

THE ROLE OF THINNING IN THE MANAGEMENT OF PRIVATELY OWNED PLANTATIONS

S. OLLERENSHAW

Softwood Holdings Limited, Mt Gambier, South Australia

ABSTRACT

The role of thinning is considered from the time of the decision to commence investing capital in plantations.

Thinnings provide the raw material for use by the firm's log conversion plants and contribute to the cash flow. They reduce the cost of growing wood in the plantation by reducing the debt on the plantation and by reducing the time taken to grow trees of a desired diameter. Capital is returned to the firm for reinvestment and a larger annual increment earned on a smaller invested capital.

Thinning gives a flexibility to the products cut from, and overall wood resource represented by, the plantation. Silvicultural roles express themselves in the well-being of the total enterprise. The effect upon the condition and size of the knots is the most important of these roles.

Thinning reduces the likelihood of attack by pathogens.

For decision-making in the future, we need a tool which relates the effect of thinnings on a plantation with the effect on the industrial wood-converting side of the enterprise.

INTRODUCTION

In this paper we refer primarily to plantations (of *Pinus radiata* D. Don) owned by an Industrial Forestry Company, i.e., an enterprise which also owns round-wood using plants. In our case this includes several sawmills of varying size, plus the associated ancillary functions such as kilns, planer mills, laminating and finger-jointing plants, chemical preservative treatment plants, and a particleboard factory using both methods of manufacture.

Throughout this paper we emphasise the total enterprise; wood-using plants and the plantation estate together constituting the unit whose well-being must be seen to, whose profit must be maintained, and whose long life must be assured. Hence management decisions for the firm's privately owned plantations are not taken in isolation from the other management decisions of the enterprise.

"It is by thinning, more than any other operation, that a forester can control the destiny of a plantation and contribute to its financial success" (Hiley, 1956). These words indicate the importance of thinning, and also summarise the private owner's objectives with regard to the role of thinning in his enterprise.

Private ownership measures its success in monetary terms and compares itself with other organisations in such terms. Therefore in planning to thin several times in a rotation of 30-40 years, economic and financial aspects are certainly considered.

However, the role of thinning is complicated by the requirements of the log conversion plants and further complicated when those plants change their log specifications.

Thus the owners are looking also for an harmonious relationship between plantations and conversion plants such that the overall financial position is optimised and not for example that the plantations are doing very well indeed but slowly crippling the mills with oversize logs.

However along the way one hears warnings of a wasp attack, one area suffers wind throw, someone grizzles about the dead knots falling out of the flooring boards, the marketing manager wants some poles quickly and out of the blue comes an inquiry for peeler logs. The forester then stalls for time to sharpen both his pencil and his wits and while stalled the bottom falls out of his pulp wood market so first thinning is halted and second thinning severely curtailed. Finally the mill manager wonders why the forester has not heard of thinning from above.

The aim of thinning? Production of interim wood yield or improvement of final crop? To the man with the "overview" the role of thinning is to ensure the present viability of the total enterprise and its long and continuing prosperity.

Finally, however, if the owners do not also have conversion plants, the objective may in fact be to grow big logs quickly rather than get best value for thinnings.

ECONOMIC AND FINANCIAL CONSIDERATIONS

"Privately Owned Plantations" are continually changing entities. Even if the owner takes no action, past costs continue to compound and wood continues to grow.

Let us consider that private ownership had begun establishing its own plantations initially in a small way as was our case. The owners had made a decision to allocate capital to plantations. At the time this was an expression of faith in the future of wood. However the decision was helped by the awareness that such plantations in the district were being thinned at about age 14-16 producing small case logs and raw material for treatment plants. Also there was talk of pulping wood, for paper, softboard and hardboard making in the area.

Therefore our own decision to move into plantation establishment was very much based on the awareness that thinnings, comparatively early in the plantation's life, were going to provide a range of products at least two of which we could make use of ourselves. From the beginning thinning was seen as the tool by which the plantation started to contribute to the well-being of the enterprise and to its flexibility.

Funds invested in a plantation may be internally generated or may have been borrowed from outside. They are invested as land, establishment and annual maintenance costs. By investing in plantations instead of in an alternative project, an alternative return has been foregone. Thus we are justified in charging interest on the amounts invested in the plantation and this compounds as for the time being the investment does not pay the interest back. The capital investment steadily grows, but up to year 13 it has not contributed to the cash flow of the firm.

However the concept of thinning, at least, has already played a role in the affairs of the firm.

First, it has been assumed in the capital allocation decisions that thinnings will occur and produce certain products from the plantations. Second, these assumptions have been quantified in the cash flow calculations which are a vital tool in the firm's

budgeting and planning, both short and long term. It is essential to realise that decisions with regard to the plantations are not isolated but made with regard to all the other capital allocation decisions of the firm. At each revision of the firm's cash flow position full account is taken of the products and hence of the cash, generated by the anticipated thinnings.

It little matters to the total unit if the cash is generated by a royalty payment to the plantation unit or by the market prices for the final products from the thinned trees. In our case the plantation unit is an accounting unit of its own and earns "royalties" on the sale of its logs. This does not invalidate the hypothesis that cash budgeting decisions are made in terms of the total firm, and likewise the cash flow considerations. Thus as the early plantings approach the accepted first thinning age, the enterprise we are describing is going to be very keen to get on with the anticipated thinning programme.

There is another consideration which has relevance but which may not be enunciated in the final decision-making process and it concerns the cost of the wood being grown as a result of the earlier capital investment decisions. That cost is rising each year due to (1) The annual maintenance charge involved in growing each year's plantation, and (2) the interest charge accumulating on the capital invested in the plantations. If cash has been generated from inside the firm it is not such an obvious cost, but nevertheless ought to be recognised in the decision-making process. The first thinning, in that it begins to return some cash from the investment, serves to reduce the compounding debt on the investment. In this sense it reduces the cost of the growing wood. Thinning also reduces the cost in that it reduces the time it takes to grow logs of a desired diameter, by concentrating the volume increment on fewer trees (Forrest, 1970).

The first thinning also reduces the capital in the plantation, thus returning capital to the firm for re-investment; it converts the wood capital to money capital.

Using Moeller's theory "that within certain wide limits the volume increment is not influenced by density of stocking", we can argue that by first thinning we have reduced the capital invested in the plantation, but we are still obtaining the same volume increment on that reduced capital. This is an important role played by thinning. Moreover, if royalty per cubic metre rises with diameter of log, the role of this thinning becomes more emphasised. The same volume increment has been concentrated on fewer trees. Thus we are in fact earning a larger money increment than before the thinning, and this is being done on a smaller capital investment than existed immediately prior to the thinning.

The above principles are equally applicable to later thinning.

FINANCIAL CONSIDERATIONS FOR A "NORMAL FOREST"

In our own case we are aiming at the establishment of a "normal forest", although in this real world we probably will not at any one time be managing such a forest. Fedkiw (1960) has described what we are aiming for as a "regulated sustained yield enterprise". Although the plantation estate arrives at this situation slowly, there comes the point at which the annual return generated by the sale of logs equals the annual expenditure of establishment and maintenance of the estate. Our plantation estate is now like a "factory", costing an annual amount, and generating an annual cash flow or return.

With development towards a "normal forest", the investment philosophy changes. Originally the investments in plantations were made for future returns. However now, money is also spent to keep the "factory" producing, or to boost its production. The decisions that affect the plantation estate, for example a change in thinning intensity, or the delaying of a clearfelling now become based on analysis of marginal costs and marginal revenues. In theory such decisions may be taken each year; in practice they will be taken each five years or at each cutting plan revision.

As outlined above, thinning has the effect of:

1. Generating cash for the total enterprise.
2. Reducing the capital in the plantation estate and thus freeing capital for redistribution within the enterprise.
3. Reducing the cost of the growing wood.

We can now add the role of regulating the balance of money and wood capital represented by the plantation estate.

In financial/economic terms the original investment in plantations was made with a view to maximising the then present value of the future net annual returns. Now that we are receiving net annual returns one objective is to maximise these returns. However our plantation estate is a flexible unit; its capital value can be manipulated by thinning and clearfelling decisions. These decisions have effects on the wellbeing of the total enterprise and must be taken with these effects in mind. Hence the prime objective of the management of the plantation estate is to minimise the capital in the plantation estate which still should play a full part in meeting the objectives of the total enterprise. Thinning has a vital role in this, particularly as it allows for more flexibility than clearfelling.

The above discussion has assumed that capital is the limiting resource of the enterprise. It can well be that land or the supply of raw material may be the limiting resource. Should this occur, the role thinning will play will need reappraisal. Volume may be more important than value of wood dependent on a price/size gradient.

A Model of a "Normal Forest"

We consider the case of a "normal forest" in which there is 100 ha in each age-class up to 35 years. The costs are for establishment and maintenance (including debt repayment) while revenue comes from thinnings and clearfelling.

The effect of thinning in the annual net return is shown below:*

Operation	Age	Yield: m ³ /ha	\$/ha	Total: \$/year
1st Thinning	13	99	315	31 500
2nd Thinning	19	64	332	33 200
3rd Thinning	25	88	633	63 300
4th Thinning	30	117	991	99 100
Clearfelling	35	314	2750	275 000
			Grand Total	502 100
			Total from Thinning	227 100

* Based on our practices and internal royalties in the Mount Gambier district of South Australia, and an average Site Quality of IV-V. These royalties take no account of the effect of inflation.

Using the same model the annual expenditure may be of the following order. Costs include administrative overheads allocated from the total enterprise and are rounded average figures.

Annual Expenditure		
Establishment: \$200 × 100 ha	=	\$20 000
Maintenance: \$25 × 3500 ha	=	\$87 500
	TOTAL	\$107 500
Annual Net Return		
	=	\$502 100
	less	\$107 500
		\$394 600

Examination of the model shows that it is during year 25 that returns exceed costs; that is once third thinnings are being carried out. The position then is:

Returns:		
	T1	31 500
	T2	33 200
	T3	63 300
		\$128 000
Costs:		
Purchase of Land	\$240 × 100 ha	24 000
Establishment	\$200 × 100 ha	20 000
Maintenance	\$25 × 2400 ha	60 000
		\$104 000

The role played by thinning in the above consideration is evident.

ADDITIONAL CONSIDERATIONS

Other Ownership Types

Where a private forest owner does not own log conversion plants and thus sells the logs from plantations, thinning assumes an emphasis in addition to that in the roles already outlined.

If the enterprise is a farmer or farming company (mixed grazing company), this type of ownership does not have to consider the effect of thinning on the performance of wood conversion plants, unless of course treatment of its forest is so bizarre as to discourage sale of the logs. Rather interest is in maximising royalty returns on investment in plantations. If it operates under a prize/size gradient similar to that already described, thinning will be used to increase the proportion of merchantable wood in large sizes. This ownership may in fact carry out unmerchantable thinning and certainly would consider foregoing some merchantable volume production for larger royalty returns at a later date. In fact the optimum path, assuming an outlet for small diameter material, might well be to manage plantations for a comparatively large production of small material at a young age, thus generating some cash, and then to “change horses” and go for volume in large sizes.

However there can be several, separate or linked, objectives for investing in plantations. Insurance against bad agricultural times in the future, an investment for

the owner's children, to make use of otherwise unproductive land, or as one farmer told the writer "to be able to look at the cool green of the pines on stinking hot days". Thus the owner will not necessarily be wanting to maximise his annual return from the plantation, or the present net worth of the plantation estate, or see his objectives in these terms.

In the case of the industrial owner, the plantation estate is there to complement the wood using plants and thus play its part in the objectives of the total enterprise. If maximising the annual net royalty return to the plantation does not complement the role of the wood-using plants then obviously the return from the plantation estate will not be maximised.

It seems that tools of economic analysis would serve well the owners who have plantations alone but the same tools become complicated and unwieldy when plantations and log converting plants are owned together.

Flexibility of Range of Products

When establishment of our plantations began in 1950 it was assumed that thinnings would be carried out in keeping with the practices of the district. It was understood that such thinnings would produce material for round treated products, material for case production, and billets for pulp and particleboard production.

We were already milling case and board material and one reason for investing in our own plantations was to give us more confidence in our raw material supply. This initially was to come from thinnings and now does so. Those same thinnings allowed us to invest in a treatment plant, the round raw material for which came from thinnings from our young woods. One might ask why did we bother with case and round treatment material when we could have remained largely a seller of board products from larger logs purchased at that stage on the open market. Well we had aspirations of growing into a large and therefore more stable industrial user of round wood and providing the market place with a wide range of products. In the early planning thinning seemed appropriate, in fact vital, to the early growth of the total enterprise. Events have vindicated the early planning and faith in wood. Thinnings have continued to provide raw material for treated round wood products, packaging material, particleboard manufacture, pulp and board products.

The sale of pulpwood is an excellent example of the wisdom of establishing plantations with thinning very much in mind. In the mid-1960s we were able to enter into a long-term agreement to sell pulpwood. At present this agreement is equivalent to the first thinning of 526 hectares per annum. This added to the broad base and flexibility from which we continue to grow.

To a lesser degree, but none the less significant, is our being able to take advantage of the current market in vineyard posts, and this from thinnings of our plantation estate.

Flexibility of Resource

Discussion of the flexibility or range of products from a plantation must necessarily be coupled with some thoughts on the flexibility of the plantation. It seems to us that this flexibility of the resource can only be enhanced if a thinning programme of one sort or another is carried out. Certainly not to thin, having established 1700-2200 trees per hectare severely limits flexibility and in fact the total merchantable wood produced

in a rotation. It seems equally certain that to establish so few trees that thinning is unnecessary from a silvicultural point of view or to use a heavy unmerchantable thinning similarly reduces the flexibility inherent in a "middle of the road" managed plantation.

Most certainly is the above true of a growing industrial forestry enterprise planning a broad base of wood products from which to earn its income and ensure its long life.

Silvicultural Role

It is probably unreal to isolate this role from the others. However, it is quite obvious that there are definite effects upon the remaining trees after a thinning. These effects must be considered in relation to the products being sought from the plantation. Our aim is to grow board logs. The characteristics of those logs which thinning affects and which interest us, are:

Diameter under bark; condition of knots; knot size; taper; ring width. (*See Appendix*).

In addition selective thinning removes trees of poor form and thus plays the role of selecting the final-crop trees. This is a vital role considering the present availability of seed from orchards in Southern Australia, but may not be so crucial in the future.

An industrial complex such as ours must take careful note of the grading requirements of its products. Essentially a separation can be made between boards on the one hand and building timbers on the other. Boards are essentially graded for appearance and building timbers for strength. For boards we require tight, preferably green knots of limited size and distribution. For building timbers loose dead knots are acceptable. Size and distribution are important, relatively large knots being acceptable in relatively large pieces. The first thinning is thus the most important. It serves to arrest the rising green level. It allows the diameter increment to be increased on the remaining trees, after the early juvenile wood has been formed. This increment is of wood whose physical and mechanical properties are improving with age. However questions of taper, limb growth and even ring width must be considered.

Protection Against Pathogens

The sirex wood wasp is a good example here. Now that southern Australia has had several years' experience with this wasp it is apparent that a thinned plantation is the owner's best defence against damage caused by this insect.

It has been stated that sirex damages 40% of stems of an unthinned stand and 3% of a thinned stand. It can be said that the 40% would represent no more than an unmerchantable thinning, but in carrying out this thinning sirex would not have the aims of the plantation owner firmly in mind, and it is quite unlikely that he could distinguish between the various aims of different owners. The principle that sirex does very much less damage in a healthy vigorous wood than in an unhealthy wood containing significant numbers of suppressed trees is applicable to other pathogens.

Constraints Imposed by the Total Enterprise

The role of thinning regimes goes much further than the plantation boundary. It goes into the mill manager's market place where certain products sell with wider profit margins than others and where all products sell in competition. We can thin only if there is a market for the products produced. If there is no market the preceding discussion is irrelevant. On the other hand if the industrial owner, working from a

broad base, can create markets for a range of products, his thinning will be carried out, even if not strictly according to his original planning.

In our case a very close alliance exists between a flexible wood resource (whose management includes thinnings) on the one hand and a broadly-based wood using industrial enterprise on the other. Without the industrial enterprise the plantation is of little consequence, without the flexible plantation the would-be industrial enterprise "does not even get to bat".

Again we stress that the decisions taken as to plantation management will be those seen to benefit the total enterprise.

Examples of Thinning Decisions Within our Company

a. *Stand area 240 ha; spacing 2.4 × 2.4 m; planted 1946. First thinning 1961.*

The first thinning of this paddock was almost solely dependent upon the market for case material. As this market fluctuated so did the thinning operation. The writer's first meeting with the Company's Log Procurement Manager was while marking in this paddock for first thinning. The advice given by the Procurement Manager was to give the marking away there and then as thinning was to cease. It was as abrupt as that.

Today the thinning operation can fluctuate but there is a stability about it which did not exist in the early 1960s.

b. *Area 240 ha; natural regeneration from 1960. Thinning begun 1972.*

This natural regeneration resulted from the 1959 fire in the south-east of South Australia. Thinning is about two-thirds completed after three years. The wetness of the block in winter, rather than other reasons, has slowed the operation down.

The reasons for thinning this block are silvicultural. The form of the trees was good but if we were to grow sawlogs it had to be thinned. In fact such importance was put on the future production from this block that the cost of falling, over and above the set limits, was subsidised from royalties. The cost of the subsidy was of the order of 10% of the royalty. Today there is no need to subsidise the falling operation; however there is a small subsidy on the hauling operation due to the frequency of stumps in the outcrops causing above normal tyre damage.

c. *Change of site in response to changing demand.*

Quite recently there has been a significant reduction in pulpwood demand in the south-east of South Australia. At present we are being asked to supply about 75% of the agreed-to figure for the year. However to date this has not meant a reduction in our first thinning operations due to the flexibility allowed us by the demand of a range of products from our plantation investment.

In this case thinning has been transferred from a high site quality and poor form block to a lower site quality, better form block, thus increasing the production of round treatment material and reducing that of pulpwood.

THE FUTURE

There seems little doubt first, that thinnings will continue to play a vital role in the management of privately-owned plantations; and secondly that the mode of thinning will change to allow the growing plantation estate to remain as flexible a wood resource as possible. The decisions to make these changes, particularly once the situation

of a "normal forest" is being approximated, will be based on considerations of marginal costs and marginal revenues. The difficulty will be to accurately measure the anticipated revenues with respect to the total enterprise.

We need for the future an economics model linking plantation management decisions with their effect on the well-being of the total enterprise, showing us how to arrange our thinnings and clearfellings optimally. This may be wishful thinking. Therefore with regard to the sawmiller's changing markets and his changing technology plantations will continue to be thinned to maintain their flexibility.

"In order to ensure a high financial yield it is more important to thin intelligently than to adopt short rotations" (Hiley, 1956).

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APPENDIX: Description of Ideal Logs Currently Required by Our Sawmills

A. Appearance Grades

1. Low taper
2. Knots small in size
tight and green
3. For higher qualities —
knots few in number
4. Diameter range of 6-14 in., mean 10 in.
Normally obtained from 2nd and 3rd thinnings.

B. Structural Grades

1. Low taper
2. Knots can be larger, and dead or loose knots are acceptable.
3. Reasonably even ring width.
4. Diameter range 8-20 in., mean 13 in.
Normally obtained from 4th thinnings and clearfelling.

C. Poles

Poles have a limited but important market. We are gaining the required numbers from our normal forestry practices, in particular from slower growing areas.