THINNING PLANTED RADIATA PINE TO WASTE IN STATE FORESTRY

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SYNOPSIS

State forestry should establish the most profitable compromise between quality and quantity production. Management can use the operation of thinning-to-waste to manipulate stand quality production, quantity production and production cost. The benefits, although recognized, have not been quantified. Any gains from an intermediate harvest must be balanced against interference with main crop quality, restriction in growth of the final crop element, and the cost of delayed main crop returns. This cost can be formidable and far outweigh the value of production thinnings. Lower initial stockings and genetically improved stock would greatly facilitate many stages of wood production, including thinning. Thinning-to-waste must be carried out with precision. The advantages of severance methods would appear to outweigh any cost savings achieved by poisoning methods.

INTRODUCTION

This paper deals only with planted radiata pine in State forests. Thus, natural regeneration in State plantations and private forestry practices are both excluded from consideration.

Few would quibble when I say radiata pine production forestry in New Zealand should have three objectives:

(1) The production of whatever quantity of wood is required at any point in time.

(2) This quantity must be of the type and quality demanded.

(3) Such produce must be available at a price people are prepared to pay.

These multiple objectives can, of course, be contradictory. Frequent, light production thinnings can increase volume production, and long rotations may improve quality, but both would undoubtedly increase production costs under New Zealand conditions. The answer lies in compromise — the ubiquitous solution to most forest management situations. However, if we assume that ultimately there will be some link between production cost of wood and stumpage value, it will be important to all branches of the wood-growing and wood-using sectors that our requirements for forest products be produced as efficiently as possible. This means reaching the

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most profitable compromise between quality and quantity production. The close link between efficiency and profitability was emphasized by L. N. Ross at our previous Institute meeting when he said:

"It is, or should be, generally accepted that the profitability of any enterprise is a measure of its economic efficiency. Most of us strive for greater efficiency and there can be little doubt that efficiency and profits are very closely linked indeed" (Ross, 1968).

Bearing Mr Ross's comments in mind, we should also remember that the success of any State Forest Service will depend on its relationship with Treasury. Treasury must have confidence in the forest policy being followed, whether it is the development of assets owned by the State, or the provision of incentives for private forestry. The Treasury follows Government policy but a government is far more likely to adopt a policy favourable to forestry if the Treasury can be convinced that forestry proposals are a suitable call on national resources, and are backed by sound economic studies. This basis of sound economic evaluation must support not only new projects but also current production methods — and these include our silvicultural practice.

Thinning-to-waste is one of several tools available to management for the manipulation of stand quality production, quantity production and production cost. The effect on gross quantity production is, of course, negative but this may be more than compensated for by improvements in wood quality, merchantable volume or profitability.

If we accept that our minor forest produce requirements can be met from relatively small areas, then most stands will have to yield about 200 merchantable stems or fewer per acre, irrespective of the particular end-use envisaged. Current practice aims at the establishment of approximately 900 trees per acre, yet many of these stems (say, 500 or more) have subsequently to be removed by thinning-to-waste. In other words, about 50% of the trees we successfully establish generate another cost in that they then have to be successfully removed. We go through this apparently very wasteful procedure in an effort to obtain straighter, better quality merchantable stems to harvest. The burden on seed collection, nursery, establishment, and maintenance resources is of course considerable, although I have not attempted to quantify it in cash terms.

Tending practice, being a function of management, depends as much on the economic background of a country as on silvicultural considerations to produce maximum volume or value yields. The area of proven tending practice for radiata pine is most limited and few regions can provide practical experience of any magnitude. This is especially true of thinning-to-waste. Only Queensland has recorded thinning-to-waste on any scale and this has diminished over recent years in favour of pulpwood production. Other regions have either adopted wide initial spacing (e.g., South Africa 9 ft x 9 ft) or early commercial thinning (e.g., South Australia) or in the absence of suitable markets do not thin (e.g., Chile). The various factors in these regions which lead to avoidance of thinning-to-
waste include: Superior stem form compared with some New Zealand regions (e.g., pumice soils), acute softwood shortages, established outlets for small diameter material, cheap and plentiful labour resources, easy topography and technical inexperience with the species.

Hence, thinning-to-waste is currently a rare operation overseas and this has been commented on by visitors to New Zealand, one of whom recently described it as "... another novel feature" (Cremer, 1968).

It would seem, therefore, that for one reason or another we have thinning-to-waste virtually to ourselves and can learn little from overseas experience. This situation is not surprising when we examine the many special factors within this country which favour the operation.

These include: large surpluses of low grade softwood, very restricted outlets for small diameter produce, poor stem form in some regions, close initial spacings in all regions, expensive and scarce labour resource, often steep country for extraction.

The only factor which does not favour thinning-to-waste in New Zealand is the general absence of value gradients for piece size. "The price-size gradient is the weakest link in the chain of evidence from which the relative profitability of various methods of cultivation is established" (Hiley, 1956). Considerable difficulties flow from this situation and they have been mentioned in recent literature. Sutton (1968) has said, "A uniform stumpage tends to overvalue small logs and thinnings, and to undervalue the larger logs. An economic study based on the same stumpage irrespective of piece size must invariably favour regimes producing the highest volume. Only when the stumpage rate reflects true costs and realizations can a realistic economic evaluation be attempted." Thus, under current exotic sales practice there is little incentive for growers to adopt silvicultural regimes which produce a greater proportion of the more useful sizes, or produce the larger sizes quickly. This emphasis on volume instead of value increment may have resulted in the adoption of tending schedules which, while they are technically feasible, may be sub-optimal in their financial results.

"Thinning and pruning regimes require careful assessment to correlate optimum production with economic efficiency" (Hinds, 1962).

However, in spite of the general absence of a value gradient for piece size, thinning-to-waste is still widely accepted and practised in our radiata pine silviculture. I feel that this acceptance is probably too apologetic and until we base our silvicultural practice on economics and adopt financial rotations it is likely to remain so.

**OBJECTIVES OF THINNING-TO-WASTE**

With regard to objectives, it is relevant to quote Lewis (1964) who stated, "The refreshing aspect of South African schedules was that they had a defined objective. This is in marked contrast to the endless debate elsewhere over thin-
ning practices instead of thinning objectives”; and Wood (1962) who said, “Thinning is becoming an increasingly pur-
pasive operation, aiming at the production of trees of definite characteristics and not merely at healthy looking crops”. To
have specific objectives which are the production of trees of
definite characteristics, we need to know what product we are
trying to produce and what characteristics are important.
It follows that, until a specific end-use decision has been
made, wood quality is a meaningless term. For example, knot
size is an important quality-determining characteristic in
framing timber and groundwood. Thinning in stands grown
for these uses must take cognisance of the knot sizes pro-
duced. Conversely, knot condition is more important than
knot size in board grades, and stands grown for board produc-
tion must manipulate knot condition — knot size being rela-
tively unimportant. In fact, to produce quality board grades
from radiata pine, we have to dominate knot condition by
pruning, but this is only successful if knotty cores are small
and subsequent tree sizes are large. It would appear, there-
fore, that stands grown for framing do not require pruning
but only some branch-size suppression, while stands grown for
board grades require early pruning followed by heavy thin-
ing. This is the only way quality objectives can be met. The
tending required to meet these suggests that to expect quality
framing and quality board grades from the same regime may
be expecting too much.

Obviously, we need to identify the quality-determining fea-
tures for specific products and industries and to quantify the
extent to which thinning practice can manipulate these fea-
tures. Then we can very deliberately choose what we want to
produce and grow our crops accordingly. Silvicultural regimes
can be designed to produce the chosen product (say, export
logs, groundwood, board grades or framing timbers) in the
cheapest way that ensures quality. Single product stands over-
come the problem of multiple objectives and compromise. The
idea is not new: Lewis (1964) mentioned “There has been
some talk of growing pulpwood and sawlogs in separate crops
in South Africa.”

The extent to which thinning-to-waste can improve crop
quantity and quality production is considerable at present. A
thinning-to-waste operation allows increment to be concen-
trated on straighter stems of desired branching characteristics.
It can be timed so that the non-merchantable stems manipu-
late branch size and condition on the crop trees, as well as
piece size. Less malformation and straighter main crop trees
should favour gains in logging and production costs and mini-
mize wastage — especially in the lower log-height classes
where value increment is concentrated. However, the degree
of improvement in merchantable yields that can be expected
from tending has yet to be measured. These benefits can of
course be obtained from production thinning, at least in
theory. The assumption is that the production thinning can
be carried out as efficiently and as effectively as the waste
operation. This has yet to be demonstrated (Fenton and Sut-
ton, 1968).
It would appear from the Maraetai short-rotation sawlog model that small and feasible improvements in straightness, piece size or grade outturn can have a dramatic impact on realizations. For example, a 2.5% increase in conversion factor was worth $6 Land Expectation Value (LEV) equivalent (about the same as logging equipment capital) and a change of 7% merchantable grade (8 x 1) to factory grade (10 x 1) is worth about $16 LEV equivalent (about the same as total pruning costs). These factors alone could justify the operation — quite apart from the remarkable increases in profitability that can be achieved.

The use of thinning-to-waste as a tool for increasing profitability has not been generally recognized. Rotation lengths have tended to be purely technical or simply tools for allocating the available resources to utilization plants. Short-term management problems have dominated any rigorous investigation of the most profitable production techniques and Fenton (1967) has said "... an unfortunate by-product of the current surplus of large size timber, low stumpages, and lack of value gradients for size is that they have concealed the need for thorough economic analyses of rotation period... One would expect that man-made forests, in which resources are invested in anticipation of future returns, should be providing data whereby optimum decisions could be made. Unfortunately, these opportunities are scarcely being realized anywhere."

The result has been a surprising degree of inflexibility in our approach to production forestry. Pulpwood and sawlog production has been planned to come from the one stand and production thinnings are planned on a large scale. An emphasis on volume instead of value increment has resulted in the continued prescription of merchantable thinnings which have yet to be justified in profitability terms. In contrast to waste operations, their timing is more dependent on harvest and market considerations than any silvicultural ones. Sutton (1968) in an analysis of the Woodhill spacing trial showed that, if a "profitable" first thinning with a net return of $28 per acre was replaced by a thinning-to-waste two years earlier costing $16 per acre, the LEV at 5% interest was increased by nearly $24 per acre. This increase was simply due to the increase in mean tree size. A modest price gradient was used in the analysis.

It would appear that, if delayed thinning results in any restriction in the growth of main crop trees, the cost could be formidable. Recent forest models (Fenton et al., 1968) based on the Maraetai blocks support this hypothesis. Short rotations were designed to produce a final crop as quickly as possible. Management was simple because thinning operations were to waste and had the sole objective of improving final crop quality. In the board grade model, intermediate yields were sacrificed to produce the same sized final crop tree in 26 years that current prescriptions achieve in 35 years. This shortening of the rotation increased the LEV by approximately $100 at 7% interest — a dramatic increase in profitability. Ten extra years on a rotation make a formidable difference to the interplay of costs and returns. At the 7% rate set for
State forestry by Treasury, each dollar of cost at planting compounds to $6 in 26 years or nearly $11 in 35 years. Or, to look at the return side, the present worth of $1 to be received 26 years and 35 years in the future are 17c and 9c, respectively. Judicious thinning-to-waste operations can allow us to take full advantage of the diameter growth rate of radiata pine and in doing so we may find the most efficient way to grow the species. We should certainly recognize two things. Firstly, any immediate returns from "production thinnings" are usually so far outweighed by a consequent reduction of volume and quality of the final crop that such operations can generally be regarded as a major charge against production. Secondly, short rotations are the best insurance against market risk and technological change.

FUTURE PRACTICE

The long-term outlook for thinning-to-waste depends upon whether we can grow trees of guaranteed good form and branch size. Our tree improvement programme is starting to yield results which could have a revolutionary effect on silvicultural practice. By 1976, 10,000 pounds of seed orchard seed should be available per year and this quantity could support the bulk of future planting programmes (I. J. Thulin, pers. comm.). Initial evidence suggests that, relative to current seed sources and spacings, orchard seed will increase the numbers of acceptable stems by 100% even if only 500 s.p.a. are planted (C. J. A. Shelbourne, pers. comm.). In these circumstances, initial stockings need not exceed 500 s.p.a. (9 ft x 9 ft) and could probably be considerably fewer. Similarly, stock from cuttings will be available in increasing quantities from now on. The form of this stock is also superior and only the spacing/branch-size interaction will determine what initial stockings would be required. Obviously the gains from high initial stockings and intensive selection will become small in the future and thinning-to-waste will then become less important. The problem, of course, is to know what the crop is being grown for and the maximum acceptable branch sizes for that particular use. If the full potential of improved stock, whether it be from cuttings or seed orchard seed, is to be realized, much will depend on full evaluation of a series of spacing trials which are not yet established. Such trials should be established as soon as possible.

At least in the short term, thinning-to-waste will be very important, but probably not of equal importance in all regions. Regional variations in stem form, branching characteristics and numbers of acceptable stems obtained from standard espacements have been widely recognized, though quantification is needed to support this opinion. Such variability could allow considerable deviation from what is currently a national prescription of 900 s.p.a. or more per acre, and favours wider initial spacing in some areas (e.g., Nelson district and the sand forests). In these areas a less rigorous selection could produce the same gains in stem form. On these grounds close initial spacings are difficult to justify and wide initial spacings (say, 10 ft x 6 ft or wider) may have immediate application.
With regard to methods of thinning-to-waste, the picture is somewhat confused. I have found no complete comparative evaluation of felling and the various poisoning methods. Both work study and silvicultural information is scarce. Most research has been fragmented and unpublished, while long-term trials have lacked continuity. Consequently, practice precedes research by a long way in this field.

Poisoning methods were originally preferred to felling because they were quicker, cheaper, conserved man-power and facilitated stand access. Other justifications were a reduced fire hazard and improved wind stability in the residual crop, but factual data to support these are not evident in the literature. The size of the stems marked for removal also undoubtedly influenced choice of method. Relative costs seem to have been the overriding factor governing the choice between poisoning and felling; while the choice of poison and application technique has depended on many factors including cost, operator safety, effectiveness in killing trees for removal, and personal preference of the officer-in-charge. Certainty of main crop selection and release, growth response of the residual crop and safety for subsequent operations have generally been ignored. The importance of these factors is not known and thus the conditions in which one thinning method is better than the other remain in doubt. The extent to which equipment availability has determined methods is also not clear.

Substitution of axes by power-saws has had a large influence on felling costs for large stems. Labour costs have been reduced by about one-third. Hence, the differential between felling and poisoning costs is less now than when the comparison was between axe-felling and poisoning.

In view of the general lack of any objective evaluation of methods I will restrict myself to general comment.

Firstly, a word of warning: choice of method on the basis of comparative cost alone is probably not valid — especially in comparing felling methods with poisoning methods. Poisoning has many disadvantages including the following:

(1) Both the poison and the application technique need to be good or the operation will fail or be only partially successful.

(2) Poisoning can be sensitive to season and weather.

(3) Quick, effective, safe methods are not currently practised on a large scale.

(4) The supervision and silvicultural control of poisoning operations are relatively difficult owing to the nature of the work and the delayed effect on the crop.

(5) Results can be variable, poisoned trees may not die, and the main crop can suffer death or damage after the thinning. Of particular importance here is the generation of defects in the main crop trees. Such defects may be undetectable or difficult to detect externally.
All these factors, singly or in combination, may more than outweigh any cost differential, particularly if it is small. Furthermore, heavier early thinning, lighter power saws and more lenient job specification (such as allowing high stumps) will all favour felling-to-waste in the future rather than poisoning.

**CONCLUSION**

Radiata pine silviculture in New Zealand has special features and problems. To solve them we thin-to-waste. It is not important that other countries do not make use of this operation. They face different combinations of physical, social and economic forces.

The benefits of thinning-to-waste, with regard to quantity and quality production, have been recognized for some time but not quantified. Positive silviculture directed to the production of single-product stands would help to avoid confusion over, and frustration of, quality objectives. The benefits of thinning-to-waste with regard to profitability have been largely overlooked. Any gains from an intermediate harvest must be balanced against interference with main crop quality, restriction in growth of the final crop element, and the cost of delayed main crop returns. This cost can be formidable and far outweigh the value of production thinnings. Although thinning-to-waste is a powerful tool for crop manipulation within the New Zealand environment, this is only true if the operation is carried out with precision. It is important that the choice of method is not made merely on the basis of comparative cost. When compared with the chainsaw, poisoning methods have many disadvantages.

Our radiata pine culture would be greatly facilitated if fewer trees could be planted initially. All stages of production, from seed collection through to thinning-to-waste, would benefit. Improved stock will undoubtedly play an important role here, but the quality of land clearing, nursery work, transport, handling, planting and release-cutting all have a part to play. In the long term, much lower stockings than are currently prescribed will probably be used. It will be of extreme importance that New Zealand foresters adopt a flexible attitude to silviculture, not only because our forestry has a high tempo and faces dynamic market situations but because this is the essential ingredient if quantity and quality objectives are to be met at lowest cost.

**REFERENCES**


