PART 3

OPERATIONAL AND TECHNOLOGICAL CONSIDERATIONS

EXTRACTION THINNING OPERATIONS IN YOUNG RADIATA PINE AT KAINGAROA FOREST

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ABSTRACT

The past and present problems of extraction thinning on a large exotic forest of predominantly easy topography is discussed in relation to previous silviculture and other, competing logging operations. Despite a background of successful extraction thinning of other species and old crop radiata pine, thinning of young radiata pine has only recently become a silviculturally successful and economically viable operation. The relatively small tree size and high labour and capital content per unit volume produced are seen as the cause of poor past performances in this operation.

INTRODUCTION

The age class distribution of Kaingaroa young crop radiata pine, up to the 1969 establishment year and estimated proportion of country topographically suited for extraction thinning is as follows (hectares):—

Est. Year	Accessible Area	Inaccessible Area	Total
1937-49	795	47	842
1950-54	1 516	132	1 648
1955-59	4 351	1 003	5 354
1960-64	6 479	2 204	8 683
1965-69	22 034	1 912	23 946
TOTAL	35 175	5 298	40 473

As at 31 March 1974, 1 840 ha of young crop had been extraction thinned for pulpwood, 650 ha for posts and 1 318 ha of old crop for peelers, sawlogs and pulp. Site index as measured by the stand top height in metres at age 20 ranges from under 24 in the south to over 35 in the north, but the bulk of the young crop area shown above lies on sites better than height index 29, a reflection of the concentration of early clearfelling and extensive new plantings on lower altitude northern sites. The old crop received virtually no silvicultural treatment except for sirex (*Sirex noctilio* F.) thinning at 20-25 years of age. Young crop established 1945-52, which included regeneration arising from the first clearfelling, was prescribed to be thinned to 590 stems/ha by height 13 m, followed by an extraction thinning at height 27 m ("18

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year old" thinning) leaving 200 residual stems/ha. Stands established between 1952 and 1959 were prescribed for and generally received a waste thinning at 8-9 m to a residual 740 to 990 stems/ha, with the intention of carrying out the first extraction thinning at 18-21 m (13-15 years of age) or the "14 year old" thinning, to be followed by a second extraction thinning at 36-40 m (28-32 years of age). Due to a lack of finance and manpower and the low priority afforded to silviculture in the late 1950s and early 1960s this early waste thinning was not always on schedule and sometimes did not take place at all, resulting in a group of age classes with very variable stockings in which extraction thinning commenced and has largely continued in, to this day.

Thinning was intended to occupy a more important role in total forest production than it has in the past or will in the future. In 1968 it represented 1.4% (22 000 m^3) of the total forest cut compared to 5.3% (108 000 m^3) in 1973, and a projected 4.8% (170 000 m^3) in 1978. The need to shorten crop rotations and so reduce the life of an increasingly unstable old crop has eliminated the need for a 30-year-old thinning, and indeed questioned the wisdom of practising silvicultural regimes that require even one extraction thinning. However, since the bulk of 1960 to 1969 age classes, comprising some 32 600 ha has been or is scheduled to be waste thinned to residual stockings of 500 to 600 stems/ha on projected rotations of 25-30 years, it is apparent that extraction thinning must continue for some years yet unless tree size and/or total volume yields at clearfelling are to be sacrificed.

HISTORY

In the 1960s extraction thinning of all species occupied a much more important role in total forest production than it now does. In 1968, some 494 000 m^3 representing 33% of total production came from thinnings of radiata pine old crop, Douglas fir, Corsican, ponderosa and strobus pines, versus 283 000 m^3 (11%) in 1974. Despite some years of accumulated experience in the techniques of extraction thinning, operations in young crop radiata pine began with a very shaky start in 1962, when 25 ha of an untreated 15-year-old stand was thinned with H.D. 11 crawler tractors. The operation was terminated because of windthrow, high costs and excessive damage to crop trees. During the next four years a further 53 ha of age 15 or less were thinned on a more or less trial basis but again proved to be operationally unsatisfactory, due to the small piece size, unsuitable equipment (H.D. 11s were used to haul and fleet), difficult topography, and perhaps most significantly, the inability of the pulp mill to handle thinnings during periods of mechanical breakdown.

In 1966 a contractor with rubber-tyred skidder and fleeter commenced work in 32 m-high 20-year-old stands on easy topography yielding 0.5 cubic metre mean tree size, and proved to be economically successful, although some doubts were expressed as to the high level of damage to crop trees and the inadequacy of final crop stocking. This operation continued until 1969 when a further contractor with an 80 hp skidder began in 30 m-plus stands, at a contract price of $2.72/m^3.

In 1969 another attempt to thin 14-year-old stands was initiated by hiring two contractors with modified 40 to 55 hp farm tractors. Despite the small piece size of 0.25 m^3 and frequent mechanical problems, these operators remained viable at contract rates of $3.35 to $3.53/m^3, that is 25% above the large wood contractors. The following two years saw a period of consolidation by existing contractors cutting approximately 57 000 m^3 annually, representing 25% in small wood and 75% in large wood thinnings. During this period, methods of pre-thinning assessment and post-thinning quality control assessment were refined with obvious improvement in assessment of basic work content, and silvicultural aspects such as number and quality of the final crop.

However, the long gestation period had had serious effects on the silvicultural condition of the crop. By the end of 1970, approximately 690 ha had been thinned versus the prescribed 2 700 accessible hectares, and the less attractive small tree operation comprising the bulk of the 1955 to 1959 age classes was building up more rapidly than the 57 000 m^3 annual cut was covering the ground. In an attempt to bring silviculture back on schedule a decision was made to abandon any pretence of thinning 1 050 ha of the oldest most heavily stocked stands and increase the cut to the maximum that known sales outlets and contractor availability would allow. It was estimated that a cut of 481 000 m^3 during the four years would enable extraction thinning of 1959 and younger age classes to be done on schedule from 1975 onwards. Programmed annual cuts were therefore set as follows:

Year	Programmed	Achieved
1971	99 000 cubic metres	62 300 cubic metres
1972	99 000 cubic metres	76 500 cubic metres
1973	113 000 cubic metres	107 600 cubic metres
1974	170 000 cubic metres	118 900 cubic metres

These cuts took cognisance of proposed pulp mill expansions in 1973 an 1974 which unfortunately did not occur, and in fact the industrial re-construction required for these expansions periodically reduced the mills' log handling facilities to the point that small diameter elements in the log supply such as radiata thinnings, were seriously restricted.

The hiring of new contractors was therefore delayed until 1972, when a very buoyant Japanese market offered an opportunity to dispose of thinnings independently of local industry. Productive capacity was increased from 62 000 to 108 000 m^3, a level which was held for 1973 and improved upon in 1974. The pressures placed upon the logging organisation to meet shipping schedules were unprecedented in thinning operations and drew attention to the difficulty of consistently achieving production targets where skid segregation and cutting patterns had become extremely complicated due to the relatively tight export log specifications, and the high proportion of small diameter short log packets which increased log handling time at all points from bush to boat. The loggers' instinctive response to these problems was to reduce the volume of small wood thinnings and improve the piece size and long log proportion by moving to older stands or by increasing clearfelling.

A further complicating factor in achievement of production targets was the realisation at this point that belated thinning to previously conceived residual basal area and stockings would seriously affect predicted final crop yields. Higher residual stockings were therefore prescribed and implemented, leading to poorer form and lower size of trees extracted.

CURRENT OPERATIONS

Although radiata pine thinning during the past 13 years has evolved into an essential component of the forest's log production effort, it is still beset by the same basic problems as was evident in 1962—that if silviculturally on time the operation is much more expensive, difficult and labour intensive than is clearfelling, particularly clearfelling of old crop which comprises 63% of total log production and therefore acts as a base for comparison with other operations. The piece size, form and degree of planning and quality control required are the major differences between clearfelling and thinning.

Piece Size and Productivity

Tree size extracted is determined by previous silviculture and the age of thinning. The latter can be varied by the logger, e.g. defer thinning to obtain a larger tree and log size, an expedient which has been unconsciously practised in the past, but he has no control over the former. Thus silviculturally sound schedules, such as the 860 stems/ha thinning at 8 m, proved to be impracticable 10 years later; the 0.25 m^3 tree size could not be economically handled by existing logging equipment, whereas a 590 stems/ha thinning at 13 m improved tree size and form (0.4 m^3 mean tree size) made the operation viable.

The influence of small tree size on logging productivity is felt in increased felling, trimming, hauling and fleeting times per unit volume handled, as shown by the following comparison of clearfelling and thinning by Forest Service contractors on similar topography in 1974.

TABLE 1—Radiata thinning and clearfelling productivity

	Thinning	Clearfelling
Mean tree volume (m^3)	.28-.51	2.83-3.40
Annual contract volume (m^3)	134 700	229 200
Average contract price ($/$m^3$)*	4.31	2.47
Average performance as % of contract	84%	113%
Actual production (m^3)	112 000	259 000
Number of men	57	35
Man year production (m^3)	1,965	7,400
Machinery:		
No. of skidders	14 (50-100 hp)	5 (130-180 hp)
Fleeters/loaders	8	5
Saws	39	22
Approximate capital value ($)	312 000	227 000
Approximate value/m^3 produced ($)	2.78	0.88

* Thinnings price is on forest ride; clearfelling price is loaded on truck, therefore to be strictly comparable add $0.32/$m^3$ to thinnings price.

The most important features of this comparison between thinning and clearfelling is the high labour and capital content per cubic metre produced for thinnings compared to clearfelling. Thinning contractors have had difficulty in attracting and retaining experienced labour to an operation which is dirtier and more physically demanding than clearfelling and this has undoubtedly contributed to the relatively poor performance of thinning, particularly in times of labour shortage. The capital cost of setting up a typical extraction thinning gang comprising one 90 to 100 hp skidder, one 60 to 70 hp fleeter plus saws and ancillary equipment is in excess of $50,000 if new equipment is purchased, compared to approximately $67,000 for a 160 to 170 hp skidder and fleeter equipped clearfelling gang. If he achieves his contract level of, say, 14 500 m^3/yr, the thinning contractor expects an annual income of $62,500 (based on the average contract rate of $4.31/$m^3$) and if circumstances permit him to produce 10% above level this would add $6,250 to his income. The clearfelling contractor, however, on a contract level of 50 000 m^3/yr can expect an income of $123 500 and for a 10% increase above target his income can be increased by $12,350. Thus despite a similar initial capital outlay, profit-earning potential over and above that already incorporated in the contract rates is much less in thinning. In practice during a period when few restrictions on production have been applied, thinning contractors have generally produced at 10% or more below contract in contrast to the clearfellers at 10% or more above contract.

Thus clearfelling of radiata pine in particular but of other large wood extraction operations as well, is a much more attractive operation for both contractor and labour and has tended to attract and retain the best of both at the expense of thinning.

Planning and Control

The organisation required to effectively manage a 135 000 m^3/yr extraction thinning programme of second rotation crops is much more complex than that required for clearfelling of untended planted stands, due to the silvicultural requirements of the operation and variability in age classes and previous silvicultural treatment. Although individual stands are programmed for extraction thinning some years in advance the broad nature of the basic data used in this programme is frequently insufficiently detailed to show the true extent of variation in stocking, height and topography within the stand. The situation is most often true of regenerated stands where logging may have extended over several years, or include slow growing frost flats, which subsequently received different silvicultural treatment. It is then impossible for each stand to be thinned at the optimum time unless it can be subdivided into workable units each of which is reasonably homogeneous and exceeds 20 ha in area. Up to 12 months prior to the programmed date of thinning each stand is individually assessed to determine stocking, height, distribution of pruned trees and degree of malformation. Based on this assessment, the final crop stocking is prescribed, yields estimated and contract rates set. Logging planning locates the position of roads and squares (where these are still not evident from clearfelling of the first crop) and the crop trees are marked individually. During thinning, which may last for 12 months in the same stand, supervisors constantly check to ensure that marked trees are not being felled and that damage is minimised. On completion of thinning, plots are re-located and remeasured as a quality control exercise and for mensurational purposes.

Although elaborate by clearfelling standards, the planning and supervisionary procedures outlined above have proved to be necessary and successful in safeguarding the silvicultural aspects of the operation, but make heavy demands on technical and supervisory staff as indicated in the following comparison of staff and vehicles directly involved in the administration of radiata pine thinnings and clearfelling operations.

TABLE 2—Administration staff time (man years) and vehicles

Planning	Thin	Clearfell
Senior Forester	.15	.10
Foresters	.60	.16
Technician	1.00	
Technician Assistants	2.00	
Logging Planning Ranger	.40	.30
Logging Planning Ranger Assistant	.40	.30
	4.55	.86
Vehicle — kilometres	26 000	7 000
Supervision	Thin	Clearfell
Senior Rangers	.50	.40
Senior Supervisors	1.00	1.00
Junior Supervisors	2.10	
Cutover Inspectors		.20
	3.60	1.60
Vehicle — kilometres	84 000	47 000
TOTALS:		
Total Staff Time	8.15	2.46
Direct Cost of Salaries ($)	45 700	17 400
Total Vehicle Distance (km)	110 000	54 000
Cost at 9 cents per km ($)	9 900	4 860
Total Administration Cost ($)	55 600	22 260
Total Volume Produced (m^3)	112 000	259 000
Cost per m^3 ($)	0.49	0.08

Topography

Because of the relatively small area of forest topographically unsuitable for extraction thinning and the fact that the thinning programme has constantly been in arrears, there has been no need to push logging operations to the limit. Short steep slopes in excess of 25 degrees have proved workable with rubber tyred skidders provided that the top of the felled tree is accessible from the bottom of the slope. Douglas fir thinning of long slopes in excess of 20 degrees have been contour tracked to enable thinning by skidders. The extent to which country now considered impracticable for thinning will be worked in future, will depend largely on the demand for wood — there is little doubt that all of Kaingaroa can be thinned at a cost.

Yields

Thinning yields range from 125 to 245 m^3/ha, including clearfelling of road lines and landings. In the three-year period 1971 to 1973, 1 214 ha were thinned and 52 ha clearfelled for roads and landings (this excludes 23 ha clearfelled because of windthrow following thinning), thus 4.1% of initial stocked area is left unproductive for the remainder of the rotation.

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A number of Kaingaroa Forest unpublished internal reports have been used as sources.