PART I

BACKGROUND TO THINNING PRACTICE IN AUSTRALIA AND NEW ZEALAND

BACKGROUND TO THINNING PRACTICE IN AUSTRALIA

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INTRODUCTION

This paper deals mainly with radiata pine (*Pinus radiata* D. Don) in Australia. In 1974, this species covered 65% of Australia's total plantation area of 560 000 ha. Thinning in forests other than plantations was negligible. In concentrating on radiata pine, the most important plantation species which will be neglected are slash and hoop pines (*Pinus elliottii* Engelm. and *Araucaria cunninghamii* Ait.); together these amounted to 20% of the plantation area in 1974. Attention is drawn to this exclusion because there are significant plantations of species other than radiata, and because a good deal of effort has been given to the thinning of these other species by staff of the Queensland Forestry Department.

No special reference is made to material which is to be presented in detail by other speakers over the next three days, so that, to the remarks which follow, the various position papers must be added in order to obtain a full summary of Australian past and present practice, and likely future trends.

HISTORIC DEVELOPMENT OF THINNING RADIATA PINE IN AUSTRALIA

It is thought that radiata pine was introduced to Australia in 1857, almost 120 years ago (Fielding, 1957). In the early 1880s, a plantation was established at Wirrabara, S.A., selection thinning from which provided logs for a case mill set up in 1903. The fellings in this early operation were governed by a lower d.b.h. limit of 30 cm (Jolly, 1950). Even before that time, thinning had been carried out as a silvicultural measure in the pilot plantations.

In 1911-12, thinnings started at Mt Gambier when a case mill was opened to cut material from a 14 ha plantation bought by the Department.

Thinning operations of this nature, which could be described as a cottage industry, have persisted in some plantation areas almost to the present time.

The sawmill at Mt Burr, opened in 1931 in an area where planting had started 50 years earlier, was the first of the large industrial operations which now characterise radiata pine projects in Australia. Although the demand for thinnings and the nature of their processing were suddenly transformed in scale by the establishment of this

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and other similar sawmills (Nangwarry 1940, Mt Gambier 1948), pulpmills and particle board plants, the technology of harvesting altered relatively slowly.

South Australian ideas and practice, which have naturally been influenced by the operating conditions (particularly the flat terrain) in the south-east of that State, have played a very large part in developing Australian thought on thinning. The main reasons for this are the high proportion of the total Australian plantation area which existed in south-east S.A. (Table 1), the immediate local need for timber products (cf., for example, some N.S.W. southern tablelands plantations), and thirdly the work and writings of South Australian foresters (e.g., Jolly, 1950; Jacobs, 1962; Lewis, 1963).

Bednall (1950) outlined the position 25 years ago:

Present thinning practice is based on . . . sample plots laid down in 1935 . . . (when) heavy early thinnings (to 100/ha at 5 or 6 years) were advocated . . . (these) showed in the first few years a marked loss in volume production. It has now been concluded (that) first thinnings (should be) made at ages 12-17 years depending on quality and the stand reduced to (140-160/ha). . . . Advocates of very heavy thinning . . . may loose increment . . . and in addition seriously affect future yields.

TABLE 1—Areas of radiata pine plantation in Australia, by States and Territories (ha)

State or Territory	1900	1910	1920	1930	1940	1950	1960 30 Sept.	1970 31 Mar.	1974 31 Mar.
New South Wales*§			10	2250	6600	9460	30100	64600	104700
Victoria	100	400	1400	8900	18000	22000	40600	84700	111900
Queensland**§				25	90	110	680	2000	2100
South Australia†§	<140	2800	6000	18000	27000	34000	55000	75600	83300
Western Australia‡§				360	1100	1300	4450	11900	19700
Tasmania‡§				10	180	1840	8000	22600	30900
A.C.T.‡				170	3440	4970	8600	11300	12800
N.T.				0	0	0	0	0	0
Total	<240	3200	7410	29715	56410	73680	147430	272700	365400

* 1930 and 1950 figures include plantings in those years.

** Figures up to 31 March each year. In addition, from 1940 onwards, small mixed-species plantings including **P. radiata** were made; these amounted to 20 ha by 1940 and had increased to 60 ha by 1974.

† The figures up to 1940 are approximate because areas lost to firebreaks, etc., were not separately recorded, although they have been estimated for this table.

‡ Figures prior to 1960 have been calculated from age class structures reported in 1957.

§ Figures prior to 1960 exclude private plantations. In Tasmania, these amounted to almost half the crown area in 1957; in South Australia they were one-third of the Crown area in 1960.

The author is grateful for help received from Messrs D. Watts, J. Wright, P. Hawkins and N.B. Lewis in compiling this table.

In both Bednall's account, and the contemporary one by Jolly, volume was used to present the results of alternative silvicultural practices because, respectively — "departmental policy (was) directed to the supply . . . of all requirements in timber and pulp and paper" **and** "ever changing sale values of logs . . . nullify . . . (financial) calculations."

Thus in South Australia there was a clearly stated policy which was practicable because a market existed, labour was available and there were no significant technological or biological problems.

Although planting in Gippsland by APM Forests Pty Ltd did not commence until 1950, the large areas planted after that time (16 000 ha by 1965; Hill, 1966) and the demand for logs for a purpose for which size was not a critical factor led to a very active interest from 1960 onwards by that company in thinning. This is reflected in the company's operations research (e.g. Hill, 1966), equipment innovations (e.g. the Windsor harvester; Raymond, 1975) and management studies (e.g. Hall, 1974).

Thinning operations are well-established in the low-altitude plantations, which very closely resemble those in the south-east of S.A. The much steeper stands in the hill forests, however, are only now being tackled; in these the frequent light thinnings used in the areas of easy terrain will not be practicable.

New South Wales, after a later and hesitant start in comparison with S.A., has become a major grower of radiata pine. Past thinning practice has been described by Shepherd (1969) and Forestry Commission of N.S.W. (1970). The two main centres of activity, the southern and central highlands, differ appreciably from south-east S.A. and Gippsland, and to some extent from each other, in factors likely to influence thinning —

(a) both locations are relatively distant from the coast, hence the disposal of effluent from pulp mills of the type which operate in south-east S.A. and Gippsland would pose serious problems. This disability has to some extent been offset by growth of the particle board industry;

(b) plantation access is often poor for modified highway vehicles such as were introduced at an early stage on the almost flat terrain, free of obstacles (rock, and eucalypt stumps and logs) in the south-east of S.A.;

(c) less conspicuously, the more uniform rainfall pattern, and soils which are often heavier and of greater intrinsic fertility, produce constraints different from those in the southern plantations.

The N.S.W. Forestry Commission has had less direct involvement in utilisation than either the Woods and Forest Department or A.P.M., whose involvement has provided extensive first-hand data on the intrinsic worth of thinning produce. By the same token, it has been less committed to provide material for existing industry and therefore has been particularly active in studies which will influence the management of the large areas which will reach the age of potential first thinning in the next decade (e.g. Forrest, 1974).

The Forests Department of Western Australia, because of local climatic and market conditions, has adopted a silvicultural regime which entails a short rotation, heavy early thinning, high pruning of crop trees, and heavy and infrequent production thinnings. In radiata pine, the single production thinning at age 11 reduces the stand to the final-crop density of 200 stems/ha (Anon, 1973).

Silvicultural and Environmental Factors

Two silvicultural factors are of outstanding significance in relation to thinning — initial spacing and establishment success, and secondly pruning practice.

Spacing of 2.4 × 2.4 m has been very widely used, although in a few cases where no small-log market could be foreseen (as in the A.C.T.) considerable areas were planted at 3.1 × 3.1 m or even 3.7 × 3.7 m in the 1920s and 1930s. With the advent of better seed from seed orchards, and because of first-thinning problems, initial spacing is now tending to rise. Rectangular rather than square spacings are increasingly being adopted in new plantations for reasons of economy of machine travel (e.g. at planting) and access. In second-rotation stands, new spacing is constrained by the rows of old stumps.

Establishment success with radiata pine has usually been high in Australia — 80 percent is commonly aimed for, and generally attained in the absence of climatic extremes such as the 1967/68 drought. More intensive site preparation (e.g. Stewart, 1970) and better nursery stock (Benson, 1974) should enable high survival rates to be maintained.

Initial stocking is important because of its effects on the choice of good final-crop trees and on potential total production. Stand density affects diameter growth and branch development, and interacts significantly with both site fertility and moisture availability insofar as thinning requirements are concerned. There are, for example, extensive stands on sites of fairly low fertility in S.A. where branch development is light even under heavy thinning regimes. Waring (unpublished) has closely examined the relationship between stand density and mortality in a plantation area of low rainfall near Canberra.

Pruning beyond 2-3 m has not been extensively carried out in radiata pine, and in this respect the silviculture of this species has differed significantly from that of slash pine and hoop pine in Queensland (e.g. Bevege, 1972).

Forrest (1974) summed up what he thought to be the most important silvicultural considerations in regard to thinning radiata pine in N.S.W. as follows —

. . . intense competition, common after stand canopy closure, results in undesirable suppression of the dominant, final-crop trees. Serious economic opportunity cost is experienced in stands where intense competition develops. . . Examination of extensive growth data . . . confirms the value of early thinning . . .; . . . in many circumstances it is possible to thin for sale only a short time after a non-commercial thinning might be applied. (Holding) stands unthinned till the first production thinning is feasible, beyond the time when competition becomes intense, should be avoided aggressively. Management regimes which do not provide for release thinning in the second half of the rotation necessarily result in extremely dense stands and an opportunity cost is (again) incurred. . . .

Wind has not been regarded as a serious constraint to thinning, but there is growing evidence that losses from this cause may be significant. Cremer (unpublished) closely examined windfalls in 1974 in the A.C.T. These seriously affected several hundred hectares of old stands and are the most significant experienced so far in Australian plantations.

Technology of Harvesting Thinnings

Typical thinning operations involve the clear-felling of extraction rows ("outrows"), and a modified low thinning in the "bays" remaining between the outrows

(Jacobs, 1962). Special-purpose regimes to produce particular products (e.g. telephone poles) have been used on a limited scale for many years.

In 1950, all felling of thinnings in the south-east of S.A. was by hand, and the resulting billets from first thinnings, as well as small-diameter material from later operations, were hand-loaded across the trays of table-top trucks (Bednall, 1950).

In other regions, extraction of small wood by horses and of both pulp billets and larger logs by blitz trucks was common.

In the mid-1960s both A.P.M. and the Forestry and Timber Bureau carried out studies to improve the efficiency of this harvesting operation (Hill, 1966; Kerruish, 1967, 1969). A very important outcome of this interest was the Windsor tree harvester. In addition, however, many less spectacular but extensive and important improvements in methods of harvesting early thinnings have taken place because of the initiative and stimulus of Kerruish and his colleagues; the introduction of vehicle-mounted hydraulic hoists for loading is an example. It is only relatively recently, in fact, that attempts have been made to give harvesting (which often accounts for half or more of the mill-door wood cost) the attention in research, development and extension which it clearly warrants. Historically, Australian plantation harvesting has been a fragmented industry characterised by many small entrepreneurs with low capital investment and a mobile, largely untrained labour force. With only one or two significant exceptions, harvesting was a no-man's land between the forest services, who sold at the stump (and who are served by a number of research and development organisations) and the consuming industries who bought at the mill-door (and who are also comparatively well served with in this respect).

THE MANAGEMENT PROBLEM

Two groups of factors are now operating which potentially will change the overall Australian picture outlined so far.

The first of these is related to the great increase in the plantation areas which will be of thinning age (and especially first-thinning age) in the next decade (Fig. 1).

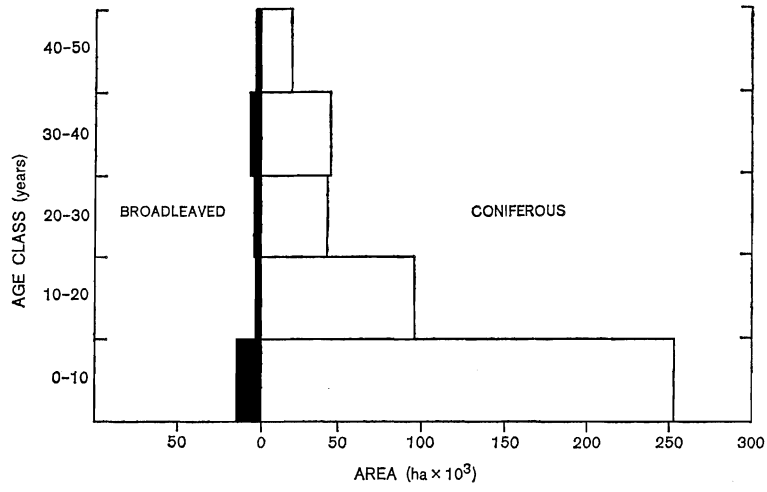

FIG. 1. Plantation area at 31 March 1972 by age classes and species groups.

About 250 000 ha will enter the 10-20 year age class in the next decade, that is more than twice the area which entered this age class in the last ten years. Many new areas which will come into production are in new regions not within economic haulage distance for established markets or processing facilities. These areas therefore may require a management approach quite different from the well-established operations which have dominated our past experience.

The second group of considerations is related to logistics and costs. The harvesting of early thinnings is now usually a labour-intensive job. A large pulp mill with an annual intake of 300 000 m^3 (10 million cu ft) and drawing most of this from early thinnings (over 3 000 ha, or 6 400 ac, would be cut each year if the yield was 100 m^3/ha, or 1 400 cu ft/ac) might require a harvesting force of about 300 men, using an annual productivity of 1 000 m^3/man (the 1970-71 Australian average — FORWOOD 1974 Panel 5; also Kerruish unpublished). Work forces of this size will be increasingly hard to establish and maintain in such a way that wide fluctuations in productivity are avoided and costs are predictable. Records for the percentage of workers in each age group of the work force from South Australia in two different years are given below:

Age group	1965 (%)	1968 (%)
Below 26	27	24
26-30	21	16
31-35	20	18
36-40	15	15
Over 40	17	27

These show that worker age is increasing, indicating difficulty of recruitment to jobs which are unattractive and dangerous. The latter is reflected in high workers' compensation premium rates, which for example in Victoria and S.A. amount to 20% or more of wages. Very many of the workers are migrants; changes in migration patterns or policies could conceivably cut off this labour supply (factors similar to these—i.e. the difficulty of recruiting an indigenous, stable labour force have led to a rapid mechanisation of Canadian pulpwood-harvesting operations).

Cutting now consumes about 80% of the labour involved in harvesting and transporting first thinnings wood to the mill. The cost of this labour is about 70% of the total harvesting and transport cost. Mechanical harvesting combined with row thinning can reduce the labour content of first-thinnings. FORWOOD (1974, Panel 4) anticipated a great labour reduction, to about one-eighth of that needed with present techniques, although other sources are less optimistic than this. A corollary of the reduced labour requirements of mechanised operations, and the changing ratio of labour to equipment costs, is that plantations on sites too steep for easy mechanised harvesting may have to forego early commercial thinnings.

Unless there are major innovations in the harvesting of early thinnings, it seems certain that at least the cost structure of wood landed at the mill door will alter. Harvesting costs will account for relatively more of the delivered cost than they do at present (Fig. 2, from C. M. Kerruish) leaving the forest owner with an ever-smaller return on what is often, even now, a product of marginal value.

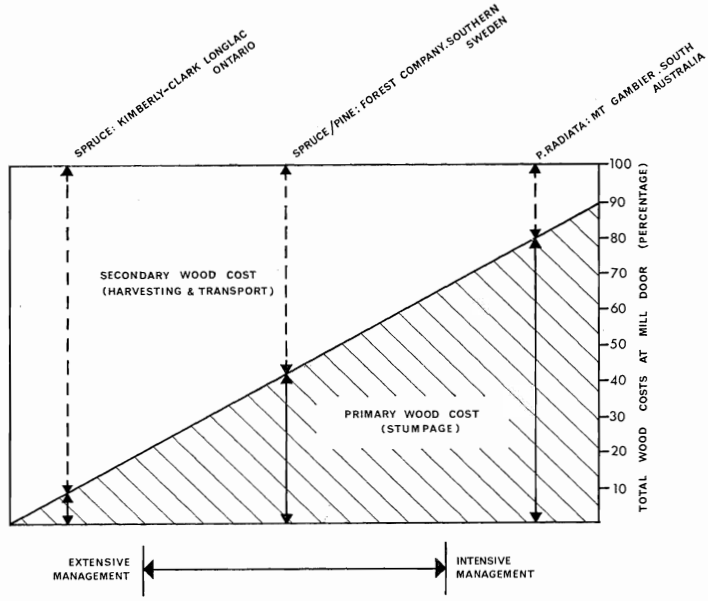

FIG 2 Showing the relationship between component costs of wood at mill door

Our Changing Environment

No discussion of background factors would be complete without noting the changing nature of the economic scene, especially in relation to domestic inflation rates and international commodity trade. Prices of wood products and oil have risen sharply in the last two or three years, although we in Australia have so far been sheltered from the full effects of the latter.

For at least the last 10 years it has been appreciated that costs were changing so that increasing mechanisation of harvesting was inevitable (e.g. Goudie, 1970; Kerruish, 1970). Some new mechanised processes may not simply ensure that harvesting as we know it can be continued, but rather introduce completely new practices, such as whole-tree chipping.

It is not at all easy to foresee the position 5 or 10 years hence. The balance between labour and equipment costs may not be as we anticipate, and in addition factors such as the real income of consumers of forest products may change in unexpected ways.

Some guesses about these factors, or at least an appraisal of the degree of uncertainty associated with them, is necessary in planning our early thinnings. The lead times of 5-10 years are much greater than those which most other industries regard as normal. The decisions taken in thinning are often exclusive ones.

The title of this paper is the "Background to thinning practice in Australia". The situation in Australia is not a uniform one. We have a diversity of environmental and market conditions and several major forest owners with different forest policies. Recognition of these differences and the reasons for them will help to ensure that discussion in this meeting is constructive and productive.

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