer than six rings per inch.

Clear-wood Yields

R. T. Fenton (FRI) presented a paper on "Clear-wood Yields" showing calculations of theoretical yields from various pruning regimes, and highlighting the inevitable rise in knotty-core diameter with increase in height. He calculated that (for example) a 50% yield of clear wood from the 18–36 ft length on a knotty core of 10 in. would require a final diameter at breast height over bark of 26.6 in. at least. He referred to the great influence of increasing log size in reducing sawing cost, and discussed the effects of varying core sizes and varying log sizes on theoretical clear-wood yields.

Characteristics of Radiata Pine to be Preferred in Selection

M. H. Bannister (FRI) presented a paper on "The Branching and Coning Patterns of *Pinus radiata*", and in discussing this led up to a tentative specification of the kind of tree to retain in the stand at thinning. He showed that low whorl frequency, few stem cones, large branches, steep angles in the branches, and crooked trunks tended to be associated, while the opposite characteristics — high whorl frequency, many stem cones, small branches, large branch angles, and straight stems — also tended to be correlated. He pointed out that it is not practicable to select for all the desirable characteristics at once.

G. B. Sweet (FRI) presented his paper on "Tree Specification for Breeding Purposes" and discussed the possibility of breeding an ideal radiata pine tree, and the difficulty of doing so because of the correlations referred to by Bannister. He said that in selecting for breeding for sawlog production he did not take any factor as being of overriding importance. He selected from healthy, vigorous trees of good stem and branch form, with as few stem cones as possible. In discussion, Sweet added that, for pulpwood, vigour would receive a higher rating. The breeding programme was aimed at types for four different regions in New Zealand, not for the whole country as a unit.

The Chairman summed up by suggesting that silviculturists should aim for a final-crop tree of d.b.h. in excess of 23 in., straight, with a knotty core kept small as high as possible, the branches above the pruned length small and preferably green, and with no stem cones below 50 ft and no swollen nodes.

AFTERNOON SESSION, JULY 16

Silvicultural Aspects of Thinning and Pruning

G. S. Brown (FRI) tabled his paper on "The Silvicultural Aspects of Thinning and Pruning", which was mainly a review of the literature on the subject. In presenting it he did not attempt to cover the field but confined himself to a discussion of the effect of green pruning on increment. He drew attention to the possibility of distinguishing between the part of the conifer crown open to the sky (the open crown) and the part below it (shade crown), and showed that the boundary could be located by comparing branch ring counts with stem ring counts at the same level. He suggested that

the shade crown, and probably only the shade crown, could safely be pruned off without loss.

In discussion he said that shade crown branches generally do not themselves respond to thinning and probably contribute little to stem-increment response to thinning. Depth of open crown is dependent mainly on stand density if the stand has closed canopy. R. T. Fenton suggested that pruning for grade improvement is likely to fail in its object, as occlusion bark pockets and the like would be substituted for potential encased knots and would be equally damaging to grade, a proposition which Brown thought exaggerated.

Brown then turned to his paper on "Crown Depth Deficiency as a Standard for Control of Pruning and Thinning". He suggested that the severity of any pruning or thinning operation, or any combination of the two, could be assessed by comparing the actual crown depth left after the operation with what the depth would be in a comparable stand of the same density that had been left to develop a full natural crown depth, and he demonstrated how the calculation might be made. On the basis of such calculations he pointed out as possible danger points (*i.e.*, operations involving either excessive pruning or excessive thinning or both) in the schedules before the meeting the operations at 73 ft top height in the Forest Products schedule, at 45 ft in the Rotorua Conservancy hauler-country schedule, at 30 ft in the Rotorua pulpwood schedule, and at 34 ft in the Southland schedule, and predicted that the Rotorua Corsican pine schedule would be unlikely to eliminate the encased knot. He suggested that one implication of the method was that it would be futile to thin for the purpose of increasing diameter growth while at the same time pruning "like demons" (a phrase used by Bunn).

J. Beekhuis (FRI) spoke on his paper "Crown Depth of Radiata Pine in Relation to Stand Density and Height". He defined green-crown depth as the difference between predominant mean height and average height of green-crown base in a stand. He showed that, for a given site, stand density and age were the major factors influencing green-crown depth so defined, that normal thinning intensities are likely to have only a small effect on it, and that they are unlikely to enable green crowns to be kept down to pruning levels. For example, at predominant mean height 110 ft and a density of 125 stems per acre, he predicted a green crown depth of only 59 ft.

Spacing Trials

C. van der Voort (FRI) presented his paper on "Some Results on the Effect of Initial Spacing in *Pinus radiata* Spacing Trials". He pointed out that several factors had prevented him from drawing firm statistically supported conclusions from the trials. For example, too little time had elapsed in many, and the introduction of a range of thinning treatments had resulted in a lack of adequate replication and had introduced an incalculable subjective element. He sketched some tentative conclusions based on subjective interpretation. He found that the largest 100 stems in a 3 × 3 ft spacing at age 8 in Kaingaroa are about 1 in. larger in diameter than the largest 100 stems in 10 × 10 ft spacing — probably because the former includes

a larger range of diameters from which the top 100 can be chosen. To capitalize on this advantage it would be necessary to thin the 3 × 3 ft before age 8. If it is not thinned, competition soon reverses the position — the average of the largest 100 diameters in the 10 × 10 ft becomes greater than that in the 3 × 3 ft. At Kaingaroa, later thinning in both espacements has tended in practice to reduce the difference or to reverse the position again, probably because markers tend to mark for removal trees of poor form though these are frequently trees of the largest diameters. The final result, in consequence, may quite possibly be that the largest diameters will be found in the plots initially planted most closely, although the average of the largest 100 diameters might be a little greater (covering a smaller range), in plots initially planted more widely, than the average in the more closely planted plots. With increasing age, the diameter differences between different initial espacements have tended to disappear. At a mean top height of 90 ft the largest 100 stems per acre in 10 × 10 ft spacing are barely 1 in. larger than in 3 × 3 ft spacing. As regards form, this may appear to the eye to be poorer in the plots of wider initial spacings but no such difference has yet been statistically proved.

In discussion, van der Voort said the trials suggested that it paid to have a large number of stems to select from early in the life of the stand, provided that an early thinning (before age 11) is applied so that advantage may be taken of the available selection, even although the thinning may be only a light one. P. Olsen agreed, from general observation in Kaingaroa Forest, that the potential benefits of the greater selection are lost if thinning is delayed. In reply to a question, van der Voort agreed that his discussion referred mainly to plots in Kaingaroa Forest, and that conclusions based on these plots might well not be valid for other areas.

Yield Prediction

J. Beekhuis presented his second paper, "The Prediction of Yield and Increment for Thinned *Pinus radiata* in New Zealand", a work based on permanent sample plots observed over a period of 15 years. He had plotted increments against predominant mean height instead of against age as the independent variable, and had developed a method for the prediction of gross basal-area increment based on the increase in stand height over a given interval between thinnings, and the height and net basal area of the stand at the middle of the interval. The method allows for the prediction of yield under a wide variety of thinning regimes instead of being tied to a limited number of often vaguely defined thinning grades.

Beekhuis's paper and in consequence its presentation were highly technical and not of a nature lending themselves to condensation. To say more, without reporting the whole verbatim and complete with blackboard illustrations, would add little and remain inadequate. The essence of a large part of the work, however, is contained in the table "Increment and Yield under Different Thinning Regimes", which is reproduced, in modified form, on pages 64–5.

The Chairman deferred the discussion of this paper until the next day.

Thinning	Ht	Age	Stems per Acre			B.A. sq. ft (Mean d.b.h., in		
Regime *	ft	yr	Total	Residual	Cut	Total	Residual	Cut
1000/3/130/16%	44	9	930	370	560	160 (5.6)	82	78 (5.0)
	73	14½	344	190	154	186 (10.0)	119	67 (8.9)
	101	21	177	115	62	202 (14.5)	147	55 (12.7)
	130	31	107	0	107	220 (19.4)	0	220 (19.4)
1000/3/130/19%	37	7¾	970	300	670	135 (5.1)	55	80 (4.7)
	68	13½	291	140	151	170 (10.3)	97	73 (9.4)
	99	20½	136	82	54	191 (16.0)	130	161 (14.4)
	130	31	80	0	80	210 (21.9)	0	210 (21.9)
1000/3/130/22%	32	7	990	245	745	115 (4.6)	39	76 (4.3)
	65	13	243	110	133	163 (11.1)	86	77 (10.3)
	97	20	109	61	48	184 (17.6)	118	66 (15.9)
	130	31	60	0	60	204 (25.0)	0	204 (25.0)
1000/4/130/19%	37	7¾	970	390	580	135 (5.1)	69	66 (4.6)
	60	12	378	200	178	157 (8.7)	97	60 (7.9)
	84	17	194	122	72	175 (12.9)	124	51 (11.4)
	107	22¾	118	82	36	189 (17.1)	146	43 (14.8)
	130	31	80	0	80	204 (21.6)	0	204 (21.6)
1000/2/130/19%	37	7¾	970	200	770	135 (5.1)	39	96 (4.8)
	84	17	194	82	112	205 (13.9)	109	96 (12.5)
	130	31	80	0	80	213 (22.1)	0	213 (22.1)
750/3/130/19%	43	9	728	270	458	135 (5.8)	65	70 (5.3)
	72	14½	262	135	127	168 (10.8)	102	66 (9.8)
	101	21	131	82	49	188 (16.2)	133	55 (14.3)
	130	31	80	0	80	203 (21.8)	0	208 (21.8)
560/3/130/19%	50	10	543	235	308	135 (6.7)	73	62 (6.1)
	77	15¼	228	130	98	164 (11.5)	113	51 (9.8)
	103	21¾	126	82	44	189 (16.6)	138	51 (14.6)
	130	31	80	0	80	207 (21.8)	0	207 (21.8)

* Initial density/number of thinnings/final height/spacing height ratio immediately before each successive thinning.

DIFFERENT THINNING REGIMES

Total Vol. cu. ft			*Incr. cu. ft*		*6 in. Vol.*		*4 in. Vol.*	
Total	*Residual*	*Cut*	*M.A.*	*C.A.*	*%*	*Cut*	*%*	*Cut*
2,592	1,360	1,232	288	—	3	37	54	665
4,631	3,003	1,628	404	595	65	1,058	90	1,465
6,727	4,939	1,788	457	573	88	1,573	96	1,716
9,240	—	9,240	448	430	96	8,870	98	9,055
		13,888				11,538		12,901
1,904	808	1,096	246	—	—	—	46	504
3,978	2,314	1,664	376	551	70	1,165	91	1,514
6,246	4,300	1,946	439	562	92	1,790	97	1,888
8,820	—	8,820	436	430	97	8,555	99	8,732
		13,526				11,510		12,638
1,449	514	935	207	—	—	—	35	327
3,668	1,982	1,686	354	526	77	1,298	93	1,568
5,906	3,840	2,066	426	561	94	1,942	97	2,004
8,568	—	8,568	428	430	97	8,311	99	8,482
		13,255				11,551		12,381
1,904	1,000	904	246	—	—	—	44	398
3,297	2,067	1,230	350	540	53	652	86	1,058
4,935	3,533	1,402	416	574	83	1,164	95	1,332
6,634	5,163	1,471	447	539	92	1,353	97	1,427
8,568	—	8,568	438	413	97	8,311	99	8,482
		13,575				11,480		12,697
1,904	589	1,315	246	—	—	—	49	644
5,781	3,141	2,640	417	561	88	2,323	95	2,508
8,946	—	8,946	416	415	97	8,678	99	8,857
		12,901				11,001		12,009
2,146	1,061	1,085	238	—	7	76	60	651
4,133	2,549	1,584	366	585	74	1,172	92	1,457
6,260	4,472	1,788	425	550	91	1,627	97	1,734
8,736	—	8,736	426	426	97	8,474	99	8,649
		13,193				11,349		12,491
2,430	1,339	1,091	243	—	19	207	71	775
4,280	2,985	1,295	352	560	74	958	92	1,191
6,407	4,719	1,688	404	526	92	1,553	97	1,637
8,694	—	8,694	412	430	97	8,433	99	8,607
		12,768				11,151		12,210

(Compiled by J. Beekhuis)

Discussion of Beekhuis's paper consisted largely of his elucidation, in response to questions, of details of the method of preparation of his yield tables. He showed that gross basal-area increment, but not necessarily net basal-area increment, is, within limits, greater in a stand of larger basal area at the beginning of the period than in a stand of lower basal area. He declined to specify an optimum basal area, but suggested that in general the stand should be reduced when it reaches a basal area of some 200–220 sq. ft, adding that the limit should probably not be static throughout the growth of the stand but should rise as the stand gets older. Discussion of the diameters to be expected in the final crop highlighted the smallness of the gain from heavy thinning as against light thinning. Thinning yields at about top height 70 ft were discussed. One speaker noted that although volumes might be impressive the thinning might not be economic in itself because of the smallness of the pieces. It was noticed that one implication of the work was that the timing of thinnings could be varied considerably to suit local circumstances without important loss of volume yield or severe effect on final diameters. The Chairman commented in summing up, "It does appear that to increase final log size and get better returns from our prunings we should lengthen the rotation, provided we can carry higher basal areas than 200 sq. ft."

Pathological Considerations

R. Zondag (FRI) spoke on the subject of his paper "*Sirex* and Thinning Operations". He said that pruning and thinning in the summer months increased the risk of *Sirex* attack. He was aware that in spite of this the practice of thinning and pruning in summer was continuing, and observed that this could be turned to some advantage in research if the Forest Research Institute could be provided with details of summer operations and subsequent *Sirex* attack, if any. If such information were to be made available, he would be in a better position to assess the dangers and perhaps predict *Sirex* population build-ups. *Sirex* breeds in the slash of summer thinnings-to-waste, and also in poisoned thinnings although to a lesser degree.

In the discussion which followed, he added that in severe pruning of selected trees the pruned trees tended to be preferred by the *Sirex* wasp. D. S. Jackson (N.Z.F.S., Hawke's Bay) mentioned that mortality from *Sirex* attack on such trees was associated with the timing of the pruning: mortality of pruned trees in one stand pruned before December was under 10% and in others pruned just before Christmas it was over 80%. J. Ure (N.Z.F.S., Rotorua) and A. W. Grayburn (N.Z. Forest Products Ltd.) expressed the view that a ban on summer thinning and pruning would be, from the management point of view, unrealistic, and that they would have to continue with these practices and accept the risk.

J. Gilmour (FRI) presented his paper on "Pathological Aspects of Thinning and Pruning", dealing mainly with the stem canker caused in radiata pine by *Diplodia pinea*. He had found a close correlation between stem wounding and the incidence of the canker,

but none between its incidence and time of year of pruning or age of the stand. A possible correlation with severity of pruning had yet to be studied. Wounding, and therefore canker, was commoner with pruning by axe or slasher than with pruning by secateurs. The effect of canker associated with pruning was to increase the area to be occluded and therefore to delay occlusion, in effect increasing the size of the knotty core.

Returns from Tending: Economic Models

R. T. Fenton presented a second paper, "Returns from Tending", showing estimated results from a series of economic models. He had found from these calculations that even a stumpage as low as 3d. a cubic foot could carry "quite a lot of compound interest", and that even allowing so low a value for sawn timber as 64s. 0d. a hundred board feet "forestry still pays". He had found that, in Southland, tending would pay 8% compound interest. His general conclusion was that tending, on a sawlog regime at least, would pay very handsomely indeed.

The discussion that followed gave emphasis to the relatively large cost of sawing small logs compared with large logs. The Chairman pointed out that the potential value of silvicultural tending for the production of large logs of high quality could only be realized to the forest owner provided some form of log grading with price differentials could be introduced, and there was some discussion of how this might be done; suggestions ranged from the keeping of accurate records of treatment to payment on grading-table results in a manner similar to the payment to farmers for lambs at the freezing works.

The Mechanics and Economics of Thinning

T. W. Swale (N.Z. Forest Products Ltd.) spoke on the subject of his paper "Future Trends in Thinning and Utilization Equipment". He referred to the general trend in modern living away from muscle power to machines, and in the latter away from tracked vehicles to wheels, and expressed the opinion that these trends should apply also in forestry. He said that we should try to get our produce into packages that can be handled mechanically as close to the stump as possible, and that the packages should be moved on wheels. He discussed the problem of thinning steep country and suggested that the use of contour tracking and light haulers might provide the best approach at present, but that a fully satisfactory solution to the problem has not yet been found.

O. Boyd (N.Z.F.S., Kaingaroa) presented his paper "Thinning Methods: Output and Limitations", and discussed in detail with a wealth of facts and figures the mechanics and economics of thinning. He said that in the pumice country there is no physical barrier to extraction of thinnings; the barriers are economic. The economic barrier is at present a serious deterrent to the extraction of thinnings of 14-year-old radiata pine stands on steep country. The economic factors include obvious ones such as market demand and distance from markets, and sometimes volume per acre; the

perhaps less obvious factor of piece size is also very important. If the piece size is too small, a thinning cannot be made to pay for itself, whatever the total volume. He commented that machinery at present in use for thinning had in the main been originally designed for other purposes and that machinery designed specifically for the job might do better.

Discussion of these two papers brought out little in the way of new solutions to the problems and revolved mainly about details of costs and methods in particular localities. One speaker shyly admitted that he was still using horses (and making it pay).

AFTERNOON SESSION, JULY 17

In the resumed discussion of the papers presented by Swale and Boyd, the question of damage to the residual stand by thinning operations was raised. Grayburn said his company had been forced back into short-length extraction of thinnings, partly to avoid damage to standing trees and partly to improve volume outturn of pulpwood. He described extraction by contractors using wheel trailers with tractors, costing 1s. 0d. per cu. ft delivered at mill skids, with a haul of about 5 miles. The desirability of having different treatment schedules for different types of country was mentioned.

W. J. Wendelken (Management Division, N.Z.F.S.) thought that thinning should be considered as an operation made primarily in the interests of the returns from the final crop and that a thinning should not necessarily be expected to pay directly for itself.

The Mechanics and Economics of Pruning

J. Whitely (N.Z.F.S., Kaingaroa) addressed the meeting on the subject of "Pruning Methods", basing his remarks mainly on experience in Kaingaroa Forest, and dealing mainly with practical aspects of the use of tools. He discussed in turn various makes of secateurs and curved-blade saws, giving details of cost and of their efficiency and limitations. He discussed the question of the sharpening of the saws, still a craftsman's job, surprisingly not lending itself to mechanization. He gave average pruning costs as: long-handled pruner to 8 ft, 3½d. a tree (£5–£6 an acre); 8–20 ft with curved saw with 16 ft handle, 2s. 0d. a tree (£12 an acre); 20–36 ft with Morris elevator and curved-blade saw with 9 ft handle, also 2s. 0d. a tree, or £6 an acre. These per-acre figures were based on current schedules. He then pointed out that the big cost lies in the lift from 8 ft to 20 ft, and accounted for it by the fact that slash from the thinning preceding it is still on the ground. He suggested that for this reason thinning should be delayed for six or seven years, recommending that a stand should be pruned as high as necessary before thinnings are started.

Subsequent discussion dealt in detail with costs and practical difficulties. One of the main difficulties arises out of irregularity of height growth, for example from planting in cut-over indigenous

forest. In some areas difficulties of access (due to gorse and other weeds) prevent early pruning.

Summary of Proceedings to Date

The Chairman asked H. V. Hinds (Conservator, N.Z.F.S.) to sum up the discussions to date. His summing up took the form of a commentary rather than a summary. He was of the opinion that technological advances would result in marked increase in demand for chipboard and the like and was not convinced that the best place to improve our product was necessarily in the forest. He conceded that some provision should be made for pruning, and favoured long rotations for sawlogs. He felt that too much attention had been given to the possible adverse effects of green pruning, that the final answer on green-crown depth had not been found, and that we should put up with a few dead knots. He thought that nothing very conclusive had emerged from the spacing trials, but he considered the paper on prediction of yield was an important one. He asked how real was the danger of another *Sirex* epidemic. He named the problem of thinning steep country as the No. 1 problem of New Zealand forestry at present.

Overseas Practice in Thinning and Pruning

Fenton presented a paper prepared by himself, W. R. J. Sutton, and T. W. Irvine, "A Review of Overseas Practice in Tending Forests of *Pinus radiata*". He called attention to the fact that the extent of tended radiata pine referred to in the records is surprisingly small. In most countries radiata and other pines are pruned in smaller steps than are usually applied in New Zealand, and pruning is usually limited to about 20 ft, probably partly intended as one log length and partly because it is roughly the limit of convenient reach from the ground. He mentioned that all countries now practise pruning except South Australia, and suggested that the latter might eventually provide a useful "control" for estimation of the value of pruning in other countries.

The log size aimed at in South Africa is 17 in. d.b.h.o.b. J. Ure observed that in East Africa the aim is an average d.b.h.o.b. of 18 in.

Fenton referred to the British intention of thinning 300,000 acres in 1970 (he suggested sending a message of good will), and commented on the compression-wood problem in patula pine in South Africa.

Current Practice in New Zealand: Thinning and Pruning

By way of introduction to discussion of current thinning and pruning schedules, Hinds gave a brief review of the evolution of silvicultural practices in New Zealand. In regard to thinning and pruning he noted first a reluctance to do anything, and then neglect of the phenomenal rate of growth of trees in New Zealand. He stressed that one of the chief mistakes made in the early days, one to note for correction, was failure to set up sufficient experi-

ments. "If we have some ideas," he said, "let's try them." He was of the opinion that treatment schedules — although they should be open to modification in the light of experience or research — had been allowed to become too fluid, and made a plea for some degree of standardization. He suggested that thinning practice had been too much influenced by the abnormal *Sirex* attacks of the fifties, and questioned the need to reduce to 200 or 300 stems per acre soon after canopy closure.

The Chairman then turned to the subject of current silvicultural practices and began with initial spacing.

A. W. Grayburn said that Forest Products Ltd. were still planting radiata pine at 8 × 8 ft with the aim of an initial stocking of 680 to 700 stems per acre. In natural regeneration a slasher thinning was carried out at 2½ to 3 years with the same object. At the first pruning for access, etc. (called by them underscrubbing), at about age 5, the stand would be reduced to 500, all pruned. The reduction is made so early in order that it may be done cheaply.

Ure (N.Z.F.S., Rotorua) had tried thinning natural regeneration at age 3, but found that many of the cut stems survived and had therefore changed to first thinning at age 5. He believed 8 × 6 ft planting gave adequate selection on the East Coast but was barely adequate around Rotorua.

S. B. Phibbs (H. Baigent and Sons) said that on Nelson soils 540 stems per acre gave adequate selection and helped them to get sawlogs in the shortest possible rotation.

C. G. R. Chavasse (N.Z.F.S., Southland) said that because of mortality from hares, etc., 8 × 6 ft planting had proved inadequate. Where markets for small material were available, he planted at a nominal 6 × 6 ft and in other areas at 7 × 6 ft.

H. H. Wilson (N.Z.F.S., Canterbury) said he had found that 6 × 6 ft gave adequate selection; current planting was at 8 × 6 ft.

D. St. John (N.Z.F.S., Auckland) said that 10 × 6 ft looked like being adequate on the sand dunes (where growth was even and the branches small), and might improve piece size at the first utilization thinning.

Ure mentioned the difficulty, with natural regeneration, of variability in height.

Current Practice: First-stage Pruning

Rotorua Conservancy officers said that for the first pruning for access (underscrubbing) combined with pruning to 400 stems per acre secateurs were used, and quoted costs of about £24 for the combined operation.

The Chairman noted that the schedules called for pruning to heights of 6–10 ft at top heights varying from 15 to 35 ft.

Chavasse said that, with long-handled secateurs, the cost of pruning to any height greater than 6 ft rose sharply, and this had decided the limitation to that figure in Southland. This pruning was followed two years later by saw pruning to 12 ft. Workers selected the better of each two trees for pruning, with the result that about 300 stems per acre were being pruned.

Grayburn said that in their forests all stems were pruned to 7 ft, and this was followed by a second lift, to 12 ft, on 250 stems per acre with worker selection.

D. S. Jackson (N.Z.F.S., Hawke's Bay) agreed that marking for first pruning was impracticable and that worker selection of one out of two or one out of three should be practised. He believed that pruning of 500 stems per acre at top height 15 ft could be done for as little as £5 an acre; delays in pruning added to the cost very rapidly, and 350 stems per acre did not give adequate selection for later high pruning.

J. P. Fitzgerald (N.Z.F.S., Auckland) said that on the Auckland clays 150 stems per acre provided adequate selection for the later prunings. Stands were even and the pruned trees did not lose dominance.

There was general agreement that site was a major factor in determining how many stems should be pruned at the first pruning. In general, the poorer the site the better the form, this allowing the pruning to be confined to a smaller number of stems.

Current Practice: Second-stage Pruning

The Chairman described as second-stage pruning any lift reaching to 18 ft or more from 12 ft or less, and noted that according to the schedules the number selected for such pruning ranged from 125 to 250 and top heights from 33 ft to 45 ft.

Grayburn said of his pruning to 20 ft at 40 ft top height that earlier pruning to this height would leave the trees "looking pretty naked". He aimed at 150 trees per acre at this stage and usually found it difficult to find more than 130. Because of the increasing scale of operations they were training contractors and workers to make the selection.

P. Olsen (N.Z.F.S., Rotorua) said that he was trying worker selection by gangs on piecework. Payment was based on plot sampling; trees incorrectly selected or badly pruned were rejected from the tally. He said that on this system gangs soon learned.

Others also mentioned the difficulty of finding up to 150 trees of good form and vigour to take pruning to 20 ft.

EVENING SESSION, JULY 17 (9.30 p.m.)

The Chairman raised the question of what decides the height limit of the second-stage pruning. Various suggestions were made — wind in the South Island, convenience where 10 ft ladder sections are used, a comparatively easy reach from the ground with a pole saw, and compliance with local conventional log lengths. In a discussion of the relative merits of pole saws and ladders for the lift to 20 ft, Grayburn was emphatic that branch size decided the matter, saying that at that height pole saws could cope economically only with small branches. One speaker said that ladders could not be handled over slash and another said that in heavy slash the worker can lay down his ladder and use it as a viaduct to cross the slash between trees. In Rotorua Conservancy, workers used to pole saws preferred them but in some other areas contractors, given the choice, pre-

ferred ladders. Bunn said that, whatever the reason, most pruning to 20 ft was being done with pole saws.

Current Practice: Pruning to 36 ft

The Chairman raised the question of which stands should be pruned above 20 ft or thereabouts. Chavasse said he would prune all stands to 18 ft before considering higher pruning. Grayburn said that his company would prune all stands to 20 ft first, and then selected stands of saw quality to 36 ft.

Replying to a question, R. W. M. Williams (Economics Division, N.Z.F.S.) said it would not be possible to produce too much clear wood.

H. H. Wilson (N.Z.F.S., Canterbury) said that Balmoral and Eyrewell Forests would not be pruned above 18–20 ft (because of instability in wind) but that in Ashley Forest he had no intention of not prnning to 36 ft. G. J. Molloy (N.Z.F.S., Westland) suggested that forests more distant from markets should prune more, so that the higher quality might cover higher freight costs. S. B. Phibbs (H. Baigent and Sons) said they were forced to a short rotation and would therefore not prune above 18 ft.

N. A. Barr (N.Z. Farm Forestry Assn.) said that the aim in farm forestry was to get a short, fat log with plenty of clear wood on it and that in general farmers would not go above 18 ft, but in future farm foresters might decide to go higher in the less accessible areas. J. G. Groome (Consultant) said it would depend on how long the stands could be kept in face of a strong demand for logs.

It was asked whether anyone had examined the results of these schedules on the grading table to see whether in fact pruning to 36 ft could be economic, and the Chairman pointed out that none had been in operation long enough for this to be possible.

Discussion then turned to a somewhat inconclusive consideration of methods of pruning to 36 ft and then to the question of how many trees to the acre should be pruned. The consensus of opinion was that it should amount to something approaching 75–100 stems per acre but that in practice it might be difficult to find so many of suitable form and vigour. It was evident that in most cases the schedules providing for pruning to 36 ft contained more of intention than experience.

Current Practice: Thinning to Waste

The Chairman said he had been trying to consider pruning without reference to thinning, but he doubted whether this could be a really feasible approach. He now turned to questions of thinning, and introduced the subject of thinning to waste.

Chavasse held that since the main aim is to get sawlogs as soon as possible a thinning to waste is unavoidable. Ure referred to a schedule in force for 11 years in Rotorua Conservancy and said that under it thinning had been carried out, simultaneously with pruning to 20 ft, at top height 45 ft. There had been a good although short-lived response to thinning.

Current Practice: First Utilization Thinning

A thinning at about 70 ft top height appeared to be associated with the idea of a first merchantable thinning, and discussion then revolved around such a thinning.

Ure referred to two separate schedules in force in Rotorua Conservancy and said that the first of these, the sawlog regime (started in 1950), had aimed at a first merchantable thinning at top height 90 ft and had been proved economically practicable. The second, the pulpwood regime, was comparatively new and envisaged a first merchantable thinning at top height 70 ft; its practicability had not yet been fully tested. The old sawlog regime had now been pushed on to the steep country and the other was being applied in tractor country.

The Chairman raised the question of the number of trees to be left at this thinning (top height 70 ft or so). The consensus of opinion seemed to be that it should be about 250.

Grayburn said that by top height 86 ft N.Z. Forest Products Ltd. would have done two merchantable thinnings.

Chavasse referred to "merchantable" thinnings that had lost money, largely because the volume available for extraction had been too low. He said that, for the thinning to pay, a yield of at least 1,500 cu. ft per acre would be necessary. Some other speakers held that a good deal more than that would be necessary.

Wilson said that at Ashley Forest piece size had proved more important than total volume.

MORNING SESSION, JULY 19

Consideration of the first "merchantable" thinning continued. N. A. Barr (N.Z. Farm Forestry Assn.) said that the first utilization thinning would be either for posts (which the farmers would extract themselves) or done by contractors at an agreed stumpage. Before this there would be cheap, early thinnings to waste, aimed at the rapid production of a fat bottom log.

Wilson said that in Canterbury the Forest Service are marking out zones with appropriate variation in silvicultural treatment to cater for differing potential markets. This again raised the question of flexibility in schedules; Chavasse held that, to prevent this from degenerating into fluidity, the conditions under which departures from schedules could be approved should be written into the schedules and should be limited. There was general agreement that the timing and intensity of thinnings could be varied considerably, but that pruning schedules should be rigidly adhered to. K. W. Prior (N.Z.F.S., Southland) pointed out that in relation to established markets thinning schedules could be fairly rigid, but with developing markets they must be flexible.

On the question of profitability of the thinning at about top height 70 ft the general opinion was that, unless very unusually favourable market and other conditions existed, it would be unlikely to pay for itself. There were various suggestions as to how to lessen the loss. One was to cream the stand of the larger logs, and leave the rest. Another was to substitute an operation, not quite a thinning, in which contractors were allowed to remove everything, below a

certain diameter limit, for fence posts. The Rotorua solution, or part solution, appeared to be to postpone it until piece size was sufficient to make the operation pay for itself. General experience appeared to be that where the operation had not been done at a loss it had been done on contract at a stumpage.

Current Practice: Second Utilization Thinning

The Chairman turned discussion to the topic of a thinning at about top height 90 ft, generally regarded as a last or penultimate thinning, in which the stand is left at something close to its final-crop stocking, at least on rotations of 35 or 40 years. General experience appeared to be that such a thinning would yield sufficient sawlog volume to pay for itself without much difficulty, and most of the discussion was concerned with its effect in encouraging weeds and advance growth that might inhibit the development of uniform natural regeneration at the right time. Ure said that about 70 stems per acre seemed to be about the right figure to leave at this thinning (presumably in relation to a rotation of about 35 or 40 years). Grayburn said that on a rotation of 50 years N.Z. Forest Products Ltd. were thinking of a final crop of about 40 stems per acre. Ure was of the opinion that the stand should be kept fairly tight, to reduce the problem of weeds and advance growth as much as possible. It was clear from the discussion that evidence on how many should be left was meagre.

Discussion turned to belated and late thinnings and the accompanying risk of wind damage. Forest Products Ltd. had suffered considerable loss from wind break, rather than wind throw, in such conditions. Harris added the point that belated thinnings might result in internal damage such as the development of spiral grain and compression wood in the remaining stand.

Current Practice: Rotation Age

Most of the schedules called for clear felling at top height about 130 ft.

Chavasse said that in parts of Southland wind throw was common at top height 70 ft and over, and that there rotations of more than 40 years would make logging one continuous salvage job. R. K. Usmar (N.Z.F.S., Rotorua) suggested that if it were possible to have several merchantable thinnings this would leave the economic limits of rotations much more open. Williams insisted that from a national viewpoint it is not a question of the economics of individual stands but of building up exportable forest products to provide overseas exchange, and that this in the next few decades would allow no freedom of choice, and that rotations *must* be short — *i.e.*, of the order of 35 or 40 years.

Rationalized Silvicultural Practice for a Rational Forest

The Chairman produced the following group of schedules for an imaginary forest, based largely on information gained in the discussions of the previous two days. There was surprisingly little comment on it — probably because the meeting had not had time to digest its contents — and if there was any general reaction it was probably to the effect that the treatments tended to be applied too early.

SCHEDULES FOR *PINUS RADIATA* IN NEW ZEALAND SUGGESTED AS LIKELY TO GIVE A GOOD RETURN FOR THE INVESTMENT IN TENDING

Basic Assumptions

1. Capital and labour for an expanded programme are in short supply and need to be employed to best economic advantage.
2. At present early thinnings can only be extracted at high cost, and usually at a loss.
3. We shall require more clear wood and/or finishing grades.
4. Long rotations — over 50 years — are regarded as undesirable or uneconomic while there is no profitable market for thinnings.

Desired Stocking

600 effectively established stems at time of first pruning (excludes trees that are less than half the height of their neighbours).

PRUNING AND THINNING REGIMES TO SUIT DIFFERENT MANAGEMENT CIRCUMSTANCES

A	B	C	D
Pulpwood only. Steep and/or inaccessible country: stands of too poor a standard for sawlogs	No pulp markets; sawlogs only. Steep country, little chance of economic thinning	No pulp markets; sawlog market by top height 90 ft. Tractor country	Pulp and sawlog markets. Easy country, high-quality sites, close to roads and markets
No pruning	*Pruning (common to B, C, and D)*		
	0–8 ft, 1 in 2 at 15–18 ft, 6 in. core. Selected on vigour		
	8–14 ft, 180 s.p.a. at 25–30 ft, 7 in. core. Selected on vigour and form		
	14–20 ft, 180 minus at 35 ft, 7 in. core. Selected on vigour and form		
		Additional Pruning	
		C	D
		20–28 ft. 80 minus at 45 ft	20–28 ft, 80 minus at 45 ft, 8 in. core
		Low-priority extra on good sites: 28–36 ft, 60 at 55 ft	28–36 ft, 60 minus at 55 ft, 8 in. core
No thinning		*Thinning*	
	B	C	D
	To 180 at 45 ft; to waste	To 180 at 45 ft; usually to waste	To 220 at 45 ft; usually to waste
		To 80 minus at 90 ft; yield 2,000 cu. ft	To 110 at 80 ft; yield 1,200 cu. ft
			To 60 at 110 ft; yield 1,500 cu. ft
		Clear felling	
At about 100 ft; age 16–25	At 120 ft plus; when required	At 130 ft	At 140 ft or 25 in. mean d.b.h.

Other Species: Douglas Fir

Ure observed that "of all the species we have, Douglas fir presents the fewest problems", and the truth of this was reflected in the brevity of the discussions. On the question of quality, Ure held that Douglas fir of magnificent quality could be grown in Rotorua. He believed in pruning the first log length, and possibly even the second in East Coast forests. Harris said that the practice of removing wolf trees in the first thinning had had a marked effect in improving quality (by reducing the average ring width). A second chief point of discussion was the question of disposing of first thinnings, or of avoiding the need to dispose of them by raising the Douglas in mixture with some other species which could be removed as profitable thinnings.

On the question of pruning priorities, Williams said that preference should be given to pruning radiata pine to 36 ft rather than to Douglas fir to 20 ft. Fenton pointed out that, as unpruned Douglas fir is readily saleable, the degree of improvement achieved by pruning it is less than with radiata pine.

Other Species: Eucalypts

Other pines were briefly discussed and then the Chairman directed interest to the eucalypts. N. A. Barr said, among other things, that with eucalypts it is particularly necessary to select the right species for a particular site. He said that the great characteristics of the eucalypts are that they grow up straight and produce clear wood without thinning. He said, "It is only a minor group of species I know but it has an end use for those who want to live a little gracefully and don't want to live with knotty pine veneers all the rest of their lives".

Bunn observed that the eucalypts might help to meet the future shortage of hardwood forecast by Reid and Williams.

Conclusion of the Meeting

The Chairman wound up the general discussions and asked for comments on the benefits gained from them by representatives of the various interests present. The general trend of replies was to the effect that the discussions had provided food for thought, if not definite conclusions, and that schedules would be reconsidered (although Rotorua might be excepted from this). Second-log pruning in particular would be examined more closely. Several people expressed the opinion that the profitability of second-log pruning was one big unknown, and how to thin steep country economically another. In spite of the Chairman's promptings, little constructive criticism of the Forest Research Institute research programme emerged, although there was some strong comment on the lack of adequate liaison and communication between the Institute and the forest industry generally. There was general agreement that the meeting had been valuable and the Chairman received many compliments on his management of it.

Summing Up

The Chairman asked W. J. Wendelken (N.Z.F.S.) if he would sum up the second part of the discussions. He suggested that we need consistency in objectives, and flexible practice to achieve them. He had made some rough calculations during the course of the meeting on probable clear-wood yields; he estimated that with a 20 ft pruning regime the mean diameter of the final-crop tree should be 28 in. and with a 36 ft regime it should be 31 in., to provide total yields, in the necessary high grades, of 25% and 40% respectively. He commented that, although this was not as much as Williams had asked for in his forecasts, it still called for a 50-year rotation, which Williams could not allow. He said that pruning should be regarded as a means of improving grades as well as of producing clear wood.

Concerning planting, he expressed the opinion that on our fertile sites we should start with as many stems per acre as we can afford to plant, and made a plea for more user trials of different spacings in conservancies.

Of thinning, he said that it had been generally agreed that the pruning of at least the first log length should be completed before the stand is opened up to any great extent, and that thereafter the object should be to get as much increment as possible over the pruned stubs without opening up the stand too much. There should be no acceptance, however, of the idea that thinning, particularly early thinning, must take place as a matter of course; stand type should be studied to see if and when thinning was justified.

Most of his other points were of the nature of a summary of the discussions and have already been incorporated earlier in this summary.

He concluded by complimenting E. H. Bunn on his chairmanship of the meeting, and this was received with applause.