LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

PROJECT REPORT

SMALLWOOD HARVESTING SEMINAR PROCEEDINGS

The Proceedings of a Seminar
Held in Rotorua
June, 1980.

P.R.13 1980

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

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N.Z. Logging Industry Research Assoc. Inc.

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1980

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PREPARED BY:-

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- INTRODUCTION -

As the forest industry in New Zealand moves into the 1980's it can look forward to very bright long-term prospects. However, there will be limited scope for industrial development during the 1980's. In the interests of orderly development of export markets, and the progressive rather than concentrated growth of processing plants, it will be important to make the most of what resource is available during the 1980's. Any significant forest industry development in this period will be largely based on material unsuitable (because of its size) for sawlogs - i.e. smallwood.

Experience has shown that a major disadvantage of utilising smallwood is the relatively high cost of this material to the industrial user. A large part of this cost is in logging and transport. In fulfilling industry's needs, the logging sector therefore has the responsibility of ensuring that smallwood harvesting is carried out as efficiently as possible. It was with this realisation that LIRA decided to organise a seminar on smallwood harvesting.

The objective of this seminar was to bring together all the relevant knowledge on the topic, to analyse the problems thrown up by past experience, and to explore directions for future research and development. The seminar therefore had the following shape:

1) An introduction to smallwood harvesting and its importance to the forest owner and to the industrial user.
2) An analysis of key areas, such as mechanisation, manpower and steep-country logging.
3) A series of discussions centred on special problem areas with emphasis on direction for future research and development.
4) A look at a wide range of operations and equipment options

The seminar was attended by some 140 people on 17, 18, and 19 June, 1980. These proceedings record the main papers presented and discussions which took place during the seminar.

- PRE- SEMINAR FIELD TRIP -

A field trip to highly mechanised operations in Lake Taupo Forest was held prior to the seminar for a small number of particpants. Features of this trip were:

FOREST AND WOOD SUPPLY

Lake Taupo Forest, Managed by N.Z.Forest Service.
Contractor N.Pritchard supplying pulp logs for Winstone Samsung T.M.P. mill at Karioi.

TOPOGRAPHY AND GROUND CONDITIONS

Working harvesters on slopes up to 11°.
Soil type: pumice, drains well.

STAND CONDITIONS

Stocking prior to thinning: 1000 spha
Age: 9 - 10 year old radiata pine
Tree Size: merch. stems of 0.15 m^3 x 7 m high, average
(merch. lengths up to 10 m possible)
Planned removal: 700 spha or 100 tonnes/ha
Stand history: thinned to waste and low pruned at 5 years
Stand preparation: prune,trees to remain,to 7 m. Trim lower
1 m of trees to be felled. Mark in 10th outrows.

HARVESTER OPERATION

Machines:
- Hitachi DFB 440's and 540
- 40 cm shear and delimb capacity
- 7 m reach horizontal and vertical

Work Pattern:
- 10th row out (for skidders) and thin between

Machine Function:
- Delimb to 7 m (top), fell, bunch

Performance:
- Averaging 60 trees per hour (4 strokes)
- Potential delay free - 120 trees per hour (2 strokes)
- Average production rate (1 x 8 hour shift)- 50 tonnes

Limitations of Harvester:
- Will not trim bottom 1 m or above 7 m.
- No topping off facility.
- Sensitive to tree height (max.vol.to 7 m ideal)

Features of Harvesters Compared to Others:
- Uses standard base unit - lower cost
- Swing type machine gives good operator comfort and ability to work well on slopes.
- Tracks give low ground pressure.
- Concept leaves slash at stump.

Features of System Compared to Manual Systems:
Much reduced labour requirement
Safer working conditions
Not restricted by darkness or weather
Machine Cost & Supplier:
Approximately $120,000 cost.
Supplied by Waratah Engineering - Tokoroa.

OTHER PARTS OF SYSTEM

Extraction: C8 grapple skidder
Sorting and loading: 605 & 645 RTFE loaders
Trucking: short log truck/trailer units

STAND AFTER THINNING

Final stocking: 300 spha
Damage to residual trees: 4%, mainly by skidders

- SEMINAR FIELD TRIP -

The first day of the Smallwood Harvesting Seminar consisted of a field trip to Tahorakuri and Kinleith Forests of N.Z. Forest Products Limited. All stands were radiata pine and the following stops were made:

STOP 1. MANUAL FELLING AND DELIMBING

STAND: Approximately 1000 spha thinned to 250 spha. Gently rolling topography.
OPERATION: Demonstration of safer techniques, felling aids (lever and felling bench) and safety equipment.
OPERATOR: John Gaskin
EQUIPMENT: Husqvarna 162 (60cc) saw with 15 inch bar, 3/8 pitch chain. Felling bench: Australian design, weight 16 kg.

STOP 2. FORWARDER EXTRACTION IN SHORTPULP THINNING

STAND: Prescription and topography as Stop 1. Age 12 years, piece size 0.14 m^3.
OPERATION: Manual fell, cut and stack for forwarder. Rubber-tyred front-end loader used for short distance extraction and loading. Loading mainly into multi-lift buncks.
OPERATOR: Pat Clarkin, Contractor
EQUIPMENT: Forwarder - modified Tree Farmer C7D 130 hp, powershift. Rear end converted to a 2 m pulpwood cradle. Cab rebuilt, with swivel seat. Roof mounted Cranab 2510 hydraulic knuckle-boom crane.
Loader: International 515, 95 hp, articulated steering 3 gears forward and reverse.

STOP 3. MINISKIDDER EXTRACTION IN LONG PULP THINNING

STAND: Prescription and topography as Stop 1. Age 14 years. Piece size 0.13 - 0.15 m^3.
OPERATION: Longlength pulpwood thinning operation using small skidder. Skidder fleets on landing, crosscutting by mobile slasher (stop 4).
OPERATOR: N. Mariner, Contractor
EQUIPMENT: Gafner Miniskidder, 42 hp, articulated steering, 8 forward, 2 reverse gears. Winch capacity 38 m of 9/16 inch rope, maximum line pull 5670 kg.

STOP 4. MOBILE SLASHER

OPERATION: Cutting long lengths of (0.15 m^3 maximum size) to 1.8 m shortpulp and loading into multi-lift bunks. Handles several extraction operations.
OPERATOR: Jim Hall, Contractor
EQUIPMENT: A TK Bedford truck carries an industrial Ford diesel engine. This drives a hydraulic pump through the power take off to operate a Hiab 670 crane and through the gear box via a V belt drive to a 125 cm circular saw.
PRODUCTIVITY: Cutting and loading, 90 m^3 per day.

STOP 5. SKIDDER EXTRACTION IN SHORTPULP THINNING

STAND: Thinning from around 1000 spha to 350 spha, on easy terrain. Stand age 14 years, piece size 0.13-0.15 m^3.
OPERATION: Trees felled, delimbed, cut to 1.8 m lengths, and stacked in 1 to 1.5 tonne bundles.
OPERATOR: Martin Spykerbos, Contractor
EQUIPMENT: Rubber-tyred skidders of the Timberjack 208, Tree Farmer C5, and Clark Ranger 664 size were used.
PRODUCTIVITY: Cutters produce 7-8 tonnes per day, and the extraction machine can handle 80-90 tonnes per day.

STOP 6. AGRICULTURAL TRACTOR EXTRACTING LONG PULP IN THINNING

STAND: Thinning from 1000 spha to 250 spha on flat topography. Stand age 11 years. Piece size 0.12 m^3.
OPERATION: Longlength pulpwood thinning operation using agricultural tractors converted for logging work.
OPERATOR: Lou Dargaville
EQUIPMENT: Zetor 6945 Agricultural tractor, 69 hp, converted for logging by Ashworth Motors, Tokoroa. Tractor cost $15,000, conversion cost $10,000 including underframe and single drum winch.
PRODUCTIVTY: 3 man gang extracting and stacking 27-30 tonnes per day.

STOP 7. CHUTE EXTRACTION IN SHORTPULP THINNING

STAND: Thinning to 300 spha, short slopes, stand age 15 years. 0.18 m^3 piece size.
OPERATION: Cut and carry 1.8 m billets to chute line. Stack billets at bottom of chute line.
OPERATOR: Mike Emerson and Vern Saies, Contractors
EQUIPMENT: High density polythene tubing, 380 mm outside diamete and 12 mm wall thickness, cut into two or three length ways. 60-100 metres of chute length.
PRODUCTIVITY: Two men produce 5-6 tonnes per day stacked.

STOP 8. HAULER EXTRACTION IN LONG LENGTH THINNINGS

STAND: Thin on slopes over 20° with 4 metre wide strips at 20 metre centres to leave 280 spha overall. Stand age 15 years, piece size 0.21 m^3.

OPERATION: Thin uphill or downhill in strips,with herringbone pattern felling to the strip. Average haul was 100 m. It was necessary to remove wood away from the machine using an integral crane or a secondary skidding machine

OPERATOR: Barry Clunie, Contractor

EQUIPMENT: Timbermaster 4070, 69 hp, truck mounted. 3 drums, skyline 400 m of 16 mm, mainline 350 m of 9 mm, haulback line 650 m of 9 mm rope. Maximum line pull 4000 kg.

PRODUCTIVITY: 6 man gang (with secondary machine) producing 30 - 40 tonnes per day,depending on piece size and volume removed per hectare.

- SESSION 1 -

KEYNOTE ADDRESSES

Chairman: Jim Spiers, LIRA

"SMALLWOOD HARVESTING - WHAT FUTURE?"
The importance of smallwood as a resource.
A. KIRKLAND, Deputy Director-General, New Zealand Forest Service

"INDUSTRY USER POINT OF VIEW"
The importance of smallwood to the industry.
J.SCOTT, General Manager, Carter Oji Kokusaku Pan Pacific Ltd.

SMALLWOOD HARVESTING : WHAT FUTURE?

A.KIRKLAND
Deputy Director-Genera
N.Z.Forest Service

Introduction

I have been asked to speak on the future smallwood scene from the resource side. For this purpose smallwood has been defined as wood unsuitable for saw timber or veneer, i.e., early commercial thinnings, clearfellings of slow growing species, and small logs recovered in clearfelling predominantly sawlog sized crops. In view of the tight wood supply we now face the timing of the seminar on this subject is very appropriate. Since the Second World War we have been steadily increasing our production of roundwood mainly by expanding the use of softwood forests planted in the late 1920s and early 1930s. The build up in exotic roundwood production has been rapid as the following table shows:

	Exotic Roundwood Production (000 000 m^3 annual average)
1950-54	1.3
1955-59	2.0
1960-64	3.4
1965-69	5.0
1970-74	7.2
1975-79	8.1

Up until the early 1970s a growth in production has exceeded 5 percent per annum average and as you may be aware from media coverage this week forest products exports are at a record level of earnings of close to $400 million.

The potential for exotic roundwood production has been calculated as:

	Exotic Roundwood Production Potential (based on then current management intentions - 1977 National Forestry Planning Model) (000 000 m^3 annual average)
1981-85	8.9
1986-90	9.2
1991-95	12.4
1996-2000	17.5

Putting these two tables together it will be obvious that we appear to have, nationally, reached a temporary plateau in our ability to produce. The 1950s and 1960s was a period of rapid expansion of forest industries based on the maturing pre-war plantations. As a country we had to learn how to use exotic timbers in place of the traditional native woods; we had to introduce new technologies for more sophisticated pulp, paper and panel products and we had to develop export outlets as well as changing our own pattern of wood use. While these developments were going on we were not using our exotic forests to their full growth potential. The speed of expansion was not therefore governed by the forest resources but by ability to develop new markets and build the associated plants. In the 1970s we began for the first time to run up against the limitations of the forest area. The absence of any major planting effort from the mid 1930s until the early 1960s began to be felt. Now we must wait a few years until the greatly expanded plantings of the 1960s and 1970s, which doubled the forest area, allow us to once more assume rapid growth in forest production and forest industries. We are faced with the dilema of wanting to develop new export markets in anticipation of the large resource that lies ahead but having limited room to do so as a result of the tight supply situation. The only way that supplies can be increased is by greater production of smallwood. Hence the appropriateness of the topic. In summary the factor that will influence a greater use of smallwood in the 1980s is simply that there is no-where else to turn for significant increases in production.

Some Limitations on Smallwood Production to Date

Why has the extraction of smallwood assumed greater importance than in the past? The answer to this question is complex but there have been four main factors:

- the forest resource, as already stated, has not until recently been used to its full potential.

- smallwood is the most expensive component of the crop to produce taking into account direct costs and, in some circumstances, "hidden" cost,

- the risk from wind and disease of holding large areas of untended forest has placed the emphasis on clearfelling the "old crop",

- with the exception of the post market many regions have had no demand for smallwood, i.e., pulpmill, panelboard or chip export outlets have not been developed until recently.

The first three are obviously linked - while there has been cheap large wood available and a strong desire to remove it, the incentive to use more expensive smallwood has been lacking, unless the small size was specifically needed - as for example for posts and stone groundwood. Despite this significant areas have been production thinned.

Some Problems in Obtaining Smallwood From Thinnings

Historically the situation in thinning has been roughly as follows. Prior to World War II plantation timber was in little demand and although the urgency of thinning the earliest plantations was much discussed from the end of World War I, the absence of markets was a disincentive to do anything. Between 1928 and 1937 large areas of State forest were thinned to waste by relief labour but the massive plantings of the 1926/36 period missed out on this treatment because of the war.

From the early 1950s the establishment of pulp and paper industries in the Central North Island, and the boom in farming and related demand for fencing, coupled with advances in preservation technology created conditions for exotic smallwood use. Smallwood in radiata pine was obtained mainly as an arising from clearfelling or thinning mature stands of sawlog size. In Corsican and ponderosa pines in State forests it was obtained from thinnings of dense 30-50 year old stands.

It was envisaged through the 1950s and early 1960s that the post war stands of radiata pine would have two or more extraction thinnings as well as an early thinning to waste to bring them down to final crop stocking. It was thus predicted that quite a high proportion of their production would be in smallwood and that this would become a much more important component of future wood supplies. It was not however until the 1960s that post-war stands were extensive enough to commence extraction thinning as a general practice and soon after it commence the desirability of such thinning was called into question. Operationally the main problems were the fact that thinning was commonly the first operation to be suspended in any downturn in demand and scheduled programmes thus fell behind. As well there were difficulties in obtaining a final crop of pruned stems and of controlling a tendency to "over thinning". All of these difficulties were likely to reduce the value of the final crop.

The economics were studied in the late 1960s. It was reasoned that while production thinning was designed to increase yields, to obtain intermediate returns and to allow greater final crop selection, increased yields were unlikely, intermediate produce was of relatively low value and obtained at the expense of the final crop either by direct damage or by the need for longer rotations, and selection should be concerned with the first two logs and could be done as soon as these were formed, i.e., at about 12 metres height. The upshot of this reasoning was advocacy of an approach to radiata pine silviculture that avoided extraction thinning and deleted smallwood production entirely by pruning and early thinning to waste. In the 1970s this approach was widely adopted by the State and some private organisations - a situation which would have to be revised if large quantities of smallwood were to be available. This in turn means considering the reservations that lead to avoiding extraction thinning and considering how valid they are in the changed supply situation.

There will doubtless be detailed discussion of costs later in the seminar. It is generally appreciated that smallwood is dear wood. Unpublished work by Terlesk documents how daily production rises rapidly with piece size in thinning radiata pine (by ground extraction in long lengths). For each 1/10th metre increase in piece size the increase in production was estimated to be 10 cubic metres per day. Cost per cubic metre declined rapidly as piece size increased until it reached a little over 0.20 cubic metres, and then declined more gently. Costs of thinning radiata pine up to 14 years old have been calculated by NZ Forest Products as three and a half to six times that of clearfelling 48 year old stands. The high cost of smallwood production may be lessened to some extent by carefully matching the equipment and labour to the physical conditions and the mean piece size but as Terlesk states "In very small piece sizes there is an irreducible amount of capital and labour input required to harvest the produce and this is shown in the high cost of production trend...". Not only is smallwood more expensive to produce but it is intrinsically of lower value than larger wood except in the case of posts. Pulpwood stumpages in State forest are currently in the range $1 to $5.50 per cubic metre, domestic sawlog stumpages $5 to $20 per cubic metre and export sawlog stumpages up to $52 per cubic metre. An early thinning of radiata pine for pulpwood may therefore yield less than $100 per hectare in stumpage compared with a clearfelling value at age 25 of several thousand dollars per hectare for the same stand based on current domestic prices (i.e. without allowing for improved quality).

The aim in intensively tended State and private plantations is commonly to obtain a final crop of well formed trees with pruned butt logs capable of yielding a high proportion of clear sawn timber. It is desirable to obtain large size in the final crop trees as rapidly as possible and this may be done by thinning to the final crop stocking immediately the pruning of the butt log is completed at about age 10 to 12. If such thinnings were utilised by non damaging methods such as short pulp billet production either with the skidding of bundles or the use of chutes, the effect on the final crop would be little different from a thinning to waste. There could be no argument against recovering what would otherwise be wasted in these circumstances, provided the very high cost of the wood produce could be met by the user. However the piece size at the time of high pruning is very small and for reasons discussed above a delay of a couple of years or more after high pruning has generally been considered necessary both to increase the extractable volume and the average piece size. To increase the volume even further some of the earlier thinnings to waste may be foregone. The effect of thinning delay and of higher stockings is to reduce the diameter growth of final crop trees and therefore necessitate a somewhat longer rotation to achieve the same size. These conditions also place pruned trees at risk from competition with unpruned trees. If the delay is only about 2 - 3 years so that shortwood pulp systems can still be used, these are the only "hidden" costs of thinnings. If the delay is longer and tree length extraction is practised damage to butt logs can further reduce the value of a pruned final crop particularly for peelers.

We therefore have a conflict - the earlier extraction thinning can be done particularly in an intensively tended stand the better from the viewpoint of value in the final crop but the later it can be left the cheaper the wood produced in thinning. Deciding where the compromise, if any, lies is a complicated business requiring precise information on growth etc. much of which is just coming to hand. The analysis must be done within the context of a whole forest. Such information is being assembled by the Radiata Pine Task Force to try and provide conclusive evidence of the relative advantages of different approaches to radiata pine silviculture.

The decision has already been made, for example by NZ Forest Products, that the smallwood available from thinnings is worth the costs, direct and indirect, of obtaining it. The likely reasons for this will be discussed later.

Early Clearfelling

The cost of producing smallwood could be significantly reduced b clearfelling young stands (say 15 to 20 years in radiata pine) rather than thinning them. One company in Northland is planting radiata pine with a 15 year rotation in mind - for pulpwood, and the Fiji Pine Commission, using Carribean pine has had a similar aim. This option would obviously be one way of advancing the us of New Zealand's plantings of the 1960s into the 1980s, rather than the following decade - a possibility suggested in the recen DFC report. It is not an option that appeals to most New Zealan foresters because it would remove tended stands at or before the height of their growth and thus sacrifice volume production, and it would forego the valuable sawlog crop available a few years later for the sake of relatively low value pulpwood. It has not be the policy of the State to grow forest on short rotations solely for pulpwood and this will generally continue to be the case. I would have to be demonstrated that the economic benefits to the nation of early clearfelling outweighed those of conventional rotations in a particular case if this policy were to be reversed. There is little indication that most private companie prefer this option to the alternative of obtaining smallwood fro thinnings and better recovery of clearfellings.

Better Cutover Clean-up

There are no silvicultural complications in increasing the volum of smallwood obtained from clearfellings by better clean-up of cutover and landing although the best methods may require some consideration. The only requirement is that the high marginal cost of hauling and loading smaller pieces is matched by their value. Where the user is also the forest owner the incentive to look to this additional source is strong particularly in a tight wood situation. Where clearfelling is part of a sale to another party it may require a continuing effort from the seller to achieve a high clean-up standard. This is because what makes broad economic sense may not be in the financial interest of the buyer.

Scope for Increased Yields by Use of Smallwood

If by better cross cutting, harvesting of shattered tops and gathering of small pieces generally the volume from clearfelling could be increased by 5 percent it would mean close to half a million cubic metres a year additional wood in the 1980s. If all stands scheduled for thinning to waste at age 10 or thereabouts were thinned with recovery (of only 35 cubic metres per hectare) the additional yield would be a little over 1 million cubic metres a year. The total increase of 1½ million cubic metres per year would represent a 16 - 17 percent increase on the figures given earlier which respresented management intentions in 1977. One of the major obstacles to realising the additional thinning volumes would be steep terrain. No precise figures can be given for the proportion of tractor to non-tractor country but from data gathered from Symposium No. 11 in 1969 by Chavasse it is probably not much more than one third of the former. Thus the techniques of getting small thinnings off hills, such as the chutes developed by NZ Forest Products, are basic to realising the potential.

If instead of attempting to recover the additional volume at the time of high pruning the thinning was delayed until age 15 and yielded 150 cubic metres per hectare a potential would exist for over 4 million cubic metres per year extra in the latter half of the 1980s. However this would be largely a hauler operation and the effect on the final crop from the delay in thinning and the physical damage of rope hauling is not likely to be generally acceptable where an investment has been put into pruning for quality logs. In general the more intensive the early silviculture the less likely that delayed extraction thinning would be acceptable.

It therefore seems to me that what are needed to realise a high proportion of the thinning production potention are non-damaging techniques for flat and hill country capable of dealing with the small piece sizes at ages 10 to 12 years, or a little older in slower growth areas, and of course a sufficient value for smallwood to make it worthwhile.

The Value of Smallwood

The cost of smallwood cannot be measured solely by the direct cost of its production and the hidden costs of adverse effects on the final crop which may result from some types of thinning operation. If by recovering this wood it is possible to conserve bigger logs for higher value end uses this must also be taken into account. For this reason there are two distinct situations in looking at the role of smallwood.

Firstly, in areas such as the Bay of Plenty where there is considerable smallwood demand from existing industries increased use of smallwood may release an equivalent volume of sawlog and peeler sized material which can be exported at relatively high value, used to increase local mill throughput, or conserved to smooth the transition from pre-war to post-war crops (which will be very different in size and quality characteristics). These opportunities must be analysed on a forest wide basis over time and not for individual stands. In forests the younger age classes which have not been pruned the effect on the final crop of holding wood for extraction thinning may be simply to reduce tree size at the time of clearfelling or to add 2 or 3 years to the rotation to get trees of the same size. If the extraction thinning immediately releases mature timber in the forest for other purposes then in effect a transfer of such wood from the future to the present has been achieved and as you will be aware a dollar now is worth considerably more than a dollar 10 to 15 years hence. In stands which have been pruned and intensively tended the position is more complicated because the value of the future harvest that may be foregone or delayed by thinning is that much greater. Differences in the attitudes of forest owners are therefore to be expected and will reflect the investment they have made in pruning and early thinnings and the relative importance they attach to immediate versus longer term gains.

In summary the value of having the additional smallwood from thinning is not measured solely by increased pulp or panelboard production but must take account of redirection of bigger logs to a more valuable end use. NZ Forest Products Ltd currently has programmed about 18 percent of its Kinleith input in thinnings and plans to increase this proportion. It seems probable that this has advantages to the company not only in increased total production but in the greater flexibility in the use of the diminishing old crop in the manner described. The main contract for supply from Bay of Plenty State forests is being renegotiated and an important feature is the provision of incentives in pricing etc. to use non-sawlog material as pulpwood to the maximum possible extent. Greater efforts to utilise smallwood will be required if maximum production is to be achieved.

There is an opportunity to conserve older and larger logs by increased use of smallwood wherever there are existing pulp and/or panel board plants, i.e., Auckland metropolitan area, Central North Island, Hawkes Bay and Canterbury. It is likely that the whole of the North Island with the exception of the remoter parts of the East Coast and Northland, could be regarded as a timber "catchment" for this purpose.

The second situation exists in areas such as Nelson, Otago and Northland which have no reconstituted wood processing plants, limited areas of older plantations and large areas of young exotic forest. When the young forests are ready to harvest in the 1990s there will need to be an outlet for the residues from sawmilling and for smallwood. In the meantime more limited volumes of residues currently available must either by wasted, used for fuel or exported unprocessed as chips - a trade which has not been particularly profitable in the past. The advent of relatively small scale pulping using the thermomechanical process presents another option and one that is being examined by CSR-Baigents in Nelson and Odlins in Otago. Although the proposed plants are not large (300 and 200 t.p.d. respectively with requirement of 200 000 and 150 000 cubic metres per year) the supply position is tight in the 1980s and icreased use of roundwood would be needed to make them feasible. In the case of Nelson, Baigents propose to achieve this by lowering rotations tc 21 years for pulpwood and 25 years for sawlogs and to use their own forests relatively heavily in the early years. In the case of Otago the use of thinnings to supplement sawmill residues has been mooted*. In both cases it would be possible to build the proposed plant without lowering rotations or otherwise increasing the smallwood proportion of sacrificing the sawlog potential in any way simply by waiting a few more years. However both from the viewpoint of individual companies and from that of Government earnings generated now rather than later are important and may be sufficiently so to forego a portion of the overall potential earnings for the sake of early returns.

The job of foresters is to try and measure what may be foregone so that those making the necessary value judgment, be it Boards of Directors or Ministers, are well informed on all of the costs.

In Summary

- There is potential to increase production in the 1980s by greater use of smallwood and there are specific proposals to do so.

- There can be little argument about doing so by greater recovery in clearfellings or by using early thinnings that would otherwise be wasted.

- Despite the keen demand for more wood cheaper extraction methods for flat and hill country must be developed if early thinnings are to be used.

- The desirability of later thinnings is arguable and they are likely to be practised only where the resultant loss of final crop values is offset by immediate release of mature wood for other purposes and/or where the early investment in tending, particularly pruning, has been minimal.

- There is a challenge to loggers to develop lower cost, non damaging thinning methods if the full potential for smallwood is to be realised in the 1980s.

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*Footnote: The proposal for a Northland pulpmill has not been taken to the point where the process is certain. The locally produced component of the high value finished paper could be T.M.P. or pressure groundwood. If the latter it would be unique in relying solely on smallwood, probably from thinnings.

SESSION 1
Paper (b)

INDUSTRY USER POINT OF VIEW

R. SCOTT
General Manager,
Carter Oji Kokusaku
Pan Pacific Ltd.

I am very pleased to have been asked to deputise for my Managing Director, Mr K.F.L. Carter, and to speak in conjunction with Mr Andy Kirkland on the subject of smallwood harvesting.

In 1970 I would have had to say to you that industry was not much interested in smallwood although a few major projects were relying to a small extent on this source of raw material. Standing here today in 1980 I must say to you that industry is deeply involved and in fact is totally committed to the necessity of smallwood harvesting to enable it to continue its satisfactory levels of operation during the 1980's. In 1970 we were basically a sawlog wood processing country however with the demands of the market and the manufacturing units throughout the 1980's I feel sure, by successful smallwood processing, we will be able to even out the radiata wood supply in New Zealand over the next two decades.

Pan Pac has become increasingly committed to smallwood supplies throughout the 1970's however has at the same time encountered increasing problems of higher costs, harvesting techniques and processing requirements. These problems generally relate around the small stem sizes and cover the difficulties of maintenance of supply, productivity and therefore costs.

It is encouraging to see that throughout the next two days this Seminar will cover all of these aspects and many other worthy of your attention. On Monday afternoon I had a look at the radiata thinnings in the Lake Taupo Forest. After our several years experience in mechanical harvesting of small-wood in Kaingaroa I was again reminded that the best ideas in research do not always result in the most successful operations. That is not meant to be a criticism of our operation in the past, not what I saw on Monday however the key point I would like to commend to you here is that if going to mechanisation, selection and training of operators is of the utmost importance.

I would now like to start from the final product and work back towards the forest. I will go over experiences of Pan Pac and hope that many of these will demonstrate our company's involvement and deep commitment to the smallwood scenario.

In referring to the market I would like first of all to say that it has become very clear that one of the most important smallwood sources now and in the future, radiata thinnings, can make one of the best mechanical pulps in the world. In fact, with the aid of the thermo-mechanical process I feel sure that we will be able to reach the highest standard in the near future. I have been saying for over five years that in New Zealand we are not doing enough research into mechanical pulping techniques. In the main, little progress is being made because increasing costs of electricity and smallwood on the surface appear to count out any early rapid expansion in the mechanical pulping field. The overall market position now and in the future in this field is most encouraging and if prices continue to rise there is a great danger that the smallwood harvesting research will, like the mechanical pulping research, be left well behind the market requirements. Recent expansion announcements in the press support this view.

I have said before that I do not believe this country, (if it was called upon to do so) could through its logging sector, not its manufacturing sector, cope with the forecast peak in wood supply in the 1990's. (The demands of capital, labour, management etc, must steadily progress.) If this Seminar over the next two days can bring about a realisation that efficient smallwood harvesting linked up with the market requirements can bridge this gap, then we will all have made a significant contribution to the smooth development of the forest based industries in New Zealand.

I would now like to move my comment into the wood processing area and indicate to you some of the experience Pan Pac has had over the last decade. Can I firstly say that we believe we have been successful because we have a totally integrated operation covering the full range of products from short length thinnings through to large diameter reject logs. We also believe we have been successful because we have been able to efficiently handle each of these readily identifiable wood groups. We have no experience of handling solely smallwood to make the ultimate manufacturing process economical however our indications of costs that I will give later clearly show that a new industry based on smallwood alone is exceedingly vulnerable to the wood harvesting and processing sector.
As far as the Pan Pac operation is concerned we aim to economically extract and utilise all wood available within our various forest concessions. The smallwood group accounts for approximately 40% of our wood intake and the techniques we use begin in the forest where log selection and cutting must allow for efficient transportation and ultimate conversion into chip material ready for final processing. Smallwood, as far as we are concerned, falls into three categories and these are :-

(a) Short length thinnings 5-7ft (1.5 to 2.1 metres),

(b) Short length for truck and trailer operation 8-25ft (2.4 metres to 7.5 metres), and

(c) Long lengths 25-41ft (7.5 metres to 12.3 metres).

(a) SHORT LENGTH THINNINGS

This category is generally delivered to our mill on a flat deck truck with the 6-8ft lengths of radiata thinnings loaded across the tray of the truck. The truck is generally loaded with a hydraulic crane and can be off-loaded the same way or simply tipped from the truck. At the mill conventional mobile log handling equipment is not suitable for the unloading process nor the handling process. We have adapted a log loader with a multiple bottom fork arrangement and a cage type curved hold down. This arrangement allows any foreign materia to drop free while at the same time securing the short lengths of logs for the distance between the stockpile and the infeed chains. The short lengths are fed into a drag chain arrangeme specifically designed to deliver them directly to the debarkin drum.

(b) SHORTS

Many of the top logs from radiata clear felling as well as radiata thinnings fall into the category of shorts. The technique of delivery from the forest to the mill is either by loading the shorts in with the long lengths or loading them onto truck and trailer units separately. When shorts are loaded in with long lengths it is best if the log stacker can lift them directly from the truck to the deck for processing. When placed in log yards the shorts tend to separate and tangle with the longer lengths. Shorts delivered on short trucks store quite satisfactorily and can be handled by conventional log handling equipment. The critical fact as far as the mill is concerned is that the infeed deck for short must be fitted with a hydraulic cherry picker which can readil untangle and process the short lengths.

(c) LONG LENGTHS

Thinnings (11 to 12 year old), top logs and other species (Ponderosa, Corsican etc) are the main types that fit into this category. Upon delivery at the mill conventional mobile log stackers can be used although additional hold down arms to restrict the movement of small diameter wood can improve the handling characteristics. Recovery of long lengths of small-wood from the stockpiles can vary greatly. We have found that Ponderosa and Corsican with its very high taper is exceedingly difficult to recover from the stockpile to an infeed deck. The logs have generally been loaded into the truck, top and tail, for the maximum transport efficiency and when recovered from the log yard tend to "birds nest" as the stacker forces the heavier butts apart. When this "birds nest" is placed on the infeed decks the problem is further accentuated and under these circumstances a cherry picker fitted to the decks is essential for good productivity. In fact, our experience in the early days was that it is almost impossible to transfer this sort of material from an infeed deck to a cut-off saw infeed chain without the aid of a cherry picker. We also believe by our experience in this field that the popular over-seas trend of using slash decks for random length smallwood would not be suitable for Ponderosa and Corsican.

Smallwood handling in the mill also has several other drawbacks, in that the thinnings, Ponderosa, Corsican etc, all fall into the category of low bone dry fibre yield when being processed into chips. This has a significant affect on the costs of this chip production. The Ponderosa and Corsican fibre for mechanical pulping is considerably inferior to the radiata, and in particular the thinnings fibre. We believe that if this was better recognised in the royalties the use of some of these less thrifty species may be made more attractive for the manufacturer. The Ponderosa and Corsican species in particular have very high bark percentages generally ranging between 12 and 15 % of the green weight of the log delivered on site. These factors in combination make Ponderosa and Corsican very expensive as a fibre source.

Another problem that is encountered with all smallwood handling techniques in the mill is that when using dry drum debarkers the random length and low diameter combine to cause major refuse handling problems. During the cross cutting procedure for feeding the dry drum debarker multiple stems are the most efficient way of handling. This invariably leads to short lengths of small diameter wood going into the drum and generally forcing their way through slots into the refuse system. The belts, elevators and drag chains designed to handle bark and sawdust do not like handling two to three foot lengths of 2 to 4 inch diameter pulpwood. In addition, if the small lengths succeed in getting through to the chipper, they can create what we call cards when they enter the chipper sideways generating large surface area curved chips which when rechipped, often are reduced to sawdust.

Our No.2 woodroom built in 1976 (for smallwood handling exclusively), is capable of processing in excess of one thousand tonnes of smallwood in a 13 hour working day. Considering one thousand tonnes per day at approximately 2 logs on the deck per tonne, or ten lengths per tonne in the drum debarker, can be processed from infeed through to chip screens by two shifts of three men each day, we beleive we have made a significant step forward. If our company and any others in New Zealand are to adequately cope with the needs of the 1980's, recognition must be given to the rapid trend towards smallwood and the need for developing efficient handling techniques in the mills.

The cartage of smallwood is more expensive than larger logs and this is particularly so for short haul operations. Smallwood takes much longer to load efficiently onto logging trucks and with the increasing road user charges operators do their very best to place the load in the best position and load to the maximum legal limit. The assembly of smallwood in the various categories at the skid site has necessitated a rapidly increasing area for skids as compared to the volume of wood being removed. The use of rubber tyred mobile plant at the skid site has practically proved to be the most efficient however with the high capital cost of these units it has meant large volumes need to be handled per day to keep costs at a reasonable level. In this area I cannot stress enough the importance of good training and the selection of experienced operators as the difference between a good and bad operator when handling smallwood can affect your productivity by as much as 100%.

I would now like to move my comment back to the area of extraction which is I believe the most critical. We have experience in extracting more than 1,000,000 tonnes of smallwood mainly from the Central North Island pumice lands, but also from the foothills of the Hawkes Bay area. We have experience with several techniques going from conventional skidder and chainsaw gangs right through to the most sophisticated mechanical harvesting and delimbing techniques. In the mid-1970's we introduced our mechanical harvesting equipment to increase productivity in Ponderosa and to cope with a rapidly diminishing supply of skilled logging labour. In the late 1970's we abandoned this project basically because the scope of the operation proved to be incompatible with our systems, leading to lower productivity, higher costs and our belief that at this stage the small owner operator gang was more efficient. Much more I feel sure will be said about this area over the next two days.

I would now like to comment on the approximate costs of various operations which will give a better idea of where to apply our effort. The roading, skid preparation, extraction and loading of Ponderosa out of southern Kaingaroa Forest we estimate will cost us slightly over $10 per tonne this year. Radiata thinning in the same area with an age category of 9 to 12 years would have approximately the same cost factors applied. The Corsican stands in southern Kaingaroa which have a much heavier stocking and greater stem size drop back to approximately $6 per tonne for the same scope of work. The top logs and smallwood arising from the old crop radiata in Kaingaroa with the same scope of work in the coming year can be carried out for $4.50 per tonne. If we now move back to the Hawkes Bay area and in particular the foothills where often haulers are needed, Corsican would cost out of Gwavas, say, well in excess of $12 per tonne. In Esk where we have a radiata sawlog extraction operation the smallwood top logs arising cost for the same scope of work is $8 to $9 per tonne.

Our overall experience in the smallwood area shows that for extraction, a small gang with the owner-operator as the foreman, is most efficient for extraction. He is best at maintaining a regular supply and consistent productivity and generally yields the best overall costs. In the areas of loading and cartage, it is necessary to have several owner-operator contractors preferably able to move from one small extraction contractor to another clearing each maybe once or twice a week. As you can see, the cost components vary considerably and are not always in relation to the value of the wood. Unfortunately, the royalties paid also do not relate to the true values of the wood and if we are to be successful in manufacturing and marketing the products of smallwood harvesting we must have the costs of the various groups delivered at the mill more closely aligned to their true values and potential. Also, due to lack of satisfactorily efficient extraction techniques, some smallwood lots close to the mill cannot be economically harvested, while others at a considerable distance from our mill are marginally acceptable. The cost of various smallwoods delivered to our mill today can vary by as much as $10 per tonne and often the variations are the reverse of their true value to us. We,like all other wood processors,currently look at the total package and until some major restructuring can be brought about some good wood supplies in the smallwood category are subsidising other less useful species.

CONCLUSION

The additional fibre requirements and in many cases the base supply for the 1980's will come from the smallwood source. Those manufacturers and marketers depending on this material will want a steady reliable supply with maximum recovery from the forest to the mill at the most favourable costs. Failure to achieve these objectives could mean that some company and maybe State Forest would have to be sold at below the cost of producing them. This will be necessary to keep the industries operating while bridging the wood supply gap.

I think we can say that the last five years have seen the basic introduction of a reasonable scale smallwood operation in New Zealand. The techniques have varied considerably and I feel sure that as the values of labour, machinery and fuels change over the next few years a change in economics will bring about further changes in techniques.

I also believe that sales of at least five years with volumes allowing economic plant and labour selection must lead to the most steady development of smallwood harvesting over the next five to ten years. The smallwood scenario will not cope with the wildly fluctuating annual volumes that have been experienced in the log export trade over the last decade. The resulting inefficiencies in plant and labour utilisation that have challenged the cost structures of the stable continuous plant operations if allowed into the smallwood area, could see our efforts of the next two days being in the main wasted.

I have covered many areas of interest to Industry - I feel sure that you can develop these to suit the various requirements for the future in conjunction with LIRA.

- SESSION 2 -

INTRODUCTION TO SMALLWOOD HARVESTING

Chairman: Jim Spiers, LIRA

"SMALLWOOD HARVESTING - SOME DEFINITIONS"
GEOFF WELLS, Research Forester, Logging Industry Research Association.

"INDUSTRY SMALLWOOD HARVESTING INTENTIONS"
GEOFF WELLS, Research Forester, Logging Industry Research Association.

"SILVICULTURAL INFLUENCES IN SMALLWOOD HARVESTING"
BILL SEWELL, Tahorakuri Superintendent, N.Z.Forest Products Limited.

SMALLWOOD HARVESTING - SOME DEFINITIONS

G.C.WELLS
Research Forester,
LIRA.

1. INTRODUCTION

It is appropriate at this stage of the seminar to discuss what is meant by smallwood and by smallwood harvesting in some detail. This should ensure that during the seminar we all speak the same technical language. It will also set a frame of reference for dicussions during the seminar.

In defining smallwood we immediately run into the problem of deciding: "how big is small?". The answer, of course, is that "it depends". A recent article originating in the Pacific Northwest Coast of America, titled "New Yarder Ideal for Smallwood", decribes a 145 kW (193 hp) hauler logging trees averaging one cubic metre in size. At the other end of the scale a recent Finnish study discusses research work aimed at coming to grips with harvesting trees which require 25 or more to make one cubic metre. And in New Zealand? Well, the purpose of this paper is to set down working definitions suited to our own harvesting operations at the present time.

To develop a definition for smallwood it is necessary to ask: What kinds of trees or wood are we concerned about? What categories of trees present the special problems that gave rise to this seminar? Then, we can look at the options of systems to harvest these categories of timber.

1.1 The Problem Area in Harvesting

The first point is that the timber is small so that delimbing costs are high relative to the volume involved. Because of the small size there is also the problem of aggregating a full payload behind any extraction machine. The second point is that the value of the timber is generally low. Usually it is not suitable for sawlogs and is harvested mainly for pulpwood, which has an intrinsically lower value. There are some exceptions to this, such as posts and poles, and small log export sales. However, these exceptions generally require special handling so that their logging cost is accordingly higher.

Thus the timber we are concerned with is characterised by high logging costs and generally low value product. Since we are investigating logging operations in this seminar, it is consistent to define smallwood according to the kinds of operations undertaken to produce i

2. WHAT IS SMALLWOOD?

Following on from the above, smallwood is now defined as the product of the following operations:

2.1 *Thinning operations from which the majority of the products are too small for sawlogs in New Zealand. These generally produce pulpwood but there are also many operations producing posts and poles, and a few producing special export grade small logs.*

2.2 *Clearfelling stands of young trees or stands of unthrifty species where the products are too small for sawlogs in New Zealand. The main products will therefore be pulpwood with some posts and poles and small log exports. In the future there will possibly be material used as a base for energy production.*

2.3 *Harvesting logging residue in a second phase operation. These operations mainly produce pulpwood from head and branch material left behind after a clearfelling operation.*

In terms of tree or piece size, these definitions cover a reasonably wide range, although the majority of trees considered would be betwee 0.1 cubic metres and 0.35 cubic metres. For radiata pine this corresponds to trees with diametres of 10 cm to 25 cm. Other studies have shown that logging costs increase very sharply when tree size decreases below 0.2 cubic metres. While the greatest effort and potentially the greatest return may come from research and development into logging methods for the smaller sized stems, any improvemer in the economics of logging the slightly larger stems will still prove worthwhile.

The definition of smallwood given here deliberately excludes those small logs which are produced at the same time as larger sawlogs in many clearfelling operations; especially in old crop radiata pine. These small logs (sometimes called arisings) pose special problems in sorting, loading and transport. However, as they are not fully harvested from the stump area as a small tree or residue, they have not been included within the scope of smallwood for this seminar.

3. SMALLWOOD HARVESTING SYSTEMS

There is a great range of possible systems for harvesting smallwood. While this can confuse a discussion it helps if these systems can be grouped into a few general types. Once again, there are several methods of categorising logging systems, but the one described here is fairly widely accepted and understood. The basis is the relative amounts of human work and machine work used to get the logs onto a truck; i.e. the relative degree of mechanisation.

3.1 Basic Systems Classification

(a) Motor-Manual Systems (See Figure 1)

Motor-manual systems are characterised by having felling and delimbing carried out by a man with a chainsaw:

(i) Motor manual shortwood logging systems: those where manual crosscutting and stacking of short lengths of timber (shortwood) occurs in the forest, or less commonly on the landing.

(ii) Motor manual longwood systems: those where the tree lengths are extracted to a landing. A small amount of manual crosscutting may occur, but most subsequent operations are carried out by specialised machines.

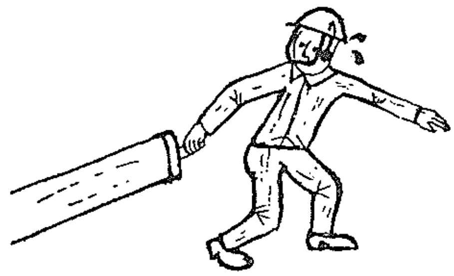
Figure 1

MOTOR-MANUAL - CHARACTERISED BY MANUAL FELLING AND MANUAL TRIMMING
(Labour intensive)

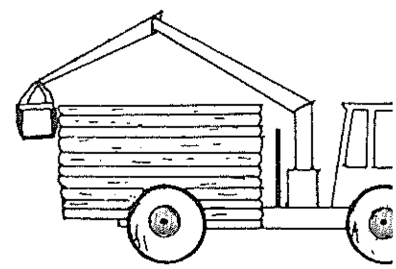
TYPE (A) - SHORTWOOD

Manual felling

Manual trimming & crosscutting

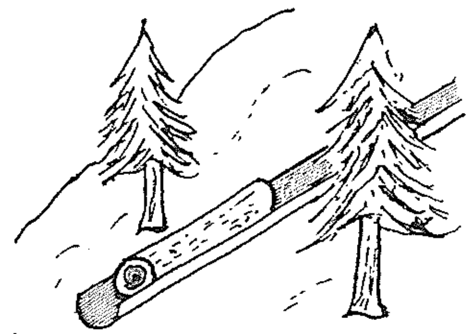


Manual stacking



Forwarder (or skidder) extraction

or

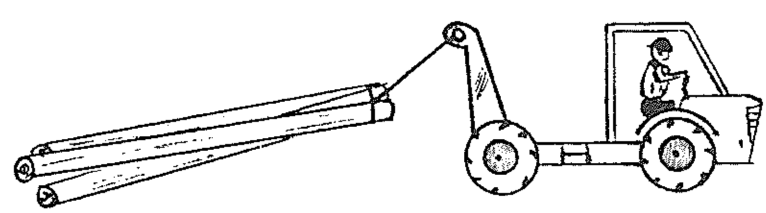


Chutes, on steep terrain

TYPE (B) - LONGWOOD

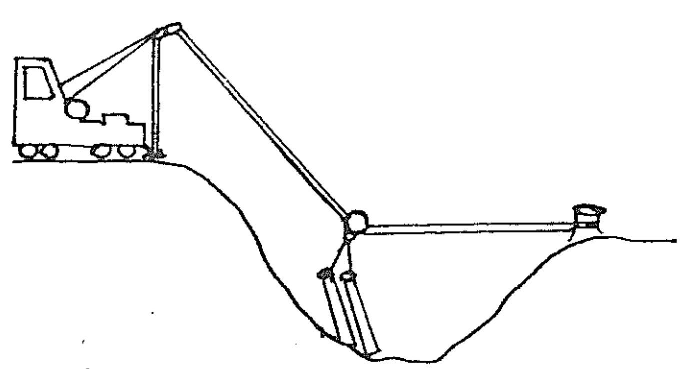
Manual felling

Manual trimming



Skidder extraction

or



Cable systems on steep country

A variety of machines and methods may be used to extract timber from the stump to a landing and to load it from the landing to a truck. In New Zealand skidders and agricultural tractors are most commonly used on moderate terrain and small haulers on steeper terrain. Forwarders for extracting shortwood are not common although they would represent a common method overseas. A small number of operations utilise gravity to extract timber in short lengths, such as wire rope or chute methods. Rubber-tyred front-end loaders are commonly used to load trucks. Some equipment specialised for loading smallwood is also used, such as self-loading trucks, stacked out trailers, and bunks loaded by knuckle-boom cranes or sometimes by hand

(b) Mechanised Systems *(See Figure 2)*

Mechanised systems are characterised by having either felling or delimbing, or both operations, carried out by a specialised machine. The actual degree of mechanisation can be quantified according to the proportion of motor-manual operations performed by a specialised machine. For N.Z. smallwood operations, where felling and trimming are the main non-mechanised operations, 20-25% of time is spent felling and 75-80% spent trimming. Therefore an operation where trimming is mechanised represents a higher degree of mechanisation than one where only felling is mechanised. A similar analysis can be used for operations such as crosscutting and stacking. However, the classification used here recognises only two levels of mechanisation.

(i) Semi-mechanised systems: felling may be undertaken by a specialised machine followed by trimming using a man with a chainsaw. Alternatively, felling may be undertaken by a man with a chainsaw and trimming done by a specialised machine. The second alternative represents a higher degree of mechanisation than the first.

(ii) Highly mechanised systems: both felling and trimming are undertaken by a specialised logging machine. This may be mounted on one carrier or two separate machines may be used.

Mechanised logging systems have made only a small impact on smallwood harvesting in New Zealand. However, both partly and fully mechanised systems are in use. There is a great variety of machines for carrying out the functions of felling and delimbing, many of which have been developed overseas, while a few have been developed within New Zealand Extraction and loading of wood produced from mechanised systems have not developed differently from methods used for wood produced from motor-manual systems.

3.2 Possible System Options

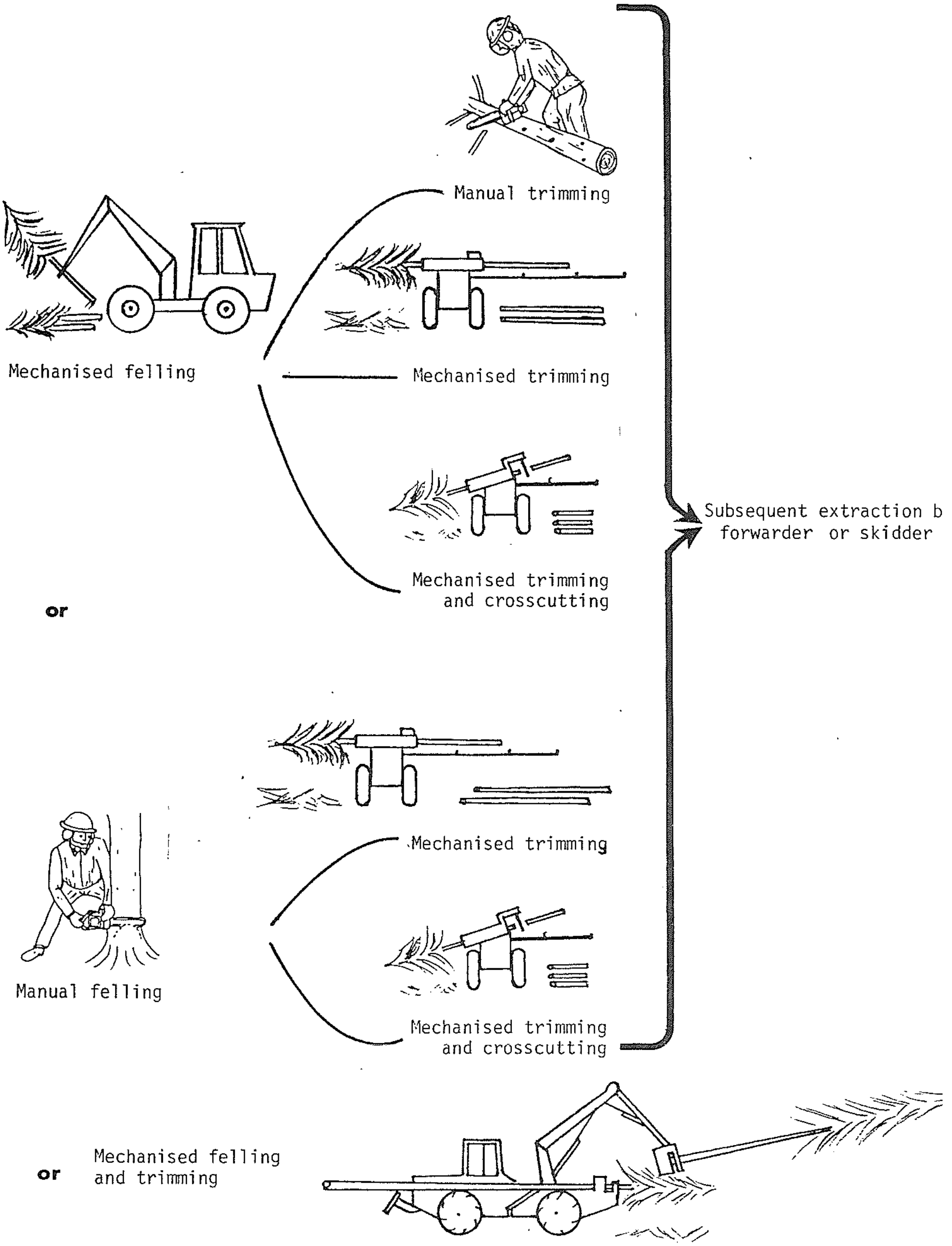
Having grouped smallwood logging systems into four basic categories, further subdivision of each category is possible to assist in describing a particular logging operation. The basis of this further subdivision is:

(i) The sequence of operations: fell, trim, crosscut, extract, and load, are the main operations.
(ii) Location of operation: this may be at the stump area, on a landing, or a central processing yard.
(iii) Method of operation: this describes the equipment used to perform each operation, e.g. chainsaw or felling shear.

Not all of the potential systems are possible. For example, it is necessary to fell a tree before it can be extracted or loaded! However

Figure 2

MECHANISED - CHARACTERISED BY MECHANISED FELLING, OR TRIMMING, OR BO



there are several hundred different ways (possibly as many as engineers have the ingenuity and time to design and develop!) for putting together the equipment necessary to get logs onto a truck. These varied possibilities do not give rise to any confusion as long as the same method of description is adhered to in all of them. The following two examples show how this system can describe two widely dissimilar logging systems:

System 1. Motor-manual longwood, slashing on landing, loading to bunks.

Operation Sequence	Fell	Trim	Extract	Crosscut	Load
Location	Stump area	Stump area	-	Landing	Landing
Method	Chainsaw	Chainsaw	Agric. tractor	Mobile slasher	Knuckle-boom crane to bunks

System 2. Highly mechanised, delimber-feller-buncher, grapple skidder extraction

Operation Sequence	Delimb	Fell & bunch	Extract	Load
Location	Stump area	Stump area	-	Landing
Method	Delimbing knives	Shear	Grapple skidder	Front-end loader

4. CHOOSING A SYSTEM FOR SMALLWOOD HARVESTING

This section looks at the factors which have a major affect on the choice of system used in smallwood harvesting. During the seminar these topics will provide a major area for further discussion.

4.1 Mill Requirements

This is perhaps the first area which must be looked at before considering which system to use. For a start, the mill will require either shortwood for longwood. If shortwood is required, an extra crosscutting operation must be fitted into the system, at one of the several locations and using one of a wide variety of the methods. Another factor is the standard of presentation of logs required. Some end uses require a very high standard in terms of delimbing and cutting to length. The mill is also likely to set the rate of production. This is discussed below.

4.2 The Forest

An important consideration in the forest is the variability of tree size and terrain. In a variable forest, flexibility is required and this may mean that more than one system is necessary,or that a flexible system should be used. Motor manual systems tend to be more flexible than mechanised systems. This is because a man with a chainsaw can cope with a wide range of tree sizes, and rubber-tyred skidders or tractors can cope with a variety of terrains. When the forest is uniform over a reasonably large area then a mechanised system can be considered.

4.3 Terrain and Environmental Sensitivity

High mechanised systems, and in particular mechanised felling, have production rates which are very sensitive to slope and do not operate well above 10-15°. Mechanised delimbing, however, can take place at a level landing area or on a roadside in steep country. In steep areas and some less steep areas, soil disturbance must be kept to a minimum for environmental reasons. Steep country logging methods such as cables or chutes must be employed.

4.4 Production Rates

The overall production rate required by the end user and the production rate per system must be considered. Mechanised systems generally have a higher production rate than motor-manual systems. It is mormally unwise to rely on just one harvesting system to supply the total needs of any one user. Therefore, a relatively low production rate requirement may be catered for by several motor-manual harvesting systems, while a high production rate can be catered for with several mechanised systems, or a larger number of motor-manual systems. The forest size or total production of an area of forest should be considered here also. There is little point in employing a very high producing system in a small forest area, as time spent shifting from one forest area to another will become too large a proportion of the total time. Unfortunately reliable production rates for particualr systems in particular forests are not readily available.

4.5 Capital Availability

The introduction of mechanised logging systems almost always means a high requirement for capital. If this is not available, less capital intensive systems must be used, and this will point to the use of motor-manual systems.

4.6 Machine Servicing Facilities

A very important consideration with any machine is the availability of repair and maintenance facilities. Highly sophisticated machines (that is those used in mechanised logging systems) generally require specialist servicing facilities for hydraulic and electrical components In New Zealand these specialised machines tend to be present in low numbers and servicing in areas away from major industrial centres can be a very big problem. On the other hand, the common extraction machines used in motor-manual systems tend to be more readily serviced in rural areas.

4.7 Availability of Labour and Labour Skills

All harvesting operations require skilled labour. To start up an operation this labour must be either trained from a locally available labour pool or attracted from elsewhere. Providing other factors favour it, a mechanised logging system does reduce the requirement for skilled labour. However, the intensity of training for the smaller number of men required may be greater and more specialised in the case of a mechanised operation. The problem is obviously greatest in relatively small operations remote from pools of skilled labour. Here, motor-manual systems will have to be used but low productivity can be expected until skills have been acquired.

4.8 The Relative Costs and Production Rates of Labour and Machines

Perhaps the most critical factor, yet one of the hardest to determine, is the final cost of getting a cubic metre of wood onto a truck using the various systems. It is necessary to know both production rates and costs. Possibly because these are unknown or at best poorly understood, this relative cost comparison is rarely made when choosing a logging system for smallwood harvesting.

5. SUMMARY

Smallwood has been defined on the basis of the kind of operation which produces it. The area of concern is for trees which are expensive to harvest and yet which have a generally low market value. Logging systems to harvest this smallwood can be classified according to the relative inputs of man power or machine power. While there is a large number of possible ways of putting together machinery to do the logging work, they can be easily described in a relatively simple listing of sequence, location, and method of operation. When it comes to choosing a particular smallwood harvesting system, many factors need to be taken into account. Unfortunately, some of the most critical are not well understood so that the best decision cannot always be made. It is expected that this seminar will provide some useful information for loggers, logging managers, and planners, which can be used for making rational choices of smallwood harvesting system options.

INDUSTRY SMALLWOOD HARVESTING INTENTIONS

G.C.WELLS
Research Forester
LIRA.

1. INTRODUCTION

That smallwood harvesting operations will continue in New Zealand for the next decade is a certainty. However, we cannot be so certain of the actual quantity of smallwood which will be harvested. The problem is that the only available national forecasts of roundwood in New Zealand failed to use the same definitions of smallwood as those used for this Seminar. The National Planning Model was produced first so it can hardly be blamed for this oversight. It does mean however that we have a gap in our knowledge and the size of the gap,or rather the quantity of smallwood to be harvested,would give a further indication of the importance of the subject of this Seminar.

Not only do we need to know the magnitude of the problem area we are dealing with but we also need to understand what kind of problem it is. This means that we want information on the kind of material which will be logged and the way in which it will be harvested. This kind of information is needed for the development or introduction of appropriate harvesting machinery and also to indicate the directions for research and development.

Over the past few months, LIRA has undertaken a survey to find the answers to these unknowns. The survey was directed to forest owners to give a check on the proportion of the total New Zealand resource which had been covered by the survey.

The initial approach to the forest owners sought their co-operation. The list of forest owners to be approached came from the Forest Owners Association (minimum forest holding 150 hectares) and from LIRA mailing lists. After receiving agreement to co-operate in this survey, the actual questionnaire was distributed, together with some explanation and instructions. Replies have been received from all major forest owners. The result gives a good indication of what the industry intends doing in terms of smallwood harvesting over the next ten years.

ACKNOWLEDGEMENT

LIRA acknowledges the co-operation of forest owners who have made this information available to the New Zealand logging industry.

2. THE QUESTIONNAIRE

The objectives of each question in the questionnaire can be described as follows:

2.1. The first question asked the area of plantation forest established at March 31st 1980. The total forest area covered by questionnaire returns compared with the total plantation area in New Zealand would give an estimate of the survey coverage.

2.2. The second set of information requested the quantity of smallwood which the forest owner intended to harvest from his own forests. This was broken down by the type of operation: that is, whether it was from thinnings, from clear-felling young or unthrifty stands or from harvesting logging residues. For each of these three categories, the quantity to be harvested was listed as either ground hauling systems, or cable hauling systems. Finally, the quantity to be harvested was to be given in time periods, first for the current year (1980), second for 1981-85 and third for 1986-1990. The objective of these questions was to find out sufficient detail about smallwood harvesting intentions to provide useful answers to the unknowns, while not involving the forest owner in too much detailed analysis.

2.3. The questionnaire also attempted to find out what constraints there were on increasing smallwood harvesting. Thus it asked whether harvesting was being foregone because of lack of market, because of stands on steep terrain, or because of silviculture policy.

3. RESULTS

3.1 Coverage of Survey

Forest owners responding to the survey held 766,000 ha of established plantation forest at 31 March 1980. It is estimated that the total N.Z. exotic forest estate at that time was 816,000 ha. Therefore, the coverage of the survey is some 94% of the total possible forest area. This coverage is so close to the total possible that no adjustment has been made to the survey results. They therefore, represent a slightly conservative estimate of industry's intentions.

3.2 Quantity of Smallwood to be Harvested

The survey results are summarised in Figure 1. The total quantity of smallwood to be harvested remains reasonably constant over the next 10 years.

3.2.1 Logging Residues

The quantity of logging residue which, if it is intended to be harvested, is less than 1% of the total smallwood to be harveste and it will all be extracted by ground skidding methods. According to an analysis of residue availability, this represents less than 10% of the potentially available residue. (See Figure 2.)

Annual quantity of Smallwood to be harvested - m3		Time Period 1980	1981-85	1986-90	
	Thinning	60,000	99,000	121,500	Cables
		1061,000	1352,000	1098,000	Skidders
	Clearfell small trees	25,500	36,500	124,500	Cables
		765,500	771,500	591,500	Skidders
	Second phase or residue	-	-	-	Cables
		15,500	20,500	20,500	Skidders
	TOTAL	1,927,500	2,279,500	1,956,000	

Figure 1. Survey Results

Operation	Skidwaste m^3/ha	Cutover waste m^3/ha	Total waste m^3/ha
Radiata pine clearfell	4	29	33
Radiata pine thinning	1	5	6
Other species clearfell	5	16	21

Source: The originator of this survey does not wish to be identified. From the National Planning Model it is estimated that 7 to 10 thousand hectares of radiata pine will be clearfelled per year during the period 1980-1990.

Figure 2. Available Logging Residues

3.2.2 Clearfelling small trees
There is a steady volume of between 700,000 and 800,000 cubic metres per year to be harvested over the next decade. Initially the bulk of this is from stands of unthrifty species. In the latter part of the period there is an increasing contribution from clearfelling young stands of radiata pine. An important feature of this resource is the increase over the deca in cable logging methods, with a corresponding decline in the use of ground skidding methods.

3.2.3 Thinning
Estimated volumes from thinning operations are slightly higher in the early part of the decade than in the latter part. As with clearfelling small trees there is an increase,(although less dramatic), in the volume to be logged by cable methods. Thinning operations will make the major contribution to smallwood volumes (60% of the total).

3.3 Constraints on Smallwood Harvesting
Lack of markets was rarely given as a reason for foregoing smallwood harvesting operations. (The alternatives were to thin to waste or crush unthrifty stands.) Owning stands on steep terrain was the main reason given, with silvicultural policy preventing extraction thinning being a moderately common response.

4. DISCUSSION

The following points arising from this survey are worth further elaboration:

4.1 The National Planning Model estimates total roundwood removals over the next decade, of 8.6 million cubic metres per year. From this survey the average volume of smallwood will be 2.1m.cubic metres per year, or 24% of the total. However, if the cost of harvesting N.Z.'s timber resource is considered, the proportion which must be spent on smallwood further emphasises its importance. Calculating smallwood at twice the logging cost of larger timber (a conservative estimate), the smallwood share of total logging costs rises to 39%.

4.2 The production rate of motor-manual smallwood logging systems varies between thinning and clearfelling, and with tree size - but would not average more than 100 cubic metres per day, or 23,000 cubic metres per year. Cable logging thinning operations would achieve no more than half of this. Thus, relatively minor variations in volume available for harvesting can mean significant changes in the number of logging crews required.

4.3 Although the total volume to be harvested remains relatively constant, the proportion to be logged with cable systems increases considerably, for both thinning and clearfelling. Thus, this survey has further emphasised the importance of cable logging methods. It is interesting to note that steep terrain in a major constraint on further smallwood harvesting.

4.4 Industrial users were not specifically asked what plans they had for expanding smallwood intake. However, from information in trade magazines and national newspapers this year, a shortage of wood resource is holding back further expansion. As an example, the Chinese recently expressed interest in a jointly owned pulpmill in N.Z. - but there is little hope that the wood will be available.

SESSION 2
PAPER (c)

SILVICULTURAL INFLUENCES IN SMALLWOOD HARVESTING

or "WHO WAGS WHAT?"

W.D.SEWELL
Tahorakuri Superintendent
N.Z.Forest Products Limited

Introduction

The main influence of silviculture on smallwood harvesting is in relation to production thinning operations. The object of this paper is to emphasize that production thinning, in addition to being the first of the logging operations in the crop's life, is also the last of the silvicultural operations - that is, it is a tending operation, the main objective of which is to improve the quality of the crop, and maintain forest health.

Silvicultural Characteristics of *P.radiata*

P.radiata is the major species involved in current production thinning operations. Radiata grown on the pumice plateau has a number of characteristics which have a strong influence on the regimes and thinning systems practiced. Outside of the pumice-lands, some of these characteristics become less important but in general they still apply.

1. Growth rate

   P.radiata is a very vigorous species with growth rates as high as any softwood species in the world. Peak annual growth rates occur relatively early in the stand's life. (fig. 1)

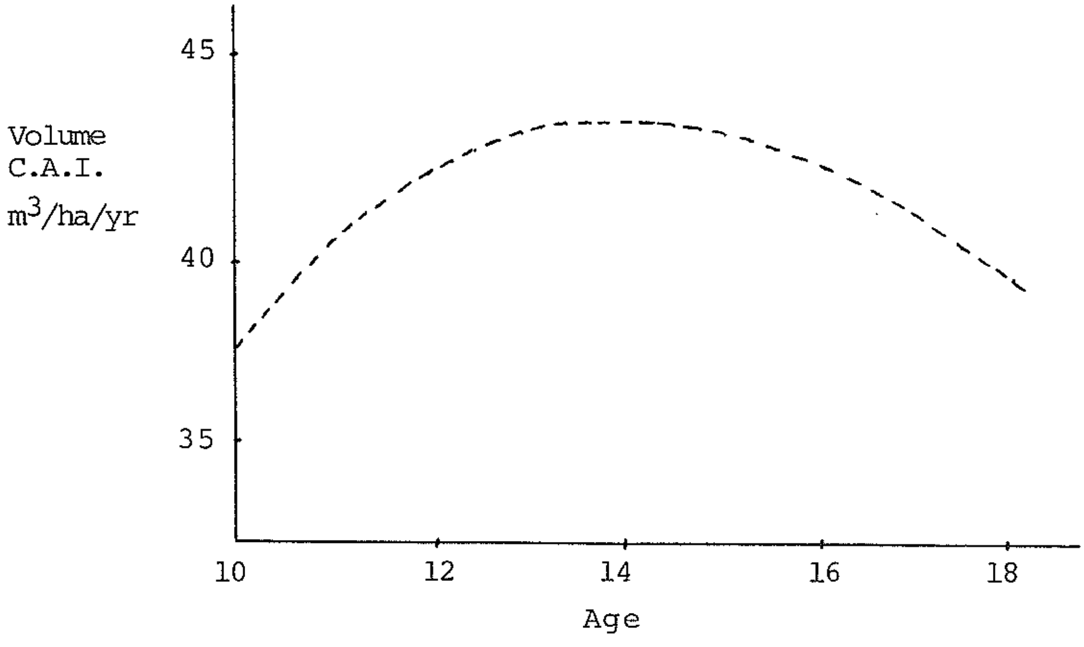


Fig. 1

Volume Current Annual Increment

With higher quality sites and with higher stocking levels the peak will be earlier and higher than for lower quality sites or lower stockings, but the general curve still pertains. Peak basal area growth occurs before peak volume growth.

2. Light demanding character

   Radiata is a strong light demanding species. In stands planted at the common stocking levels of 1500-2000 s/ha, crown closure will occur after 5 to 8 years, after which time interstem competition increases rapidly. The result is an early establishment of distinct dominance classes within the stand with the stronger trees suppressing out the less vigorous neighbours. The degree of intertree competition is dependent on site quality and is greatest on the higher site areas. The origin of the stand will also influence the degree of variation in the diameter distribution, and is usually greater in naturally regenerated stands than in planted areas.

3. Malformation

   Radiata is characterised by a high level of malformation and again this varies with site quality. In general the higher the site quality, the greater the degree of malformation. In stands grown from non-selected seed less than 15% of the crop may be straight and defect free. Increased use of seed orchard stock will result in decreased levels of malformation and a more uniform crop but in many of the stands to be thinned in the next decade we can still expect a high proportion of trees with kinks, heavy laterals, double leaders, or gross branching habit.

Silvicultural Implications

These characteristics of *P.radiata* have a number of implications in the management of the species.

1. Thinning is required to maintain forest health. If a high quality stand is left unthinned then mortality will begin by about age 10 and will continue for the next 20-25 years until stocking stabilises at between 300 and 400 s/ha. During this period nett basal area growth is often zero with live basal area plateauing at about 55-60 m^2/ha.

2. Thinning is required to achieve maximum volume production from the stand. Table 1 shows the volume production predicted by one growth model for two production thinning regimes compared to an unthinned regime.

Table 1

Regime	Age 25 Clearfall	Age 30 Clearfall	Age 35 Clearfall
	Total Volume Production as a Percentage Volume Production of an Unthinned Regim		
(a) Unthinned	100	100	100
(b) One thinning 1700/350 s/ha Age 11	104	118	130
(c) Two thinning 1700/600 s/ha Age 12 and /350 s/ha Age 18	108	121	130

3. *P.radiata* will respond rapidly to thinning.

   (a) Response will be greatest when the thinning is carried out early in the stand's life (near the peak Current Annual Increment - C.A.I.)

   (b) Individual tree response is less once the tree has become suppressed. Intermediate and codominant trees will take far longer to respond to a thinning than dominant trees, and hence the emphasis in thinning should be to minimise both the removal of dominants and the retention of trees already suffering from competition.

   (c) Thinning must therefore be "on time" in order to maximise the response. The higher the site quality and the denser the standing stocking, the earlier the thinning should be carried out.

4. The timing and intensity of thinning will also depend on the objectives of management. Heavy early thinning will result in some loss in total production compared to lighter more frequent thinnings, but will also result in an increased growth on the residual trees. The more intensive thinning regimes are usually practised on pruned stands in order to maximise the production of clear wood on the final crop. In selectively pruned stands, thinning must also be early in order to decrease the competition between the pruned and unpruned element of the crop.

5. Heavy early thinning will result in increased branch growth. Without pruning, branch growth can be controlled by decreasing the intensity and increasing the age of the thinning operations, but at a cost in diameter growth.

6. Damage to the residual crop should be avoided at thinning. Although *P.radiata* has a high ability to produce resin to protect damaged areas, and to occlude over damage scars, removal of bark can only result in a degrade in the product from the residual trees. It is especially important in

pruned areas and where veneer is being produced.

7. Wind damage following production thinning will be increased by:

   (a) Delaying the age of thinning

   (b) Increasing the intensity of thinning

   (c) Non removal of malforms. Although not all malforms are lost if retained at thinning the chances of windthrow are 3-4 times greater than with dominant well formed stems.

Implications for Logging

Production thinning will inevitably result in some conflict between the silvicultural and logging objectives. Some of the stand factors which will affect logging production levels, and therefore the cost of the logging operation are:

- The volume per hectare to be removed
- The stems per hectare to be removed
- The residual stocking remaining
- The piece size of the thinnings
- The topography of the stand.

The relative importance of these factors will vary depending on the type of logging operation

(a) Tree length extraction. Productivity is directly proportional to piece size being extracted. Productivity is similar over a wide range of volumes per hectare and stems per hectare extracted, but residual stocking will affect productivity where extraction speeds are reduced to prevent damage to the residuals. Topography has an effect but tree length extraction will be possible over a wider range of topography than with other systems.

(b) Log length extraction (e.g. using forwarders) is not used in New Zealand but is common overseas. Piece size becomes relatively less important, with the number of pieces and volume per hectare, the topography, and the stand access becoming more important. Forwarder systems require a higher degree of neutral thinning.

(c) Productivity of shortwood extraction systems is dependent much more on:

   - The volume per hectare and number of trees to be removed, which will have a strong influence on the productivity of the individual cutters.
   - Piece size is important but to a lesser extent than with tree length extraction, and piece size can even

be unacceptably large for manual moving of the smallwood billets.

- Shortwood extraction can be carried out in stands thinned to a much higher residual stocking than with other systems, especially in operations where neutral thinning (e.g. with outrows) is not practised.
- Topography will influence smallwood extraction more than long length systems.

The Compromise between the Silvicultural and Logging Objectives

The conflict between the logging and silvicultural objectives of production thinning will usually result in some form of compromise, with varying movements towards either the logging or silvicultural points of view - hence the subtitle of my paper - "who wags what?" There are varying ways that this compromise has been achieved.

(a) Alteration in the timing of the operation. Delaying in thinning age will have a large effect on productivity of the logging operation, especially for early thinning operations near the peak of the C.A.I. when the percentage increase in standing volume in one year's growth is very high. However, this is also the period when the silvicultural objective is to maximise growth on the crop trees, and the emphasis must therefore be for thinning on time. This is especially true for highly stocked stands.

(b) Altering the intensity of thinning. For thinning at a given age, altering the intensity of thinning will again mainly affect the productivity of the early thinning operations, especially shortwood systems where volume per hectare is an important variable. However, the selected intensity is again a compromise between the logging cost and the requirement for optimum growth. Over thinning will result in the site being underutilised with consequent reduction in volume production over the rotation.

(c) Adoption of more neutral thinning systems. Neutral thinning involves the automatic removal of some portion of the crop, either without any selection (line thinning) or with selection in the remaining crop (outrow thinning plus selection). Neutral thinning allows easier access to the stand and results in some increases in the logging productivity through increased volume available and a greater piece size extracted. It is strongly advocated in Australia, especially where mechanised thinning systems are practised. There have been many studies on the effect of neutral thinning on the residual stand, but the real effects are still unclear. In general:

(i) Neutral thinning will result in some drop in total production from the stand. The degree of loss of production will depend on:

- the proportion of the stand removed neutrally. Increased intensity of outrows will result in greater production losses. In Australia the tendency has been to accept the decreased production and to narrow the distance between outrows in order to facilitate more mechanised operations. In Sweden, however, where there is a need to maximise production from the stands currently being thinned, the trend is to reduce the amounts of neutral thinning by increasing outrow distance.
- the age of the thinning. At older ages the codominants remaining have less ability to respond. The loss can be minimised by thinning as close to the peak C.A.I. as possible.
- the site index. Earlier establishment of distinct dominance classes on better sites again results in a reduction of the ability of residual codominants to respond.

(ii) Damage to the residual stand is generally lower with neutral thinning.

(iii) Windthrow risk can be increased through neutral thinning.

(iv) Neutral thinning is generally only applicable on very easy topography, unless the stand has been planted at right angles to the contour. If not, neutral thinning will involve removal of corridors with greater potential for over removal of dominant crop trees.

(v) Neutral thinning is less applicable in regenerated stands because the crop is generally more variable both in spacial distribution and in size.

(vi) Neutral thinning of pruned stands is unacceptable because of the loss of pruning investment.

In summary, neutral thinning is only applicable in New Zealand conditions in unpruned stands with a highly stocked even crop (preferably planted with seed orchard stock). The thinning must be early and on time.

(d) Early manipulation of the crop to improve Logging production. Because of the ability of *P.radiata* to respond to a wide range of silvicultural practices, there is opportunity for some early manipulation of the crop for later gains in logging productivity with little loss in production or growth of crop trees. The main opportunities are at planting, and in young crops well before production thinning.

(i) At planting.

1. Increase in planting spacing can result in increased piece sizes at time of thinning, with little drop in total production. However, branch sizes will inevitably be larger and decreased stockings at planting could only be possible through use of seed orchard stock. Especially on the more malformation prone higher site areas, the need for sufficient trees to select a dominant, non-malformed final crop will still be present.

2. Alteration of the planting spacing to suit future logging has been advocated, but the history of success is not good, mainly because the manager is trying to predict the extraction system which will be used in 10-15 years.

(ii) In young stands.

Probably the greatest potential for increased logging productivity is by manipulation of the stand after planting, i.e. regimes combining waste thinning and production thinning. The opportunity is greatest for tree length operations where piece size is a very important variable. Waste thinning allows the removal of the slower growing and malformed trees, which lower logging production if present at the time of thinning. Additional gains can be made if waste thinning allows delayed production thinning operations because of decreased inter-tree competition. The intensity of the waste thinning is critical: if too great then the volumes available for production thinning will be below acceptable levels (especially with shortwood systems); if too low then the objective of removing the smaller suppressed trees and concentrating growth on the dominants and codominants will not be met.

Conclusions

Production thinning of *Pinus radiata* is a silvicultural operation required to maintain forest growth and forest health, and is a means of obtaining utilisable volume early in the crop's life. This paper assumes the perfect world where a market for smallwood and the manpower required for the job are available, and in such a situation production thinning at the right age and right intensity to meet silvicultural objectives is desirable. Some compromise is required, and because of the growth characteristics of *P.radiata*, opportunity exists for manipulation of young stands in order to improve productivity in logging operations. However, because of the rapid growth rate and high malformation levels in high site quality *P.radiata* stands, the requirement is for selection thinning, on time, with retention of the dominant crop trees, in order to best meet the silvicultural objectives of managing these stands in New Zealand.

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- SESSION 3 -

EXPERIENCE WITH SMALLWOOD HARVESTING DEVELOPMENTS

Chairman: Jim Spiers, LIRA.

In this session we aim to have the practical people cover some of the history of development of smallwood logging. They will cover what has been tried, what is being used, the advantages and disadvantages of various approaches, and the reasons for making changes in smallwood harvesting systems. They will cover from motor-manual systems through to fully mechanised systems.

Individual contributions from:

TONY RUSSELL	*JIM MATHEWS*
PAT CLARKIN	*DENNIS NEILSON*
JIM SHORT	*BRIAN COCHRANE*
ALBIE PORTEOUS	*BRYCE HEARD*
NELSON PRITCHARD	*BILL SEWELL*

The following papers were also presented in this session:

"EXPERIENCE FROM THE FOREST RESEARCH INSTITUTE"
A.TWADDLE, C.J.TERLESK, & M.McCONCHIE. Presented by A. Twaddle, Forest Research Institute.

"SOME APSECTS OF MECHANICAL HARVESTING IN QUEENSLAND'S SLASH PINE PLANTATIONS"
A.V.WILLIAMS, Manager Logging Division, Woodlands Limited, Australia.

"THE EVOLUTION OF HARVESTING METHODS TO THIN PINE PLANTATIONS IN N.S.W."
C.HUMPHREYS, Australian Newsprint Mills Ltd., Australia.

TONY RUSSELL - WOODHILL FOREST

I will only cover the experience of Woodhill Forest. Woodhill is a sand forest in the Kumeu working circle just on the outskirts of Auckland. Smallwood there is produced from first thinnings, both for chipwood to supply Carters operations or for particle board and post production. Historically, both post production and the chipwood production fluctuate a great deal. Thus the operations are based around a flexible system that allows production of either posts or chipwood from the one operation, and for the quantity of posts or chipwood to be altered almost on a daily basis at times.

The stand we are working in was planted at 1800 stems per hectare. At the time of thinning (at 15-17 metres), the total stocking is around 1100 stems per hectare and is being reduced to 370. It must be thinned on time because of the wind damage. We get a lot of breakage if it is not thinned before it gets to the 17m level, and in the past we have by-passed stands that have reached 17m. We are removing between 60 and 100 metres per hectare with a tree size from around 0.09 to 0.14 cubic metres. Tree form is very very good compared with the Bay of Plenty, and branch size is quite small.

The logging methods currently used are traditional shortwood operations. Trees are felled, trimmed, stacked in the bush, with segregation into chipwood and post lengths. Extraction is with a skidder, in bundle loads. If it is post material, it is peeled on the skids, while chipwood is taken to the plant in conventional shorts trucks. Long length operations have been tried but productivity was considerably lower because of the very small tree size. We were unable to accumulate sufficient trees to get an economic use of the skidders being used in the operation. Conventional skidders are used. Farm tractors were dabbled with in the very early days but have not been used in an operational situation because there is insufficient traction in the sand for 2-wheel drive machines. Therefore the operators started out with 4-wheel drive skidders, Tree Farmer C4's and Clark 666's. There is possibly room to be able to try the current 4-wheel drive agricultural tractors in the stand, but nobody has experience with this at the present stage.

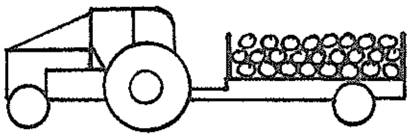
Production rates: Cutters are producing around 7-8 tonnes per day, and a skidder can extract 100 tonnes per day from that operation. With long lengths the skidders were down into the 40-50 tonnes per day bracket, because of the reasons given before.

JIM MATHEWS - LOGGING CONTRACTOR

Barry O'Neil and myself formed a partnership in the early sixties to cut and haul shortwood for N.Z. Forest Products Limited. We started the operation with a Fergusson 35 and a Fergy-type trailer fitted with a hydraulic hoist using the tractor hydraulics.

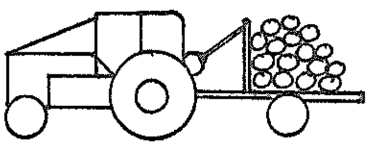
Method: Cut tracks ahead of the unit and thinned the forest in the vicinity, hand loaded produce and drove unit to mill site and unloaded into the pit. Distance from the bush to the mill was 2½ miles. Average was 10 tonne a day while using this scheme.

Added a D2 crawler with a bull blade and winch, and flat dragged logs to the landings, where the logs were cut into lengths and loaded onto the trailer.



We went our separate ways shortly after this in 1962, Barry first crop logging and I stayed with the shortwood. I fitted a winch behind the Fergy and added a two-wheel trailer.

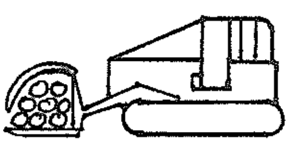
Method: Backed trailer up to stacks of shortwood (about a ton), dropped trailer frame, and ran the rope over the frame under the stack and C-hooked to itself. When winched the load would slide up the frame and drop down. Load was then taken to roadside and stockpiled.

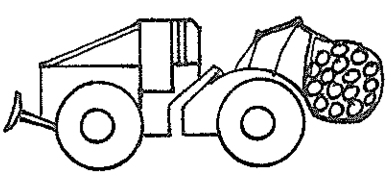


Progressed quickly in 1963 to a BTD6 Drott to which I fitted a pulp grapple of my own design.

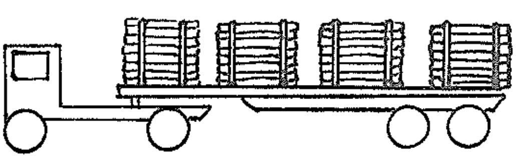
Method: Cutters formed stacks of about 3/4 of a tonne in the forest, and the Drott picked them up in the grapple and hauled them to the roadside. They were either loaded straight onto the truck or stockpiled.

Soon after I bought a S7B International skidder and piggy-backed the stacks to the roadside and stockpiled so as the Drott could load. The skidder did the long hauling and the Drott the stacks handy to the roads. This method was very successful - 72 tonnes a day over a long period of several years.





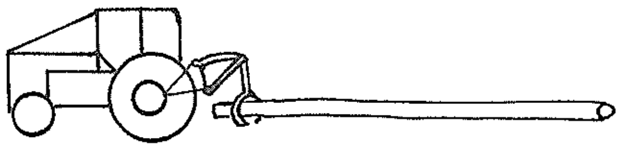
About this time transport of produce to the mill had become a problem, so I bought a short wheel base truck and made and developed a semi-trailer with bays, so as the wood could be loaded from the side. At the mill the unit drove alongside a pit, the truck heeling slightly, then the 8 staunchons were tripped hydraulically and the 18 ton load slid off, unloading in 3-4 minutes. This method is still in use today at NZFP.



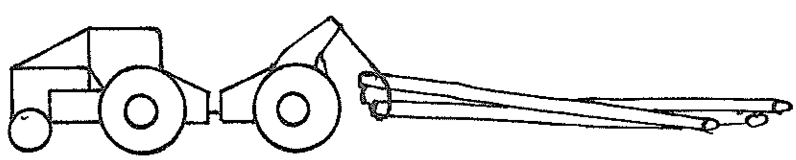
Procured a logging contract with N.Z. Forest Service in 1967, part of which was to develop a system of felling and extracting 9-10 year old radiata thinnings on the Kaingaroa Plains.

Method: In this operation the first method tried was using farm tractors, flat dragging using the drawbar and strops. I would say it was an improvement on the horse, but only just! Logs were stockpiled by a David Taylor loader with log forks. I then designed and developed a log grapple that fitted to the three point linkage of the farm tractors. This worked well but I found that the operators would not persevere.

Method: Pick up log and travel over 2 or 3 logs, release and re-grapple. In the right hands I believe this was a great improvement on the first method.



In 1972 came the mini-skidder. Using a David Brown farm tractor I removed the front wheels and fitted the rest to the skidder frame. I added a hydraulic winch, 6-7 thousand lb line pull, which proved adequate. This machine when finished, looks just like any other skidder except that it was two-wheel drive. I did develop a four-wheel drive but the cost was too great. The mini could handle undulating country very well (it was not intended for hills) and production was around 30-32 tonne a day, with 1 man felling and 1 driving.



I took a contract with Pan Pacs in 1974 on the Rangitaiki Plains to fell, haul and stockpile Ponderosa pine, piece size 7 c.ft. I had 8 minis and one Timberjack skidder along with a Yale loader fitted with a log grapple. Using a 2 man gang we averaged over 30 ton a day.

At one time I had 16 gangs of my own plus 7 outside loggers. They used several different makes of skidders but never could match the production of the minis. The best of the outsiders was the average for the minis. I believe that the minis, with further improvements, have a place in the logging scene, on the country it was designed for. Its initial cost and running costs made this my most profitable skidder. Looking back, I would say that of all the things I have developed the Drott Grapple, the shortwood side-loading trailer, and the mini skidder were my most successful ideas.

PAT CLARKIN - CONTRACTOR FOR N.Z. FOREST PRODUCTS LTD

I have been involved in shortwood operations for about 20 years with N.Z. Forest Products Limited, and we initially started off logging wood with HD6's, HD5's, and TD9's, extracting and cutting it up on the skids into short lengths. Loading was done by winching onto backs of trucks. It was a complete operation with five men: one bushman, one tractor driver, two on the skids and one truck driver. Production levels were about 60 tonne a day. It was quite big wood, about 18 years old. That was in 1959/60. In 1963 Jim Mathews came along with a Drott with forks on and we tried them in the bush, getting away from the bigger tractors and working with tighter marking. We extracted with the Drotts, stacked it at the roadside and loaded trucks as they came. The cartage was a different contract. We had eight men in the bush and one on the tractor, for about the same production levels. We started with skidders in about 1968 and production then went up to levels of 90-100 tonne.

In the middle 70's we were having trouble with labour because the bush had been slasher thinned and there was not the quantity in the bush as far as cutters were concerned. We were also getting a lot more blackberry undergrowth, and getting into areas that were all young second crop, so there were rotten logs on the ground that the men had to cope with. It became quite a hassle with labour so I decided there must be some other way to make it easier. I had intentions of mechanising the whole job and went to a lot of trouble trying to come up with an idea of a feller-buncher-delimber, but finally came to the conclusion that you couldn't get the production level to warrant it. I therefore went ahead and built a forwarder on a skidder so we could move around the bush. It was possible to manoeuvre in the stand with our forwarder built on the skidder whereas if we purchased a conventional forwarder we couldn't get that manoeuvrability in the thinnings unless we went strictly to line thinning. This was against Forest Products intentions - as much as I did try to get them to do it.

The forwarder had a lot of advantages for the men as they didn't have to carry their wood to make stacks, they just made little stacks wherever there was timber. If there was only one tree there they could cut that one tree and leave it. It also eliminated the man on the ground stropping up. It gave me the only thing that I was happy with: wood going over the weigh-bridge every day of the week instead of having stockpiles of 1500-2000 tonne on the skids. It has been very successful as far as the men are concerned in the respect that I reckon I have all the best cutters: they've left the other gangs to come to us because the conditions for the men are better.

It is only successful in that it is a complete system. The forwarder would be of no use unless the whole system was geared up to load out and get rid of your wood immediately. If you are going to extract and put it on the ground you may as well stick to conventional skidders. We've found that with the forwarder we've averaged about 75 tonne per day extracting and loading, against an average of about 93 tonne a day with one conventional skidder, and then you have to wait for someone else to come along and load it out. It has drawbacks. Going back to what was said earlier on about operators, it's hard to get good men on machines like that. They are harder to operate, and on our machine visability is bad. We made a few mistakes when we designed it but in two years we haven't had any major mechanical trouble with the base machine. We have had some trouble with the Cranab because we got one that was underpowered initially but it is still operating. In two years the only downtime the machine has had was about two weeks when we had to manufacture à part for the crane. It has advantages to the Company in that they don't have to put big dumps in anywhere for us. We can just go to the road and load directly on the road.

Generally speaking, I'd say I am happy with the forwarder. It might not suit every operation - the places that I could see they could be used would maybe something like the East Taupo forest where they would be a big advantage - providing the piece size and the end use fitted into the trucking set-up. That is where forwarders are limited, in respect of the area of use, as the forwarder can only handle wood within a certain length.

DENNIS NEILSON - TASMAN'S FORESTS

Smallwood harvesting in Tasman's forests commenced in the early 1970's when a variety of stands were production thinned for posts. In the mid-1970's, a pulpwood thinning operation was initiated in fourteen year old stands of radiata in Tarawera Forest. This operation was required as part of a two thinning regime adopted by Tasman in Tarawera for some years and continues to provide an important yield of logs for groundwood pulp into the mill.

Thinning is restricted to flat to rolling country (0-10^{o}) for economic and physical reasons (machines are traction-limited in the scoria soils of the region much above these slopes). Ridge tracks are used to log small hills. Contour tracks have been tried but production on slopes tends to be uneconomic.

At one stage a Bobcat feller-buncher and C7 grapple skidder were tried. Although the system worked well, and costs were reasonable, the operator comfort was poor and this idea was not pursued. This year 60-70,000 tonnes of pulpwood will be produced from this thinning from 700 hectares of 12 year old radiata. Six logging contractors, each with 70 - 90 h.p. skidder (Clarke 664 or John Deere 440c), and four to five men and producing 45-50 tonnes per day, are required to complete the programme. The average extracted piece size is 0.20 to 0.25 tonnes, and the yield is approximately 100 tonnes per hectare.

Logging plans are designed to provide an average haul distance generally not more than 150 to 170 metres, with a maximum of 2% of forest area lost to roads and skids.

An experimental Lotus Hauler spent three months in Tarawera last year thinning 13 year old stands with a similar piece size and stocking to the stands described. However, production averaged less than 20 tonnes per day and was uneconomic.

A Timbermaster Hauler was used recently to thin 17 to 18 year old stands of similar stocking but with an extracted piece size of 0.35 to 0.4 tonnes. The trial was a success, with a production rate exceeding 40 tonnes per day with a six man crew. However, the delayed thinning is undesirable from a silvicultural point of view and there is not enough suitable area available in Tarawera to justify the purchase of a machine.

In 1979 thinning of 9 year old stands was initiated. Thinning is from 2000 to 400 stems per hectare, with average piece sizes of 0.12 to 9.15 tonnes, and a yield of 75 tonnes of pulpwood (or 50-60 tonnes of posts) per hectare. The 1980 target is 40,000 tonnes of pulpwood and 15-20,000 tonnes of posts.

Pulpwood (in both 12 year old and 9 year old thinnings) is cut to random lengths (3.7 to 5.6 metres and 11.2 metres) to fit mill requirements.

Five crews are presently thinning 9 year old stands for pulpwood, four using 70 to 90 h.p. skidders with four men and one using a 60 h.p. Zetor tractor modified for bush work. Targets of 35 to 38 tonnes have been set for the skidder operations and 32 to 35 tonnes for the tractor. It would appear that the skidder targets are reasonable, in fact may be conservative, whilst the tractor target may be too high. However, more experience is necessary to confirm this.

It is intended to install an Igland 5000 H double drum winch to a John Deere 440 C skidder in an effort to increase productivity in the 9 year old pulp thinning operation. A seven percent gain in productivity is anticipated.

There is a large area of steep country in Tarawera that is currently being thinned to waste. We are seriously re-looking at using this in a shortwood operation - but at the moment the mill can't handle shortwood. Regarding mechanised systems, while we continue to evaluate them, we are aware that in the mid 1980's there will be a big expansion in clear fall logging. It would be foolish to let our current pool of skilled labour go in the meantime through the introduction of a mechanised system.

JIM SHORT - NELSON PINE FORESTS LTD

Nelson Pine Forests have been involved in the harvesting of minor species (or as our contractors call them, noxious weeds) since 1969. We originally started with Morito and small Dispatch haulers (two drum). At that time the management saw fit to pick out the largest wood, which of course left us with the rubbish later on. At that time the Moritos and Dispatchs were doing quite well, at probably three loads a day. Ralph Robinson from the Forest Service helped us out at that time by setting up standing skylines and that lifted the production to five loads a day.

On the loading we had multi-bolster trucking units which were bad news: high tare weight, very hard loading, and also we had Hough 50 and Hough 90 loaders which were not suitable.

We moved from there to the tracked machines. They did not last very long in the minor species once the larger trees had disappeared because they just don't have the turn-round speed. The 664's and 666 skidders came in then. The 664 was doing quite well along with a Ford County tractor. The areas had to be picked out for these machines, on the flat country. The 666's were left with the harder areas and this caused some dissatisfaction among the contractors so we lost the Ford County. I think we would probably still work some of those machines and I am pleased to see N.Z. Forest Products move into machines like the Zetor.

Originally in the skidder gangs we had four men, two men in the bush and one operator and one on the skid. So if the logs weren't properly trimmed in the bush they were finished on the skid and left you with far too much slash lying around. This slash was subsequently loaded onto the truck and sent to the chip mill. Although we had a hydraulic debarker it gives problems when there is too much slash in among the logs.

BRIAN COCHRANE and JOHN RAMSEY - Spoken for by JIM SPIERS

Brian Cochrane working for Kaingaroa Logging Company probably developed the first fully mechanised Logging system in New Zealand. Brian's system was based on an Hitachi UH07 Excavator fitted with a Vulcan felling head, a towed chain-flail delimber, and a forwarder which was basically a Komatsu tractor with forks. He worked in Ponderosa pine in Kaingaroa Forest, working to a Morbark Chip Harvestor. Everybody learnt a lot from the system: it was highly productive, but the system had to be well managed and more importantly the wood had to be taken away from it. It had a tremendous capacity and of course represented a tremendous investment. It is probably very important that when you get into mechanised logging you should use that eqipment to its full capability to reduce the overhead costs from the large investment. One of the interesting things that Brian did was to take his wood to the roadside using the front-end loader as a type of forwarder. He figured that this was particularly productive, as he averaged 12 logs per movement with his Komatsu compared with about 5.2 for a C8 grapple skidder, which was his other alternative. So that was a fairly productive type of operation but limited to easy terrain. One of the other important things about a highly mechanised system is that it must work as a complete system.

There is no doubt that a mechanised felling machine can greatly outproduce a motor-manual system but there isn't much advantage in that unless you can capitalise on it at the next stage, which brings me to the other operator.

John Ramsey first tried the Bobcat feller-buncher which Dennis Neilson mentioned, and then he went to a Hitachi UH07 and followed it up with a UH09. He certainly improved his ability to fell trees but the great gains were in the next stage of the system. He assembled logs that he had felled to make the next stage of the system very much easier, thus he got his gains in higher productivity in extraction. When he was extracting full tree lengths he stacked three or four trees with the butts together so that you could put one strop around three or four butts and take off to the landing. When he first started off he was working a shortwood system which was basically aiming at producing posts. In that case the feller-buncher laid the material down in such a way that the men who were cutting posts in the field reduced their walking distance with posts to assemble stacks for skidder extraction. Those were the gains from that system.

ALBIE PORTEOUS - CARTER OJI KOKUSAKU PAN PACIFIC LTD

We went into the Ponderosa just as Jim Mathews was leaving. He sold some of the machines to the men that were working as contractors for us. At that time the demand for pulp from Ponderosa was very high and in 1975, mainly through the shortage of men for the contractors and also suitable machines, we decided to go into mechanical harvesting. We decided to buy a Drott feller buncher, a Hydroaxe chain flail delimber and two 667 grapple skidders. So that we would have no holdups with loading, we also purchased a Fiat Allis 745 loader. A mistake we made was to change from the Hydroaxe, buy a Vulcan delimbing head (chain flail type) and mount it on a second hand 666. This machine, all during the operations gave us problems. One of the biggest things was that it didn't have a hydrostatic drive and you either rushed over the logs or you slowed right down. We also had quite a lot of engine troubles with it. We had a reasonably good run as far as the Drott went: it could fall up to 200-250 tonnes a day reasonably easily even in the small stem volumes. The flail could keep up with the Drott but it did give us problems with leaving limbs on, to an extent that we had to put an extra man on the skids to take these limbs off. It also gave a lot of troubles with hydraulics: we couldn't get them very compatible and we burnt out a couple of hydraulic motors. A lot of this was through dirt and I think there are many here who would agree that in the bush, if you blow a hose you lose a drum of oil and there is a lot of dirt that gets in. In the last year that we were operating this system we produced 176 tonnes per day. That was loaded out on truck and takes into account the time that the mill was broken down.

When we re-looked at it close to the end of last year, we found that our costs had actually risen by 40% and even with the high productivity this cost was extremely high. Skidders never gave us any problems at all. Each was set up properly and the grapple suited the machines. We put big tyres on them, made comfort for the drivers by putting cabs on and heaters in. Actually, the man never had to step out of the machine from the time he started in the morning till he finished at night. On the Drott and flail it was set up the same. We did have a lot of breakdowns with hoses and metal fatigue in the chains. We tried all types of chains: the normal chain high-tensile first, getting from 5 to 20 hours out of those. In the latter part we were able to get a round link chain from Germany that extended the time from 100-150 operational hours. This was a great benefit because it took at least an hour to change all your chains, which wasn't too bad in the day shift, but was a problem at night.

It was a two shift operation, the Drott and the flail worked together at night and during the day we worked all the machines.

The daytime utilisation was lower than it was a night, mainly because the main maintenance was being done in the daytime as we had problems getting the mechanic to come out at night. Also, we looked for an operator who was a bit scared in the dark - he used to keep the lights on and work all the time because he was frightened to leave the machine, so that helped a lot.

During that time we also tried other delimbing techniques. We made up a gate and tried poking the logs through the squares. It worked quite well for the first few runs but as the slash built up we had to spend a lot of time clearing. We also made a thing we called "jaws". A plate was cut out and we put great cuts in it. Well, that worked quite well but we had problems holding it in place and with slash. We spent only a couple of hundred dollars and then we abandoned the idea.

Well, the main reason that we gave up the mechanical harvesting as I said right from the start, was money. We found costs were up by 40%. At that time there were plenty of men available and we had continuous requests for contracts. When we actually stopped the operation, four of our men who were working on the machines took on the contracts, bought themselves small machines and they have so far done extremely well.

BRYCE HEARD - KAINGAROA LOGGING CO LTD

Reasons for getting into Mechanisation:

(i) Large volumes of corsican, ponderosa, contorta in new sales.

(ii) Doubts about labour availability.

(iii) Limited ability of wood preparation at the mill to debark.

Machines Purchased (1972-76)

1. (A) Q.M. tree shears mounted on a D6 trailer. These have a 26" diameter limit. They were cutting B.C. ponderosa for a processor at a rate of 100 trees plus per hour. The shears moved later to radiata for clear felling, working at a rate of 60 trees per hour, or 800 m^3/day. The main problems were shears bending and hydraulics overheating.

(B) C6 grapple skidders were used to pull trees from the shears to the processors. The main problem was low availability of grapples and hydraulic rams.

(C) Can Car tree processors (100 h.p.), were used to delimb and crosscut trees. They had a 16 inch (40 cm) diameter limit, 16 foot (4.8 m) length limit. Their operating principle was hydraulic knives and a guillotine. Their capacity was 35 trees /hour (11 t/per day). They gave average availability.

The whole system was worked on two shifts. Four skidders were required to do the job of two because of low availability. The result was high cost wood. We therefore put the shears into radiata, and the processors went on loan to contractors.

2. Morbark Chipper (1976-78):

This was introduced for the same reasons as the processors and shears. Considerable rebuilding was done structurally. It was powered by a 350 h.p. Cummins diesel engine. It had a 18 inch (45 cm) diameter opening. Whole trees were chipped. The rate of production was 200 tonne per shift or 400 t/day. The main problems were with knives (bolts on holders), the bark content of chip, the dirt content of chip, the uneven sized chips and cartage costs to mill.

The concept of mechanised systems was finally abandoned when it was found that labour was available and could do the job at a lower cost. In addition, it proved possible to process the manually produced wood at the mill.

NELSON PRITCHARD - CONTRACTOR, LAKE TAUPO FOREST

About two years ago our company got a contract with Winstone Afforestation for logging the East Taupo Forest, and as a result of that we've developed a whole new system of logging smallwood. You've heard about mechanical harvesting and its failings. We came in for considerable criticism and finger pointing when we decided to do what we are doing. At any rate, we have done it and we are stuck with it and it is now starting to show its true value. As for getting reliability with our machinery, we have got a system that is going to be there a long time.

We take out every 10th row and thin to that, using the 10th row as an extraction route with about 12 chain maximum haul. A delimber-feller-buncher is used. This grabs the tree about half way up and takes the branches off, cuts the head off, delimbs the rest of the tree, cuts the tree down and makes a bundle of approximately 8 stems, which is just over a tonne. A C8 grapple skidder moves in, picks up the bundle and takes it away. The skidder takes about 2½ minutes to do a round trip.

We have had a thousand and one problems with the first machines. On the prototype things literally fell to bits and hydraulic hoses and hydraulic oil.....well, it's amazing that we have never had a camel sent out to us by the Arabs. The third machine built has dramatically improved piping, and the cost of operating it would be a fraction of what the other two were. Training operators was a problem. As soon as you put a new man on the feller-buncher you can lose three hoses a day every day until he gets used to it. Some pick it up easily, it doesn't take them long and others just never get the hang of it. The advantages are that you need just an ordinary run-of-the mill guy to handle smallwood. As long as you can operate a machine you can operate one of these things successfully. It can be worked 24 hours a day - it doesn't get on the booze, it doesn't go to its grandmothers funeral every second day and generally has a lot of advantages. We are working not very far from Turangi and we have never had anybody from Turangi apply for a job - all our men come from Taupo. You can imagine how we would get on if we had to employ 40-50 men to take the place of the machines. We have 14 men and they produce around about 16 tonne a day per man, which is pretty hard to head off. There are four chainsaws on the job and one of those is a spare.

It is not a complete system of logging on its own because we can only go to a certain degree of steepness. Some people would like to see us go steeper than we do but if we start going on steep country it becomes uneconomical for us. We find that two or three men with a small skidder going along behind us tidying up the steeper slopes works in very well. A problem with the current operation is the high investment required - 3 delimber-feller-bunchers and 3 skidders. The ideal set up in the long term would be one man owns a feller-buncher and employs another man, and they do two shifts a day with it. Another man owns a grapple skidder and on his own he will pull 100 tonne a day comfortably. Then you need a truck with rubber-tyred loader and in that way you have 100 tonne put on the truck with a very small amount of labour. We now have three machines, and are in the process of building a fourth one. The first two were a bit light, the third one was over-designed, but the fourth one, I would say, will be just about what we want. So I think that we'll be running a system that will be around for a long time. Hopefully it will, as I'd hate to think we spent all those sleepless nights for nothing.

BILL SEWELL - SCANDINAVIAN EXPERIENCE

Some years ago the statement was made, "no hand on the saw no foot on the ground by 1980", with regard to Swedish wood harvesting. That has probably been achieved in most of the clearfelling operations in larger organisations but as everywhere, thinning operations still remain relatively labour intensive. The Swedish systems are all basically similar. They are working in regenerated stands with 2 or 3 species in them. Relatively parallel extraction rows or strip roads are cut, from which the produce is accumulated out on to truck roads and then loaded on trucks hauling to mills. The methods basically differ in the methods of felling, delimbing, bucking and the extraction. The basic system, at least when I was over there, was still the motor-manual system: That is, manual felling and bucking and carting out to the strip row, then forwarder extraction for the larger organisations, or in many of the smaller organisations (especially those associated with the farm forests) extraction using tractors and trailers. In this system strip rows are at 20 m apart.

One development that was becoming very popular when I was over there, was basically the same system of felling, delimbing and bucking in the bush to produce 3 m pulpwood or sawlogs. Extraction to the strip rows used an extended boom crane on a forwarder. Another forwarder followed along behind and extracted out to the truck road. When I was there there was a strong movement towards increasing the distance between strip rows and decreasing the amount of strip rows. The reasons are twofold: one was the damage in the rows and the second one was to decrease the portion of the forest lost to roads. One of the ways of overcoming this is to extend the distance between the rows and use a winching system. A number of them have been developed, and the original ones were a skid mounted type that could be carted around by a couple of men. A very popular type when I saw them was the one placed on an agricultural tractor with a radio controlled winch.

The next logical development is to take delimbing or bucking out of the bush. Using small winches, the trees are felled at right angles to the strip row and then hauled out full tree to the strip row. Small processors come along, remove all the branches, crosscut them and leave them for a forwarder to cart out. The original processors were the clearfelling processors which required very wide strip rows, but I understand that smaller thinning processors were being developed.

The last system in this logical progression is the fully mechanised system where there are no men on the ground. There were a number of ways they were looking at this. One of them was an extended boom crane with a felling head on it. This could reach about 10 metres into the stands and they were developing some that could reach about 15 metres in. The trees are felled and dragged out to the strip row. This was followed by a processor and then by a forwarder.

Thoughts amongst the researchers in Sweden on which way things would go or what other systems would be tried are first to combine all of the operations onto one machine. This means that one machine would fell, haul it out, process it and then probably cart it out to the truck road as well. Second was winching or crane extraction of whole trees to the strip rows for chain flail delimbing. One of the advantages of bringing out your full tree and processing it in the strip rows was that it enables all slash to be put down on that row. That is very important in Sweden because of the damage to their very shallow soils, and to the roots. The last one is winching of whole trees to the outrow and skidding the whole tree to the mill. This was put forward as an idea for achieving maximum usage of their biomass.

That covers the systems as I saw them. While I was there the motor-manual systems were still accounting for about 60% of the volume. Certainly as far as costs go, for the winching system they were estimating it as something like 20% more expensive than the motor-manual system. In fact, none of the mechanised systems were matching up, but with their climate they had to go to some sort of labour saving.

EXPERIENCES FROM THE FOREST RESEARCH INSTITUTE

C.J. TERLESK
A. TWADDLE
M. McCONCHIE

Introduction

The harvesting of smallwood has been both extensively and intensively researched since man came out of his cave seeking firewood. History shows the development from manpower to animals to the utilisation of the internal combustion engine. Now extensive research involving vast sums of money, is focussed on various combinations of manpower and horsepower to achieve acceptable cost levels for smallwood harvests. Systems have been designed - sophisticated machinery developed at great cost, however, the results have been disappointing. Inspite of all modern technology the high cost of smallwood handling remains. (1) The purpose of this seminar then must be to exchange views in a combined effort to minimise the costs of smallwood harvesting.

There is no one solution to the handling of smallwood. Smallwood harvesting will remain expensive relative to large wood harvesting. (By its very nature smallwood is difficult to aggregate into load sizes which will effectively defray the cost of the capital and labour used in the process. The more costly the elements of production become, be they labour or capital so will costs of smallwood increase.

The output arising from the inputs of capital and labour are not it appears of acceptable volume or value to the industries which rely on this type of wood supply. This must be the major reason for spending so much research effort and money on smallwood operations whose total production only amounts to 6.8% in 1986 to 3% in 2001 of the total cut. (National Planning Model). The gains from this effort must be small in the overall harvesting scene.

The significant components of production

Labour: In current motor/manual smallwood harvesting operations labour is required to fell and prepare the piece for extraction. Depending on the size of the extracted material and the size and cost of the extraction machine there are irreduceable levels of manpower required to ensure efficient use of the plant employed. (3) The balance between the cost of the labour and the cost of the plant is critical if costs are to be kept to the absolute minimum.

Sub-optimal labour input will lead to under utilisation of the plant component which in turn will lead to a production fall and a higher than necessary cost of production. Excess labour will result in a greater level of production than can be transported by the machinery employed again resulting in a higher than necessary cost.

As manpower always comes in units of one the balancing of the logging crew over a range of haul distances is technically difficult. This can and has been avoided by separating the bush and extraction phases. This approach can lead to significant productivity gains through the prevention of interference at the breaking out element. It also ensures that the optimum haul size (number of pieces) is more readily available.

Labour is relatively inexpensive in New Zealand (4) by many overseas standards and it is a general rule of the thumb that machines should not be kept waiting for wood during their cycle, i.e. the operation should be machine controlled. This situation tends towards a safer working environment.

<u>Capital</u>: In logging operations this is represented by extraction machines, sorter/stackers, powersaws and crew transport plus ancillary equipment. Crew transport will not be considered, nor will the loading and cartage phase at this juncture. Low capital options have been the general choice in the past for handling smallwood. (5) The primary reason being that small piece size wood results in low production rates and therefore attracts high costs. One option to reduce the high cost is to reduce the capital input.

At the other extreme the highly mechanised and fully mechanised systems are an attempt to largely replace the labour component with capital. (6) Initially these options were introduced to defray the cost of smallwood handling. This approach has not been as successful as originally expected both overseas and in New Zealand. Emphasis has since moved from cost savings to worker shortages, worker protection and the assurance of an even wood supply. These latter factors are important considerations but are considerably removed from the original objective. The main reason for not meeting the primary objective is the high cost of capital and the fact that both machine productivity and manpower productivity are very sensitive to piece size.

<u>Piece size</u>: The critical factor in smallwood operations in both the bush preparation and extraction phase is the size of the piece of material to be processed. See Table 1. To add to the complexity, in thinning operation the pieces are unevenly distributed over the area to be harvested. The residual crop stems which should be protected from damage further complicate the aggregation of an optimum haul size.

Load aggregation: Breaking out is the element in the extraction cycl that is primarily concerned with load aggregation. It is this segment of time where unevenly distributed pieces of wood are drawn together to form a unit load and where individual pieces of wood merge into a haul volume.

In conventional long length thinning operations the individual pieces are secured by a strop which is then attached to the main cable on the winch. In many current operations the strops are permanently attached to the main rope - introducing some inflexibility into the number of pieces to be secured and extracted. This can lead to the transport of pieces to be secured and extracted.

The cost of capital in harvesting operations is recovered by charging a daily dollar rate for the equipment and this can be further subdivided to a cost/minute. Therefore every additional minute at the breaking out site inflates the cost of the operation if pieces are not being accumulated efficiently.

Method changes have been introduced to overcome the problems associated with load aggregation in smallwood. (7) The motor manual shortwood system is a good example of this. In this approach the bushman piles the billets of wood into heaps of near optimum haul size for the extraction machine (modified skidder). The breaking out element time is kept to the minimum by pre-stropping the load. This approach embodies the two principles of optimum haul size and minimum breaking out time. In some cases the modified skidder has been replaced by a self loading forwarder.

Pre-stropping and the employment of a specialist breaker-out were essential components of many logging crews in the 1960s. Both components are now difficult to find in today's smallwood harvesting operations. Pre-stropping has been largely replaced by ring mounted strops with the machine operator doing double duty as the breaker-out. The most common explanation given for this change is the cost of the additional strops required for pre-stropping and the cost of employing labour for breaking out. Both these arguments are debatable. Strops are costly but so is the waiting time for machinery. The greater the capital the greater the cost. Labour is expensive but so is the cost of sub-optimal load sizes. If further research was envisaged by FRI personnel it would be in this segment of the operation.

The use of grapples in smallwood operation was another attempt to overcome the time and cost of terminal times in the bush and on the landing. Early experience with grapples fitted to low capital cost machines (modified agricultural tractors) highlighted the difficulty of aggregating good payloads in long length thinning operations particularly where 2-3 pieces/cycle were required. Furthermore the low capital machinery resulted in low availability and utilisation percentages due in part to the hostile forest environment and unsympathetic operator attitudes.

PREVIOUS FRI RESEARCH

Wood Preparation

Early work by the Harvesting Group at FRI was concerned with increasing productivity. Felling levers were imported to reduce the time consumption and heavy physical effort associated with hang-ups in felling in thinning operations. (8) The tool met with limited success.

To improve felling and trimming performance four light weight power saws in 48-55 cc range were purchased and tested in the field. These tests coincided with intensive research activity overseas, and growing concern for worker protection from Raynard's Phenomenon and hearing losses. Overseas industry demand for better power saws led to rapid improvements to the power saw, particularly in the European countries with a consequent spill-over of these benefits to the New Zealand industry.

Spring loaded tapes were also introduced into smallwood operations in the early 1970s and have gained some acceptance in the industry. (9 The tapes were relatively expensive and prone to breaking and these characteristics together with the time involved in their use retarded rapid and extensive acceptance.

Safety helmets featuring ear defenders (muffs) and eye protection were also introduced and tested extensively in the field by FRI personnel. The design and the modification (hole drilling) to secure the ear muffs were at variance with the then standards pertaining to safety helmet specifications and therefore met, understandably, at the time with little acceptance.

These approaches were promulgated to improve the productivity and increase the protection afforded to the bush worker. It should be noted that much of the foregoing equipment and approaches were more concerned with long term productivity gains through protection of the labour force from injury. However, in the short term they tended to they tended to inflate work cycles and therefore reduce production rates and increase costs. It is this syndrome that led to the slow acceptance of some of the approaches.

The use of spring loaded tapes could have led to more accurate measuring and cutting to length on the landing with a consequent increase in the value of the end product; but while as an industry we are preoccupied with production rather than value we are unlikely to see the rapid acceptance of approaches that reduce production rates. One of the most significant results from these various trials and the background research was the lead time enjoyed by many overseas countries in machinery development and the manner of its introduction into the forest environment. (10) The benefits arising from this situation should be fully utilised; some modifications of overseas experience will be necessary to suit our conditions but certainly we should not dissipate our resources by unnecessary duplication of expensive research.

Machinery - Method development: Extensive trials were carried out in smallwood operations with a variety of low capital cost extraction machines. These include the Holder AG 35 Tractor; (11) the Drabant and the Matthews Mini Skidder The objective of these trials was to develop harvesting methods in smallwood operations that minimised the cost of production through low investment and balanced gang strength. Results were mixed and though some cost reductions could be shown in the short term, important factors such as repairs and maintenance costs, availability and utilisation percentages were not established. Time however has shown that the low capital approach met with little acceptance in the Bay of Plenty region and the machines have virtually disappeared from the arena.

One of the most significant trials undertaken by FRI was the extensive testing of the Mercedes Benz (MB Trac) 4-wheel drive tractor. This machine featured twin winches which could be controlled from outside the cab through a remote control box. To complement the existing Mercedes Benz, quick attachment chokers were imported and teamed with polypropylene strops. A quick release system based on the British Forestry Commission development for their Hydrostatic Tractor was incorporated into the trials. (13) These developments together with the twin winch configuration allowed a high number (10-12) of pieces to be broken out each haul and the quick release pin reduced landing terminal times dramatically. The system required a large number of strops (20-24) and a skid worker to ensure a rapid turn round of the machine. The additional skid worker added to the cost of the operation, and unlike his British counterpart, manufacture to increase value was not possible, as virtually all our smallwood operations produce only low value pulpwood. An attempt was made to identify and cut post material from the tree lengths produced. This option proved to be feasible and would have helped defray the cost of the skid worker. The features of the Mercedes Benz and the work methods developed around it did not capture the interest of the forest industry and the system disbanded.

Highly mechanised systems: In the 1970s highly mechanised systems were introduced into New Zealand to clearfell unthrifty small piece size stands of Pinus ponderosa in Kaingaroa State Forest (14). The system intensively measured by the FRI Harvesting Group was composed of a feller/buncher, a chain flail delimber, and grapple skidders for the transport to the landing phase. As this system represented the first New Zealand attempt to replace labour with capital the system generated considerable interes Work measurement over a 3-year period showed that although the highly mechanised approach had considerable potential to produce high volumes this was not achieved for several reasons. Firstly the availability and utilisation percentages of the system were below expectations. This led to reduced daily production and consequently inflated costs. Furthermore studies showed that the highly capitalised logging approach is very sensitive to piece size.

TABLE 1: PIECE SIZE/MACHINE PRODUCTIVITY RELATIONSHIP *

Operation	Piece size (m^3)	Productivity (minutes/m^3)
A. Selection thinning C 4 Skidder	0.22	9.83
	0.29	8.04
B. Row thinning C 4 Skidder	0.22	9.32
	0.29	7.25
	0.36	6.31
C. Downhill strip thinning Lotus Hauler	0.27	11.51
	0.40	9.86
D. Clearfelling *Pinus ponderosa* Drott Feller/Buncher **	0.16	4.27
	0.23	3.01

* Based on selected FRI case studies, for a 480 minute working day

** Based on 67% utilisation

It would seem certain that the problems associated with highly capitalised systems in clearfelling will be present in smallwood thinning operations which tend to concentrate on the smaller trees within the stand. Added to this will be the restraints of machinery movement within the stand because of the residual final crop pruned stems and the need to protect these stems from damage. It is therefore extremely difficult to see high capital cost systems competing cost-wise with the "conventional motor manual system" without a radical departure from the selection thinning concept, and certainly not on more difficult terrain.

Observations in Australia suggest that some silvicultural principles are being modified to ensure that high cost harvesters can operate in first thinnings competitively. Comparable cost figures with alternative harvesting approaches are not readily available but it is evident that motor manual operators are not given the same degree of latitude when undertaking the first thinning silvicultural operation. It was evident that in some cases the Australians are not having to protect and enhance a pruning investment as is the case in many New Zealand operations.

Cable logging: Cable logging operations producing smallwood will have a cost 65-85% higher than an equivalent operation on tractorable country. (15) What has been previously said about tractor operations applies equally to extraction thinning on cable country. The problems associated with small piece size such as load aggregation, low value product are further aggravated by a reduced productive day because of rope shifting times.

Organisations that are intending to production thin their steep country should be aware of the effects of increasing the capital invested without commensurate increase in productivity. Failure to elicit increased production must lead to direct cost increases.

Salvage operations: Little research has been carried out by FRI on the salvage of smallwood from cutover *Pinus radiata* stands, and what has been done has been restricted to tractorable country. (16) However the problems in this operation are those of other smallwood operations - small piece size, low value and the produce scattered unevenly over the cutover. The observed operation is similar to the shortwood system in thinnings. The pieces are prepared and stacked on the cutover for extraction to the landing by a modified rubber tyred skidder. The operation has now been stopped because of the cost and an alternative supply of cheaper wood. In some cases where the terrain is suitable and the lead distance to the processing plant short - the salvage of wood from the cutover may be a viable alternative to thinning operations on difficult country.

Re-organisation of the stand: The problem of load aggregation in smallwood harvesting led the FRI to establish extensive logging trials at Turangi, Rotoehu, Esk and Woodhill Forests. The objective is to concentrate the thinnings into pairs of rows, physically separated from pairs of final crop rows. The thinnings are to be removed before they affect the growth of the pruned final crop stems.

The first trial area logged is situated in Rotoehu Forest. (17) A contractor from NZ Forest Products Limited was hired to harvest the area using a "Wilhaul" cable machine. The results from work measurement indicate a productivity gain in the order of 15-30% when compared to similar operations harvested on an outrow/selection basis. This was achieved through raising the average number of pieces stropped/haul. The concentration of stems underneath the skyline was successful in enabling the breaker-out to increase the average haul volume.

Subsequent row thinning trials on tractorable country at Turangi showed less dramatic productivity gains (6-12% in comparison to the selection thinning option. Although improved load aggregation (30%) was recorded in the row layout the overall production gain was diluted as a percentage of the extended cycle time. In retrospect method changes should have been instituted to take better advantage of the concentrated layout of stems in the row thinning option. These method changes should have included some pre-stropping, a larger tractor than 60 kw used in the trial, which was considered with the ring mounted strops the most suitable available machine for the selection thinning option. Time and money did not allow these and other options to be tested such as a highly mechanised system or a clambunk skidder. None the less it is clear that this line of research is worth pursuing.

A productivity gain for this approach has been demonstrated. The effect of the row arrangement of the final crop trees and thinning element, is not fully understood. The effect of the strip arrangement on the final crop tree growth has not been fully measured. Some reduction in growth is possible but the degree to which it occurs and how much the increase in productivity in thinning and possibly clear-felling offsets any possible loss, is at this stage still being evaluated. A further important result from the Turangi trial was the achieved piece size (see Table 1) was greater than the critical size of 0.20 m^3 as Graph I shows. This is an important factor in the harvesting of smallwood, if a reasonable cost/m^3 is to be achieved. Further trials of this nature will be initiated in the late 1980s in areas specifically established to test the row felling option.

FUTURE FRI RESEARCH

Conclusions

1. Smallwood harvesting costs will remain high relative to the cost of largewood harvesting because the small piece size cause problems in aggregating on optimum haul size.

2. A large research effort to solve some of the problems associated with smallwood harvesting problems is taking place overseas. These developments should be monitored with a view to adopting/adapting pertinent developments into the New Zealand harvesting scene.

3. Increased inputs of plant and/or labour without corresponding increases in production will inevitably lead to increase in the cost of production.

4. Many aids to production have been introduced into the New Zealand logging scene to minimise the costs of production. Many have failed for a variety of reasons, but not because

they were unpromising. A detailed review of these is warranted with a view of reviving some of the more promising, e.g. the double winch option.

5. Were a production thinning operation considered essential some consideration should be given to reorganising the stand to make the cost of production more acceptable while protecting final crop values.

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SOME ASPECTS OF MECHANICAL HARVESTING IN QUEENSLAND'S SLASH PINE PLANTATIONS

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SUMMARY

In Queensland, harvesting systems traditionally have been Motor-Manual, but recent developments in the Slash Pine (Pinus elliottii) operations of Woodland Limited have aimed to mechanise sections of those operations which contribute mostly to depressed productivities and work fatigue.

In achieving this, several changes were necessary, not least of which was the need for a new approach to task and profit sharing. Certain Industrial Agreements have been modified to cater for this approach.

Whether or not the systems developed could be successfully used in other Forests is debatable, due to the peculiar branching characteristics of Slash Pine, making multi-stem processing a possibility.

Management, in encouraging these developments, was motivated by a desire for more economical harvesting systems. In addition, it was considered desirable to perpetuate the skills of the Motor-Manual contractor and make him as competitive as possible with other forms of mechanisation.

How mechanised is Mechanical Harvesting? In Queensland, the answer seems to be that the ultra mechanised operation has no greater place than the ultra manual and somewhere in between is an operation that is compatible with most points of view.

A BRIEF HISTORY

Thinning of indigenous Hoop Pine (Araucaria cunninghamii) plantations commenced in 1939 and early forest workers employed manual techniques which persisted until the mid 1960's, using hand saws for felling, axes for limbing and horses for snigging.

Modifications were made during the late 1960's with the introduction of light chainsaws and small crawler tractors.

These techniques remained in use for this period of time as a result of the steep and rocky terrain and the selective thinning policy of the forest owner. Light, frequent thinnings of approximately 25 cubic metres per hectare every four to six years were carried out. This policy aimed to maximise growth on an elite pruned fraction of the stand. Equipment used for harvesting, therefore, needed to be capable of negotiating the forest without the aid of a regular extraction track or outrow system. Several generations of forest workers developed with particular skills related to smallwood thinning.

Early pulp thinnings in the more extensive Slash Pine (Pinus elliottii) Plantations of the flat coastal plain near Gympie were carried out using the experience of the Hoop Pine workers but substituting light agricultural rubber tyred tractors for light crawlers.

Three mechanical systems subsequently emerged, each with advantages to suit varying logging conditions - the "Tractor and Grid", the "Feller Buncher and Grid" and the "Feller Buncher and Clever Hole Delimber". (Appendices 1 and 2).

DEVELOPMENTS - REASONS FOR ... RESULTS OF

The motivation for mechanisation in Woodland's case, apart from the obvious desire to obtain raw material at the most economical price, was an increasing volume of pulpwood needed to supply Particleboard and Sawmilling requirements, as well as a future Pulp and Paper Project.

At the same time, it appeared that labour pay rates would increase disproportionately to other costs. Recently however, this trend was moderated and the limiting factor now for contractors wanting to introduce new systems is interest rates on invested capital.

Woodland was reluctant to introduce the high cost harvesters and processors available from overseas manufacturers. Instead, a decision was taken to upgrade the productivities of the Motor-Manual techniques so that they were as efficient as possible before embarking on any programme of high cost mechanisation.

Forwarders were introduced and the productivities of the Motor-Manual operations were greatly increased by reducing their tasks to that of Fell and Bunch to outrow or corridor. Bunching for Forwarders was necessary due to the low volume removals resulting from a selective thinning policy and to the distances between outrows. Double Drum Winches significantly improved productivities, due to the ease with which bunching could be carried out simultaneously from each side of the outrow.

At about this time, a Director of Woodland observed Slash Pine in the Southern States of the U.S.A. being delimbed satisfactorily by the simple technique of pushing the stems, tip first, through a suspended metal grill. In this way the limbs were stripped from the tree boles.

This proved to be the most significant factor governing the success of future developments in mechanical delimbing in the local Slash Pine Plantations. Several enterprising contractors set about to construct and test the first Grid Delimber for use with their Rubber Tyred Tractors. Improvements have been made in the interim, and the Grid is now universally used in First, and often Second, thinnings.

The fact that Slash Pine could be successfully delimbed in this manner, led to the development of the Boschen "Clever Hole Delimber". Graham Boschen, a contractor to Woodland, coupled a Feller Buncher to the "Clever Hole" and developed a fully mechanised system to deliver delimbed stems to outrows or corridors.

W.O.L.F. Logging, another contractor, coupled a Feller Buncher with two Rubber Tyred Tractors, delimbing by Grid Delimbers. This is an impressive system with a high output and relatively low costs.

Both of the Feller Buncher based techniques are capable of production rates in the vicinity of 3,000 cubic metres per month on a one shift basis.

A feature of this delimbing technique is the ability to delimb several stems simultaneously. Most Processors using knife delimbing heads are restricted to processing single stems at a pass. As delimbing productivities appear to be almost geometrically related to piece size, these processors are compromised by small stem size from First Thinnings. Both the Grid and the "Clever Hole" can process up to 7 or 8, First Thinning stems, at a time.

Mechanical developments were one aspect of the introduction of mechanised and semi-mechanised harvesting systems. Of equal importance, in fact vital for the success of the Grid Delimber, were the changes which took place in the attitudes of the forest worker to task allocation, contract rate setting, and profit sharing.

Traditionally, tasks of faller and snigger were well defined and quite separate. In many cases, it was as though individual contracts had been let for each phase of the total harvesting system. In Queensland, Industrial Legislation has always provided for the Department of Forestry to assess tasks and set rates for fallers. New Agreements provided for systems to be assessed individually and contract rates set accordingly.

With the Grid Delimbing system, the Faller was relieved of the time-consuming and onerous task of delimbing by chainsaw. This was one distinct advantage of the system, particularly in view of the hot Queensland climate and the fatigue attached to full time chainsaw work. At the same time, sniggers required assistance, due to the heavier work load of delimbing. In many cases, fallers are now involved with most aspects of the total system.

Most contractors formed partnerships to simplify the inherent problems of task and profit sharing. In some cases, contractors found that single operators could work efficiently at felling, delimbing and bunching, with the aid of the Grid Delimber.

The "Clever Hole" system is currently being operated on a wage basis, however, the relatively low capital needed to finance this system puts it within reach of the Motor-Manual contractors, which has the advantage of perpetuating their skills at smallwood thinning.

FUTURE TRENDS

Intensive research carried out by the Queensland Plantation Harvesting Research Committee, a combined Industry and Government Body, has indicated the need for closer outrow spacings to allow mechanical harvesters to operate efficiently.

The present fifth row out, with selective thinning of the bays, generally in use with first thinning of Slash Pine Plantations, caters satisfactorily for the mechanised systems currently in use. It is not a satisfactory thinning regime however for many of the other orthodox harvesters which local contractors may be forced to use in the future.

Modifications currently being carried out on the "Clever Hole" Delimber, will allow for cross-cutting to log length after bunching to outrow and delimbing. The machine itself will at that time probably have reached its peak of mechanical performance. Whether or not changes to work procedures, outrow spacings, etc. will provide the means for increased productivities, as has occurred with the Motor Manual systems, remains to be seen.

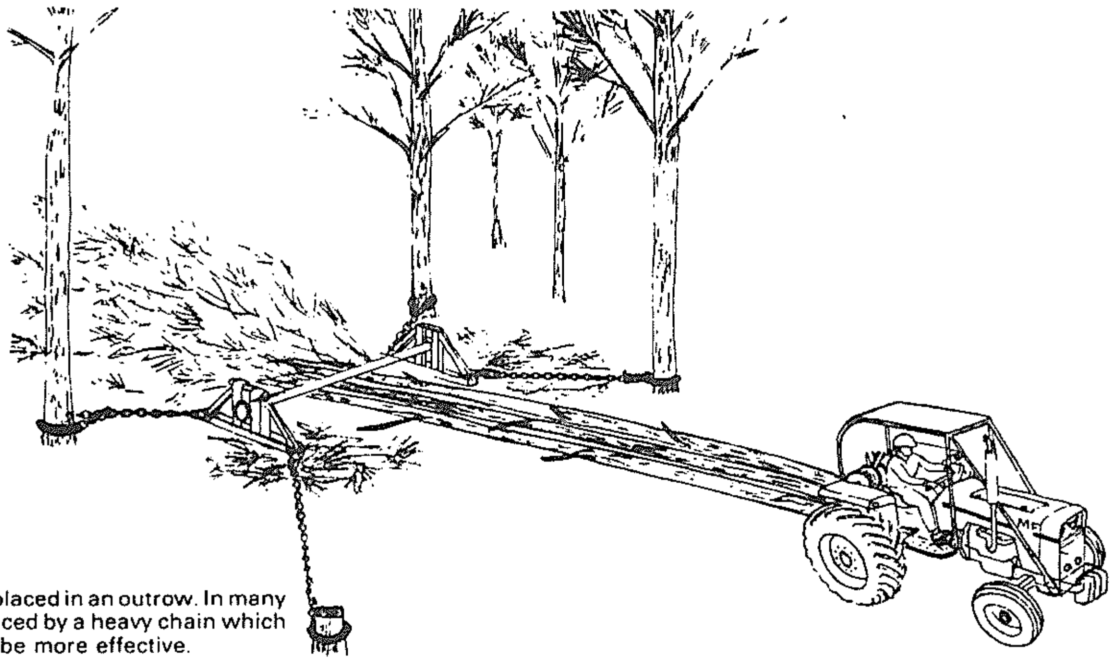
The Tractor and Grid appear to have limited lives in Slash Pine Plantation except where terrain and debris are barriers to larger mechanical harvesters.

One harvester at present being developed in the region is the Murdoch "Timber King". (Appendix 3) Andrew Murdoch, the designer and developer, envisages this machine in smallwood thinnings, felling, delimbing and cross-cutting to bunche on outrow. Certainly there is no such machine available, off the shelf, which is singularly capable of carrying out all these functions. Of relatively low capital value, this machine shows promise as a real alternative to the expensive systems which are in use in other areas.

Forest Chipping is also being seriously considered for those products which can utilise the chip produced by the present breed of Field Chippers.

There is a need to continually review work procedures and mechanical systems to keep pace with increasing costs, providing the philosophy of protecting the status of the forest worker, and considering the requirements of the Forest Grower, is maintained.

TRACTOR AND GRID APPENDIX 1



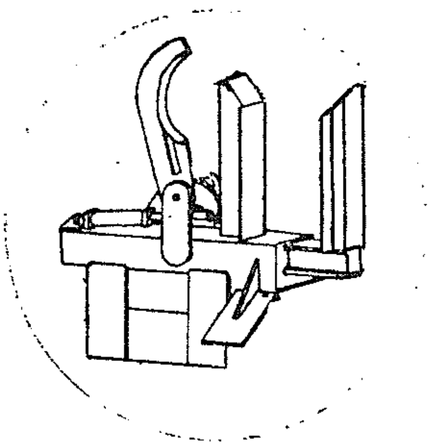
The grill delimber placed in an outrow. In many cases the bar has been replaced by a heavy chain which has been found to be more effective.

Used in conjunction with normal chainsaw felling and tractor snigging operations, the Grid Delimber consists of an angle iron rectangle placed horizontally on the ground with the long axis at right-angles to the extraction track or outrow.

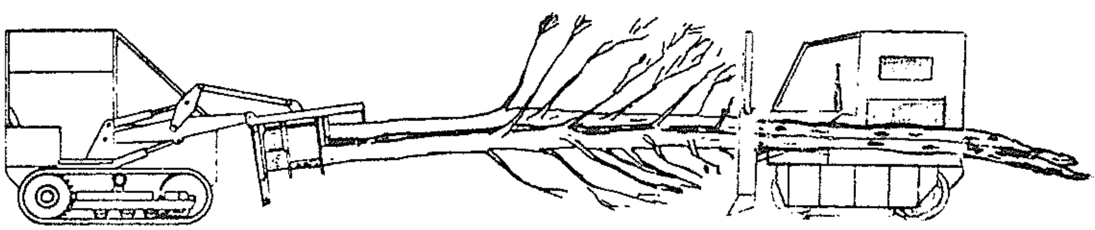
The small tractor, with the aid of a double drum winch or snigging grapple, collects a bundle of stems which has been previously felled by the faller, and snigs them over the grid rectangle, stopping when the butts of the trees are just past the centre point. To a vertical post at the centre of one short side is attached a length of chain which can be thrown over the snig of logs and attached to a corresponding post at the centre of the other short side. The tractor then strips the limbs from the bunch by moving forward and reversing the snig over the rectangle and under the chain. The abrasive action of the chain and the rectangle breaks the limbs off flush with the stem bole. The delimbed stems are then able to be stacked in readiness for subsequent cross-cutting and forwarder extraction.

BOSCHEN "CLEVER HOLE" DELIMBER

APPENDIX 2



Basic principle of the "Clever Hole" - an orifice that can be hydraulically adjusted to conform to the shape of the tree or bunch.

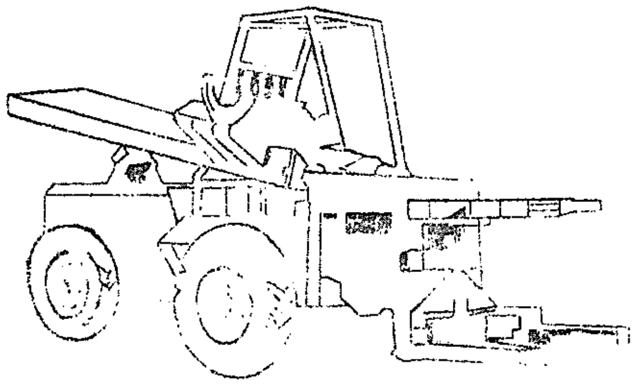


The Boschen system uses a Feller Buncher, consisting of a standard tracked loader equipped with an accumulating shear head, to fell and accumulate stems prior to combining with the "Clever Hole" for delimbing.

The "Clever Hole" can be adjusted and the standard of delimbing is good.

Once delimbed, the stems are carried along the outrow by the "Clever Hole" to be bunched with previously delimbed stems into stacks to maximize the performance of the subsequent forwarder operation.

MURDOCH "TIMBER KING"   APPENDIX 3



Prototype of a 'complete harvester' capable of feller bunching, delimbing and cross-cutting two stems simultaneously.

The unique design of the felling head holds two stems in a precise position, one directly in front of the other, before delivering them to the double knife profile delimbing head. This is accomplished by way of an 180 degree turn of the shearing head across the front of the prime mover.

Limbs are removed as a result of the combined action of the stem being forced through the felling head and the reverse stroke of the delimbing head up the stem.

After delimbing, the predetermined length of stem is left protruding from the front of the shear head. The stem can be cross-cut by the main shear at any point selected by the operator.

THE EVOLUTION OF HARVESTING METHODS TO THIN PINE PLANTATIONS IN N.S.W.

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I have been asked to outline the changes in the logging methods used in harvesting pine thinnings in New South Wales over the last 40 years. These changes have been simple and straight forward and are summarised in Table 1. For each basic element in the harvesting operation, changes have been listed at the approximate date of their occurance.

For the remainder of this paper I will discuss the changes, and the reason I believe they occurred.

But before we proceed, I am sure you will agree, that the selection of the most suitable logging system is specific for each individual task. The selection is strongly influenced by the technology and cost structure of the industry being supplied, the design of individual factories and the forest's silviculture. Environmental constraints, which legitimately vary from forest to forest, are increasingly relevant influences. Finally, a very important variable, which strongly influences the method used to harvest a forest, is the society in which the industry is set.

1. CHARACTER OF THE N.S.W. PINE MANUFACTURING INDUSTRY

The methods used to thin N.S.W. pine plantations over their forty year history, have undergone considerable change. To understand this change a knowledge of the changes in the forest manufacturing industries which use the thinnings, is necessary.

The initial pine plantings of the 1920's were thinned in N.S.W. to supply small sawmills in 1940's. These mills cut packaging material for the fruit industry as well as for secondary manufacturing factories. They were located close to pine plantations and were simple in their technology, using 2000 to 3000 m^3 of logs per annum.

As the diameter of logs became larger from second and third thinnings, boards for strip flooring, furniture and weatherboards were cut necessitating the installation of kilns. To achieve economies of scale the small case mills amalgamated into fewer larger sawmills.

In the early 1960's the particle board industry was established. In its early years this industry was dependent on small thinning logs, without any supplement from chipped sawmill residues which are now available.

The thinnings for particle board resulted in sawlogs growing more rapidly, and this, together with increased planting areas, enabled sawmills to increase log input, so that some now cut in excess of 100,000 m^3 per annum.

At the start of the 1980's pulp industries are being established in N.S.W. Their raw material comes from the expanded planting program financed by the Commonwealth Government in the 1960's and early 1970's. When this expansion is completed over the next 3 to 5 years, an annual commercial thinning yield for the State in excess of 1,000,000 tonnes will be in operation.

2. FALLING

The introduction of the chainsaws, in lieu of the axe, for falling trees in the large Australian Eucalypt forests was truly a revolution. However, for the small logs in pine thinning, chainsaws were slower to become used because the development of smaller saws was a prerequisite.

Further, in the initial stages the chainsaw was not used in delimbing stems, which consumes about half of the log cutter's work effort.

However, now in 1980's, we are seeing the felling shear getting ready to cut half the N.S.W. thinning yield.

When considering felling shears, it is important to realise that the chainsaw is still the cheapest method of falling radiata thinnings in N.S.W. plantations, and is likely to remain so for some time. A cost ratio of 1:1.25 probably reflects the current difference between the chainsaw and the shear.

The compelling reason for the movement into felling shears in thinning is a social one, i.e. the lack of suitable people willing to become log cutters in N.S.W. The rise in early thinning logging in N.S.W. will be about seven fold in the next 3 to 5 years, and the industry cannot see that it can attract the 500 to 600 new cutters necessary for the task. The manpower difficulties over the last 10 years, even when unemployment has been up to 6% indicate that the only realistic approach is to assume cutters in sufficient numbers would not be forthcoming. Additionally, the accident record resulting from the introduction of 500 to 600 rookie log cutters over such a short period, is sickening to contemplate.

3. LIMBING AND CROSS-CUTTING

The replacement of the axe by the chain saw in delimbing pine took about 10 years longer than it did for falling. It had to await further weight reductions in saws and the development of efficient and safe chainsaw limbing techniques by the Scandinavians. These new techniques were introduced into N.S.W. in the early 1970's.

Processors for delimbing and cross-cutting radiata logs were first used in N.S.W. in 1975 in the form of the Twigg. This machine, which is a delimber fitted to a Volvo forwarder undercarriage, aligns the delimber at 90° to the extraction track. Thus it took logs from the stand on one side of the track, delimbed them and deposited them amongst the retained stems on the opposite side. It thereby cramps its operation by not making use of the space in the track.

The Windsor Harvester, the John Deere Harvester and the Logma Processor all align their stems parallel with the extraction track thus utilising that space.

Again, as with falling, there is a cost disadvantage in replacing the chainsaw with the mechanical delimber, something in the order of 20 to 40%. There may also be a delimbing quality reduction depending on the machine used.

However, it should not be overlooked that with the expansion of the logging of pulpwood in N.S.W., there will still be an increase in chainsaw falling because of the slope limitations imposed on machines. Up to 20% of thinnings will be felled by chainsaws, in conjunction with mechanical felling, in N.S.W.

4. BUNCHING

The greatest single act loggers of small wood can do in order to overcome "the tyranny of small piece size", is to bunch logs as soon as possible in the logging system. Thus feller/bunchers with accumulators have a bright future.

However, in radiata thinning, this hope is considerably dampened by the lack of a processor which can delimb several stems, simultaneously, to a satisfactory standard. Thus in brittle limbed species, such as slash pine, accumulators and multi-stemmed delimbers give considerable cost advantages over radiata, in commercial thinnings.

Initially in N.S.W., man and horse bunched for many years until the sledge mounted small bunching winch was introduced into Tumut, in the 1950's.

At Bathurst, at the commencement of logging in 1960's, the particle board industry used iron pallets, which were manually loaded with logs in 2.4 m lengths, and pulled from the forest with horses and small agricultural tractors.

Finally, in the 1980's, feller/bunchers are being introduced and these give considerable flexibility in placing bunches where required by the processor, in the appropriate bunch size, alignment and indexation.

5. EXTRACTION

In N.S.W., extraction refers to the transport of logs from the stump to the plantation roadside.

For many years horses and men shared the burden of log extraction, assisted by the four wheel-drive truck which was so commonly available after the war. The trucks entered the stand along extraction tracks at 40 m spacing, where logs which had been dumped at 90° to the track were then loaded manually onto th truck.

Rubber tyred skidders were introduced via Timberjack, in the mid 1960's. The full tree length system was quickly replaced by a ten metre maximum log length, in order to reduce the excessive damage being inflicted on retained stems.

With the introduction of chainsaws and skidders, it was becoming clear that thinning pine plantations need not be dependent on the sweat of horse and man, nor the agony of the ruined spine. The possibility of complete mechanisation of commercial thinning was becoming apparent to everyone in the industry.

Forwarders were introduced, via Volvo, and along with "Nordfor" cutting systems, a new motor manual stage was reached.

The forwarder offered several advantages. Firstly it gave industry clean wood. This is a factor which is very important to many industries. For example, factories dependent on boilers often have their annual maintenance shut down period determined by how long it takes to clean boiler tubes. Thus every day saved by using clean fuel can account for several hundred thousand dollars.

Another important advantage was, that by transporting and loading short wood of consistent length, forwarders materially added the introduction of the bogey semi-trailer for the transportation of pine thinnings. It enabled the economic loading of these larger trucks within the legal length, total weight and axle weight, applying in N.S.W. As log haul distances were increasing, this was an important consideration.

A third advantage is the performance of the forwarder in wet weather relative to skidders. By concentrating limbs and debris on extraction tracks, forwarders create ruts in tracks less readily in wet weather, thus reducing damage to root systems of the retained stems and to forest soils generally.

The advantages forwarders gave to the loading element of the thinning operation is discussed under loading.

6. SPACING OF EXTRACTION TRACKS

With each change in harvesting system, it has been necessary to change the spacing of extaction tracks. With increasing mechanisation track spacing has been reduced by the N.S.W. Forestry Commission from 88 m down to 12 m. The boom mounted felling shears are limited to cutting only five rows at a time - a row out plus selection of two rows from either side. This will soon become the most common extraction pattern.

The reduction in row spacing does reduce stem selection for future crop trees, but concern that it reduces total wood volume growth of the plantation has not been verified from measurements taken so far.

7. LOADING

About 1960, the back breaking chore of manually loading wood onto the back of trucks was replaced by manually loading steel pallets (2m x 1m x 1m). These were winched over the back of trucks by winches set behind the drivers cab. The trucks were 4 x 4 vehicles which were driven along the extraction track to be loaded. This system, of course, gave very expensive road transport costs because of the low travel speed of these trucks.

Front end loaders were introduced with the longer ten metre wood snigged to the log landings by wheeled skidders. The front end loaders provided a cost efficient method of loading. However, they encountered trouble when drainage from the log landings was seen to add to the turbidity of creeks. Following the hydrological controversies of the mid 1970's , the design and location of landing suitable for front end loaders became restricted, as did their use during wet periods. Also, the odd stone that front end loaders embedded into logs when used on gravel landings, gave rise to some colourful language from chipper room staff - and rightly so.

In contrast to the mire of mud, dirty water supplies and profanity arising from front end loader usage, the loading of logs by the knuckle boom cranes of forwarders in adjacent logging operations were indeed elegant. In addition, loading could be carried out in a large number of situations, thus reducing the need for prepared landings. The more flexible loading situations also reduced the distance to be travelled from stump to roadside.

Labour with the skills necessary to use knuckle boom cranes has changed from being scarce, when forwarders were first introduced, to reasonably easy to obtain. Knuckle boom operator jobs are now popular, after ten years of forwarder use.

It soon became clear that specialised knuckle boom loaders had advantages over forwarders, because they can be placed on retired trucks and they can lift greater loads. In short, for half the capital outlay, they can load trucks twice as quickly as forwarders.

In order to load a semi-trailer, the initial breed of knuckle boom loader loaded over the side of the truck. It therefore has to align itself parallel to the side of the truck thus consuming a total width of at least six metres - and space is a scarce commodity in a pine plantation during first thinning. Extensions can be made to knuckle boom loaders which will enable loading over the back of semi-trailers. These are being introduced to save space and to ensure loaders and trucks stay on compacted gravel surfaces of roads during wet weather.

8. TRUCKS

Road haulage distances have increased since thinnings started in N.S.W. 40 years ago. This is a result of forest industry becoming concentrated into larger and larger units and thus needing to go further for log supplies.

When each new industry establishes, there is a large immediate increase in yield and the forests are stressed to supply the required volumes. However, as the plantation estate expands each year, so too does the volume available and the average road haulage distance tends to diminish. This continues until the next new industrial expansion when the haulage distances expands once more and the cycle tends to repeat itself.

Also pulpwood industries are fairly complex. In siting them, considerations other than log transportation costs also have to be considered. Factors such as social and associated industrial infra-structure, energy sources, and transport to market are just some of the other factors which are relevant. In total, it is often found that the best location of the pulpmill will not be that which gives minimal log transportation costs. Increasingly large trucks have been used for log haulage to minimize costs. From the 4 x 4 ex-Army trucks, we have evolved to the use of tri-axle skeletal trailers and the logging industry trucks run on N.S.W. highways as elegantly as those associated with other industries.

Despite popular hysteria generated as liquid fuel prices rise toward their real value, I see an expanding future for truck haulage. This will come by improved efficiency of truck design, more care in selecting engines with appropriate power, more highly trained drivers, by the continual improvement of roads, and by the use of larger trucks. On the subject of larger trucks, the bogie-bogie trailer configuration, which allows three five metre packs of logs to be loaded on the truck and the trailer, is standard practice in Scandinavia. If used in N.S.W. these would enable 50% increase in truck loads without increasing axle loadings. This system would lead to significantly reduced fuel consumption per tonne, and a strong case can be made for the use of this truck configuration in N.S.W.

9. ADMINISTRATION OF HARVESTING

Initially commercial pine thinning was administered by the Forestry Commission of N.S.W., who employed cutters with horses on piece work rates. When the uncertain small sawmills suffered a downturn in the market, many of the cutters would be offered maintenance and planting work in the pine forests.

With the advent of mechanisation, the Forestry Commission stepped out of logging administration because it felt private industry could more reasonably carry out this task. Also, larger industry would not agree to the administration of logging being outside their direct control.

Presently in N.S.W., each radiata firm is responsible for the administration of logging operations for the predominant part of their log purchases.

All logging is done via contractors. The reason the N.S.W. industry uses contractors, rather than company or Forestry Commission logging, is that the contractor system keeps the work group sufficiently small to enable forest workers to relate to a manager - the contractor. Further, because contractors are deeply committed both financially and emotionally to their logging operation, their field supervision is superior.

Contractors also broaden the managerial base of expertise in the logging systems, thus giving a greater input of ideas and innovation.

The contractor system is self cleansing because the Darwinian process of natural selection applies. In short, inadequate contractors cannot survive to the extent that is possible in the salaried structure of some companies and many bureaucracies. Over the last ten years the number of contractors has diminished in N.S.W. despite the increase in forest yields. At the same time the quality of those contractors who have survived has increased significantly.

10. CHOICE OF MECHANISED LOGGING SYSTEM BY A.N.M.

In the light of the history outlined above, together with A.N.M's experience with John Deere Harvesters and forwarders in Tasmania, the company, in consultation with the Forestry Commission of N.S.W., chose its basic logging system to log at Albury in October, 1979.

Five assumptions were basic to this choice:

1. All wood is to come from thinnings from land less than 20° slope.
2. Labour in sufficient numbers of adequate quality, would not be available for a motor-manual logging system at Albury.
3. The system must accommodate the Forestry Commission's reasonable constraints regarding stand damage, hydrology and fire.
4. Sawlogs must be produced along with pulplogs.
5. Clean logs have a significant premium to the Albury plant.
6. Machines should be oriented to operator comfort.

In summary, the choice of logging system was based on the following rationale

The trucks used will be bogey drive with tri-axle skeletal trailers. Because of the long weighted average road haul of 132 km, the choice of the longest legal rig was necessary in order to contain costs.

To load these trucks legally for axle weight, and keep within legal length limits, two short wood packs of 5.4 m will be necessary.

In the N.S.W. forests, forwarder extraction and knuckle boom loading of 5 m long wood from thinnings has been found to be more efficient than skidders plus chainsaw cross-cut at landing.

Specialised knuckle boom loaders are more efficient than forwarders in loading trucks. By loading over the back of trucks rather than over the side economies in space utilisation will be achieved.

No harvester which satisfactorily produces bunched 5 m wood parallel to the extraction track was available for selection thinning in 1979. A feller/buncher plus processor system was therefore chosen.

The only processor, which satisfactorily delimbs radiata to sawlog standard, is Kockums's Logma (85 - 41).

To enable a larger market for training, parts and maintenance, Kockums feller/buncher (880) and forwarder (850), which compare very favourably with their competitors, were chosen to match the Kockum processor.

Land less than 20^{o}, but too steep for the mechanised system, would be chainsaw felled and bunched by a crawler tractor on skidder. Depending on circumstances, it will be delimbed by the processor or by the chainsaw. Similarly, the tractor will snig logs to the processor or to the forwarder or to the roadside, as best suits each situation.

A.N.M. has offered to clear fall land over 20^{o} slope using cables. In Australia, A.N.M. has been the only company to operate these systems on a continuous basis since 1940 and currently have three systems (expanding to 4) operative in Tasmanian Eucalypts. Concerted efforts in Australia to thin steep country using cables have not been economically viable.

To operate this system 40 machine operators will be trained over a three month period by a team of seven instructors. This school is being organised by Kockums, as part of their machinery sale package to A.N.M.

Presently N.S.W. shares in the Australian movement of radiata industry management committment to increasing mechanisation. These systems will be administered by skilled contractors.

Until recently, the introduction of mechanised harvesting has been at some increase in costs. However, this disparity is decreasing each year, and several systems are now already in a position to claim that they are cheaper than motor manual operations.

The 1980's will, I believe, see in N.S.W., the introduction of mechanised thinning harvesting in a wide variety of forms each designed to best serve the different logging task each forest and industry throws up.

TABLE 1. SUMMARY OF DEVELOPMENT OF LOGGING PINE THINNINGS IN N.S.W.

Year	Industry Development	Falling	Delimbing	Track Spacing	Bunching	Extraction	Loading	Trucks	Administration
1940	Small Sawmills:2000m^3 Log/annum	Axe	Axe	88 m	Manual and Horse	Horse and Man	Man	Rigid 2 wheel drive	Forestry Commission piece workers
1945						4 x 4 Trucks		4 x 4 Military trucks	
1950									
1955	Larger Sawmills with kilns 15 000m^3/annum				Bunching Winch	Agric. Tractors			
1960	Particle Board Industry 100 000m^3 to 150 000m^3/annum	Chain saw		44 m	Pallets	Pallets	Pallets & Truck Winch	Single Axle Semi & Truck	Industry via Contractors
1965				16 m		Skidders	Front End Loaders		
1970	Sawmills to 100 000m^3/annum		Chain Saw			Forwarders	Forwarders	Dual Axle Semi	
1975									
1980	Pulp & Paper Industry 450 000m^3/annum	Felling Shear	Processors	12 m	Feller - Buncher		Knuckle Boom Truck Mounted Loaders	Tri-axle Trailer 6 x 4 truck	

- SESSION 4 -

MECHANISATION

Chairman: Jim Spiers, LIRA

"MECHANISATION OF SMALLWOOD HARVESTING IN N.Z."
BOB GORDON, Research Engineer, Logging Industry Research Association.

"ALTERNATIVE CONCEPTS FOR DEVELOPMENT IN MECHANISATION"
BILL KERRUISH, C.S.I.R.O. Australia

"MANAGEMENT AND COST IMPLICATIONS OF MECHANISED SMALLWOOD HARVESTING"
RON O'REILLY, Lecturer in Forest Engineering, School of Forestry, University of Canterbury.

Session 4
Paper (a)

MECHANISATION OF SMALLWOOD HARVESTING IN N.Z.

R.D.GORDON
Research Engineer
LIRA.

INTRODUCTION

In 1977 Terlesk observed from overseas experience that "it seemed the path towards mechanisation was strewn with rusty machinery" (Ref 1). This quote accurately portrays the current 1980 position with respect to mechanisation of smallwood harvesting (i.e. machinery to fell and trim, excluding the chainsaw), in New Zealand. Why and will this continue is the subject of this paper, which attempts to identify on an industry wide basis the lessons learnt. As well, it aims to provide some meaningful guidelines on the future use of mechanised harvesting for smallwood operations in New Zealand.

If mechanised harvesting is going to be a viable logging method it gets the best opportunity to do so in smallwood. This is because of:

1. The comparative high cost of manual operations in smallwood with which it has to compete.
2. The ease of engineering the felling and trimming process for small trees rather then large trees.

DEVELOPMENTS UP TO 1978

It is pertinent to trace the introduction of the mechanised harvesting approach in N.Z. Very briefly the following table indicates the extent of activity at four points in time, from 1970 to 1978.

APPROXIMATE NUMBER OF UNITS IN SOME FORM OF PRODUCTIVE USE				
Date	Tree Shears	Feller-bunchers	Delimbers	Harvesters
1970/71	0	0	0	0
1973/74	3	0	2	0
1976/77	4	4	4	0
1978	4	7	5	0

The tree shears introduced were all hydraulic blade and fixed anvil type shears, mounted on crawler tractors. As well as for felling larger radiata pine they were also used in clearfelling small sized trees such as Ponderosa pine. Following the tree shears,feller-bunchers arrived with initially a rubber-tyred front-end loader based unit (Bobcat) and two excavator based units (Hitachi and Drott) introduced. These were later followed with further excavator based units (Hitachi) another rubber-tyred front-end loader based unit (Clark), and a locally produced crawler tractor based unit. All had hydraulic action shear blades and some had the ability to accumulate stems. All essentially were applied primarily to clearfelling smaller trees, such as the unthrifty N.Z. Ponderosa pine crop,and a prominent reason for their introduction was poor labour availability for such work.

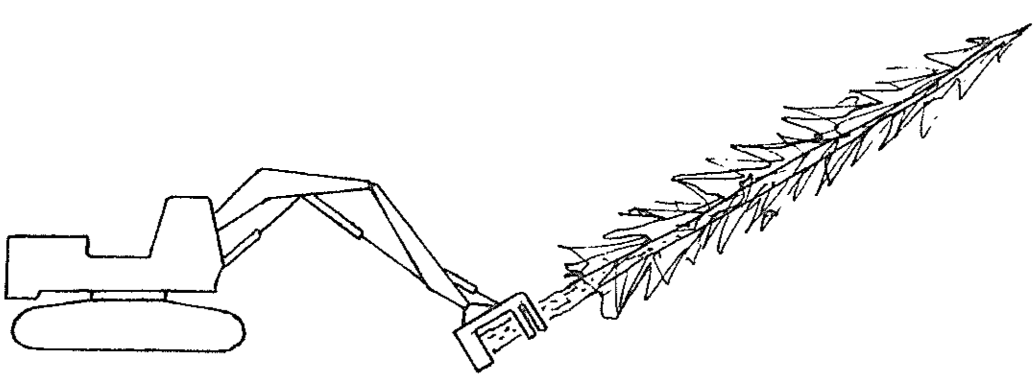
On the delimbing side, two processors (Cancar) were first introduced, although undoubtedly the use of a skidder blade to help remove limbs was tried. The processors delimbed and cut single stems to length using wrap around knives and a hydraulic ram stem feed system. These were followed by skidder mounted chain flail delimbers of various layouts. During the above period there were also brief trials carried out with other devices that included partial delimbing of standing trees and dragging multiple stems through a mesh to break off branches. Again all these applications were essentially on unthrifty species such as Ponderosa pine, and labour availability was a prominent reason for their introduction.

The 1978 point is important because at this stage a number of things occured, as follows:

1. The innovative loggers had by then dabbled in the mechanised approach and no doubt were more knowledgeable about its advantages and limitations.
2. Comprehensive studies of mechanised felling and mechanised delimbing had just been completed by LIRA and FRI, and the findings passed on to the industry through reports, talks, and a seminar.
3. This happened to be the point at which the total number of mechanised operations in N.Z. reached a peak. The number has since dropped.

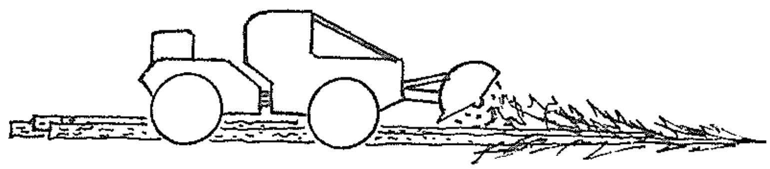
During 1978 the LIRA studies and seminar (Ref 2), at which considerable local experience was exchanged, identified the potential and limitations of mechanised harvesting in N.Z. Desirable directions for future development were also highlighted. The main findings, or conclusions emanating, were:

1. Shears and feller-bunchers were considered to be cost competitive with manual chainsaw felling in small clearfelling operations. (e.g. clearfelling of unthrifty crops such as Ponderosa pine). In the N.Z. logging scene it was desirable to make use of a standard base machine that was common to the logging industry. Machines in this category included crawler tractors, rubber-tyred front-end loaders, skidders, and excavators. All had characteristics which made them individually suited to a wide range of applications.



Example of a feller-buncher

2. Mechanised delimbing was also considered to be cost competitive with manual chainsaw trimming, but a particular form of mechanised delimbing showed up as offering significant cost savings if operable. This was basically the low capital cost multi-stem delimber attachment that could operate with base machines common to N.Z., doing a partial trim only.

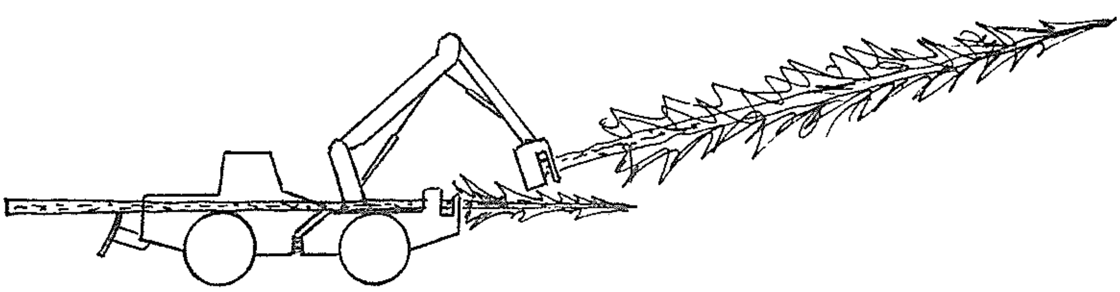


Example of a mulit-stem delimber

3. Multi-function machines such as feller-delimbers (harvesters) that were available had a marginal potential to be cost competitive with the manual chainsaw system. They could reduce costs if everything ran in their favour, such as ideal tree sizes and form, good operation management and labour, good machine maintenance and servicing etc. A modelled costing done by LIRA in 1977 resulted in the following comparative costs for felling and trimming stems of volume 0.2 to 0.3 cubic metres, in a clearfelling situation:

   - 1977 manual chainsaw felling and trimming, approx. $2.50/tonne (labour $4.50/hr)
   - 1977 harvester machine felling and trimming, approx. $2.00/tonne (machine $150,000)

   As the harvester costing is much more sensitive to variations in factors like machine life, utilisation, repairs cost, residual value, and production rate, this difference was only considered marginal.



Example of a harvester machine

Also identified during 1978 (Ref 2) were the following:

4. The immediate future for mechanised harvesting lay in clearfelling unthrifty species on the Kaingaroa Plains, however, once this was completed a greater challenge was mechanisation in radiata pine thinning.

5. Mechanisation does not necessarily get over the problem of labour shortages, as you need better system management, and labour prepared to work on shift, where more expensive machinery is used.
6. The relative value of labour (as well as labour availability) to machine costs, and the movement of their relativity would dictate the swing to and from mechanised harvesting.

SUBSEQUENT DEVELOPMENTS 1978-1980

Over the period 1978-1980 further industry trials and developments occured. This included the use of one or two home built feller-buncher on crawler tractors, the trial of multi-stem delimbers on radiata pine thinnings, and the local development of a harvester for thinning radiata pine. Hence the swing to consideration of mechanised harvesting in small radiata pine and thus of necessity in thinning operations. During this period there was a marked change in the trend pattern which is shown below, updated to 1980.

APPROX. NUMBER OF UNITS IN SOME FORM OF PRODUCTIVE USE				
Date	Tree Shears	Feller-bunchers	Delimbers	Harvesters
1970/71	0	0	0	0
1973/74	3	0	2	0
1976/77	4	4	4	0
1978	4	7	5	0
1979/80	1	3	0	3

No new tree shears, feller-bunchers, or delimbers were introduced and as well, the number of units in productive use dropped markedly (Ref 3, 5). It is often said that the proof of the pudding is in the eating. It seems N.Z.loggers have had a taste of mechanised harvesting and have spat it out again. Against this trend however, we saw the first introduction of harvesters (Hitachi) being used to delimb and fell in radiata pine thinnings.

The factors causing this trend reversal (noted as early as Nov.1977 by Terlesk in Ref. 1) for shears, feller-bunchers, and delimbers, are many and varied, but such factors that stand out most include:

1. There was a favourable change in labour availability for chainsaw operations in those areas using mechanised logging.
2. There was a significant increase in equipment costs, particularly machine purchase costs and fuel costs.
3. There are problems in making mechanised delimbing operable. Single stem delimbers are restricted by lineal throughput to production rates not high enough to easily justify high cost machines. Multistem delimbers are at a low stage of development and their output quality can have difficulty meeting mill requirements.
4. The economics of mechanised operations are very sensitive to system availability. Low availability of machines and systems was being experienced. The introduction of unskilled workers to mechanised operations and the lack of trained servicemen and managers was undoubtedly a contributing factor to this.

5. The operating conditions of tree size and terrain were less than ideal for economical mechanised harvesting.

Against this adverse mechanisation trend for felling machines and delimbing machines, we now have the emergence of harvesters. The lack of available experienced labour has been stated as a major reason for their introduction (Ref. 4). Time will undoubtedly tell whether they are here to stay or not. My limited knowledge of the operation involving these harvesters confirms some of the earlier conclusions about harvesters,in that their economics are undoubtedly sensitive to:

1. Ideal tree size and form as well as terrain.
2. Good operational on-the-job management.
3. Good machine design, maintenance and servicing.

The over-riding factor as to whether any harvesters are justified comes back to the consideration of labour availability and cost, compared to the manual alternative.

If one updates the 1977 LIRA comparative cost example for felling and trimming in 0.2 to 0.3 cubic metre stems, we get:

- 1980 manual chainsaw felling and trimming, approx. $3.50/tonne (labour $6.00/hr)
- 1980 harvester machine felling and trimming, approx. $3.00/tonne (machine $200,000)

A similar cost comparison for felling and trimming in 0.1 to 0.2 cubic metre stems results in a cost of $6.00/tonne for both manual and mechanised ($125,000 machine on double shift) approaches. Hence the present situation is similar to that in 1977 with the difference considered to be only marginal.

LESSONS LEARNT

The main points arising from this look at the N.Z. experience with mechanised harvesting in smallwood operations, are as follows:

1. While mechanised felling can be economically applied, using equipment of the type introduced in the past, a major difficulty arises in having a suitable delimbing operation that can keep up with the higher felling production rate.

2. There is money to be made by an equipment supplier or innovative logger if they can come up with a good low cost delimbing attachment for a machine common to logging. (A multistem delimber offers most potential.)

3. There is a need for better skilled labour in operators, managers, and servicing, if mechanised operations are going to be used.

4. For harvester machines (that fell and trim) we should continually watch the relativity of labour cost to machine cost, as a significant movement may economically justify the use of harvesters. Where they are currently used on the basis of labour shortages or otherwise, the operation can benefit significantly by top knotch management and ideal operating conditions. We can undoubtedly afford to watch closely, the Australian's current use of such equipment.

THE FUTURE

In attempting to gauge the future for mechanised smallwood harvesting I don't see the relativity of labour costs verses machine costs changing markedly towards encouraging mechanisation over the next five years. Equipment costs will continue to rise primarily through the influence of the energy crisis and the factor of New Zealand's location. I also do not foresee any overall labour shortages or political happenings that will drastically increase our labour costs, although there may be initial acute labour shortages in some of the newer areas to be harvested. From 1985-90 and onwards however, when the logging industry size is expected to increase significantly, there will undoubtedly be labour shortages that encourage mechanisation.

I doubt also whether N.Z. (being the size and in the location it is) can afford to get involved in an expensive form of machinery development unless the export of such machines arises. For the more sophisticated machinery then (such as harvesters) we should thus leave development to the overseas countries who are in a better position to efficiently support such. We should concentrate on monitoring and checking the relevance (through co-operative N.Z. trials of such machines, if need be) of overseas machines that look to have potential. As well we should attempt to make a better use of the excellent general engineering facilities we have in N.Z. With guidance they could readily produce lower cost attachments that could make mechanised harvesting a competitive means for smallwood harvesting.

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SESSION 4
Paper (b)

ALTERNATIVE CONCEPTS FOR DEVELOPMENT IN MECHANISATION

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There are three important points for the planning of smallwood harvesting systems:

1. The Management objectives of the enterprise must be clearly defined.

2. The performance characteristics of the different processes involved in harvesting must be understood.

3. Priority must be given to the development of machines and systems that employ those processes consistent with management objectives.

It is important to look at the development of a harvesting system on two levels. One level considers harvesting wood today and the equipment needed for it. The second is the conceptual level for harvesting tomorrow's wood. The development of harvesting technology is not a short haul and there has to be some planning and some conceptual background to it. Nowhere is this more important than in smallwood handling.

These points will be explored by looking at the performance of three different harvesting processes and how these relate to different objectives.

Figure 1 illustrates in mathmatical terms the performance of the three basic processes. In Process 1., the time to process the tree is strongly related to the size of that tree. An example of such a process is felling: it does not make much difference whether a chainsaw or feller-buncher is used, the fact is that not much other than tree size (within a terrain class) determines the performance. Output and costs are essentially linear and entirely dependent on the size of that tree.

Another common process used in harvesting is where the tree passes through the process in a linear manner, or the process passes along the tree. This describes delimbing, whether it is done with an axe or a chainsaw, or with a hydraulic delimbing head moving along the tree or the tree is moved through it.

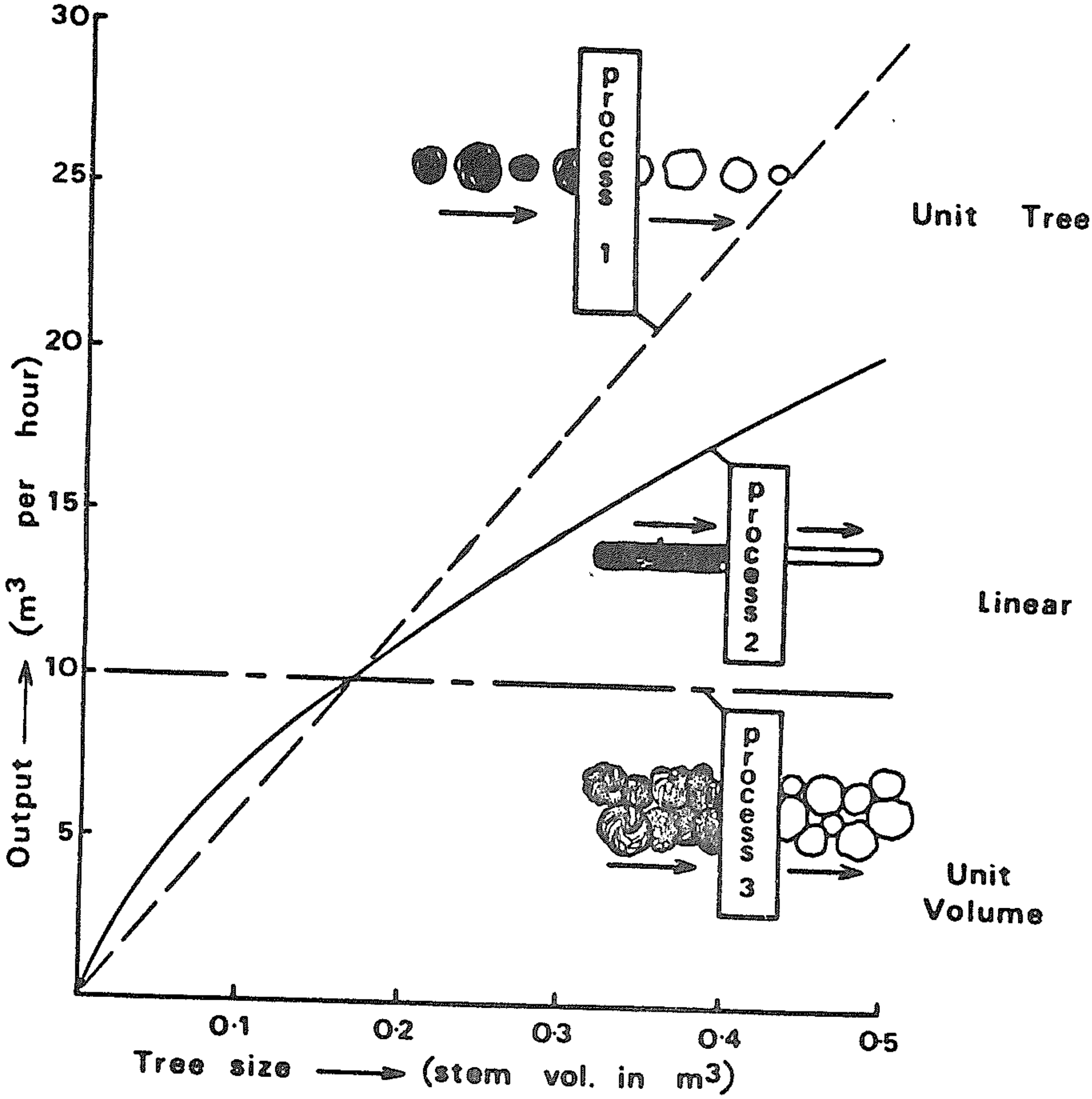

Figure 1. The Influence of Tree Size

These are all delimbing processes and output is most dependent upon tree size, and with small dimensions extremely sensitive to it. It is illustated as Process 2. in Fig.1.

By mechanising delimbing the process is not changed - more capital has been put into it but the same relationship between productivity and tree size still holds. It is the same when comparing the chainsaw and a feller-buncher - it is essentially the same process.

Where a high degree of selectivity is required these are the common processes in the bush. They offer the opportunity for producing a considerable number of different log products to high log specifications. Such processes are required if emphasis is placed on maximum value recovery from the stand, e.g. in the production of posts and poles.

There is an alternative and it is relevant in the long term to the harvesting of smallwood. These are unit volume processes, where a number of stems or pieces go through the process at a rate that is determined by the volume of the unit rather than the size of the individual piece. These are not common in harvesting systems, but are well known in the drum debarker. That is why the debarker is such a widely used tool in smallwood - it is head and shoulders above other methods of debarking smallwood. These processes are emerging in harvesting too, in multiple stem delimbing systems. There are also felling devices emerging that can do this: continuously moving saws and rotary cutting heads, which have this same theoretical consideration. Fig.1, Process 3., shows a mathmatical projection of this process which is fairly academic now, but not in the long term.

The problems associated with harvesting smallwood are not easily resolved, and the New Zealand experiences have demonstrated that. In the long run effort and energy of development must be concentrated on the right process. The slasher we saw on the field trip processing quite small sized tree lengths into short wood is such a process. It is a multiple stem process which in every way warrants the resources that are being put into its development.

Figure 2 gives the results of a Finnish study. It shows the costs of logging with a wide range of different systems: motor-manual, traditional short wood method, through to a wide range of highly mechanised systems. They all employ exactly the same process, though the delimbing head replaces the axe, and the feller-buncher replaces the chainsaw. The same cost relationships apply, and will always apply if we stick to traditional processes.

To show that it is possible to get away from these relationships, Figure 3 shows components which are working today, but have not been put together on the one machine. This concept is being looked at for harvesting short rotation eucalypts. There are several circular saw felling units working around the world today. An experimental one is under development at CSIRO right now. The machine moves along at a fixed speed, and the rate at

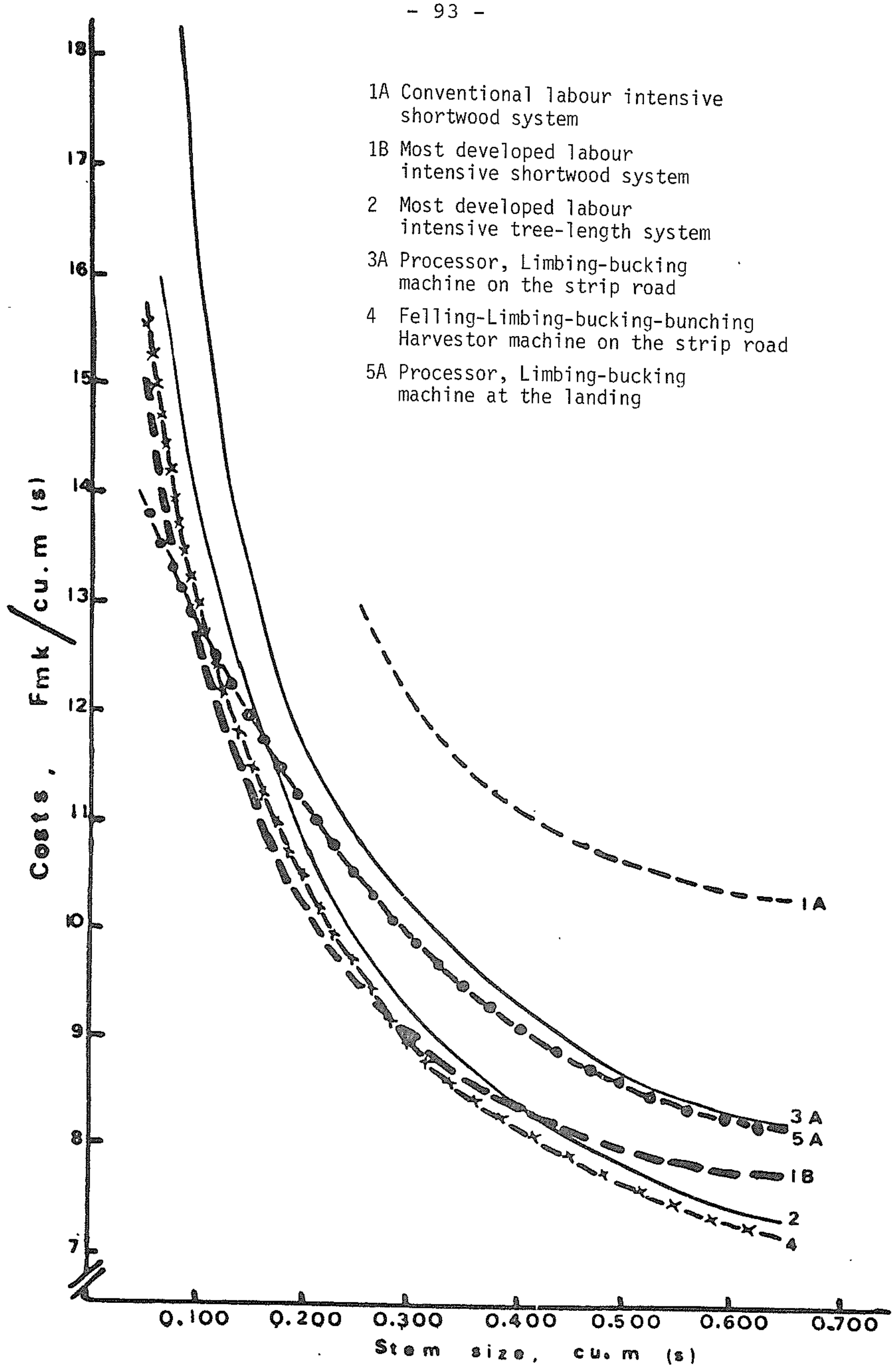

Figure 2. Relationship Between Stem Size and the Cost of Harvesting by Various Clear Felling Methods

which it produces wood depends not on the size of the tree, but on the number of trees or total sectional area of trees presented to it. It picks trees up and drops them in a chipper. The chipper has those same characteristics in its output: theoretically it is not dependent on the size of the individual stem but on the total stem sectional area that is presented to it. These are not commercial models, but have been used to demonstrate the concepts which are emerging.

The necessity to define an overall enterprise objective was mentioned earlier. A lot of logging development around the world has ignored this. For example the Scandinavians, who in their strong pursuit of mechanisation (and they have put great resources into it) have perhaps overlooked some of the marketing implications in what they have done. Just two objectives are illustrated in Figure 4, with two extremes. In one extreme the management objective is minimum wood cost, as would be the situation for a pulpmill or some crude fibre or industrial energy use - high priority has got to be given to the cost. The aim should be the relatively crude conversion of wood to perhaps a single product. In this situation the kind of processes described above as the third process can be applied: the continuously moving felling devices, flail delimbing, multiple stem slashing, drum debarking - all those machines fit into that category.

The other extreme is where emphasis is placed on the maximum value of recovery. This system will produce small sawlogs, round timber, poles, piles, in fact products which have a high premium. This represents the other management objective - felling and conversion into several different products and generally with a fairly high level of product specification. Processes one and two must generally be used.

Two logging systems show how these objectives can be achieved involving the kind of concepts described above.

The typical Canadian system has a feller-buncher with an accumulator type head bunching wood for a grapple skidder, a flail delimber, top and tail loading, and a large multi-stem slasher and drum debarker at the mill. If that is the kind of wood required those concepts should be considered.

The second system, which is fairly common in much of Europe, uses conventional felling, and a limber-bucker which can process an individual tree to quite a high standard of limbing with minimum damage to wood. Especially with small sawlogs and round treated timbers, consideration must be given to the limbing quality, the damage done to the log and the precision with which it can be cut up. In this system there is conventional grapple skidder to pull trees out to a processor. The log processsing station is used to maximise the value of the products that the forest can yield. There is a log in-feed, a debarker, electronic scanning and

(1) Felling Saw
(2) Infeed Rolls
(3) Drum Chipper
(4) Discharge to Trailer Container
(5) Bogie

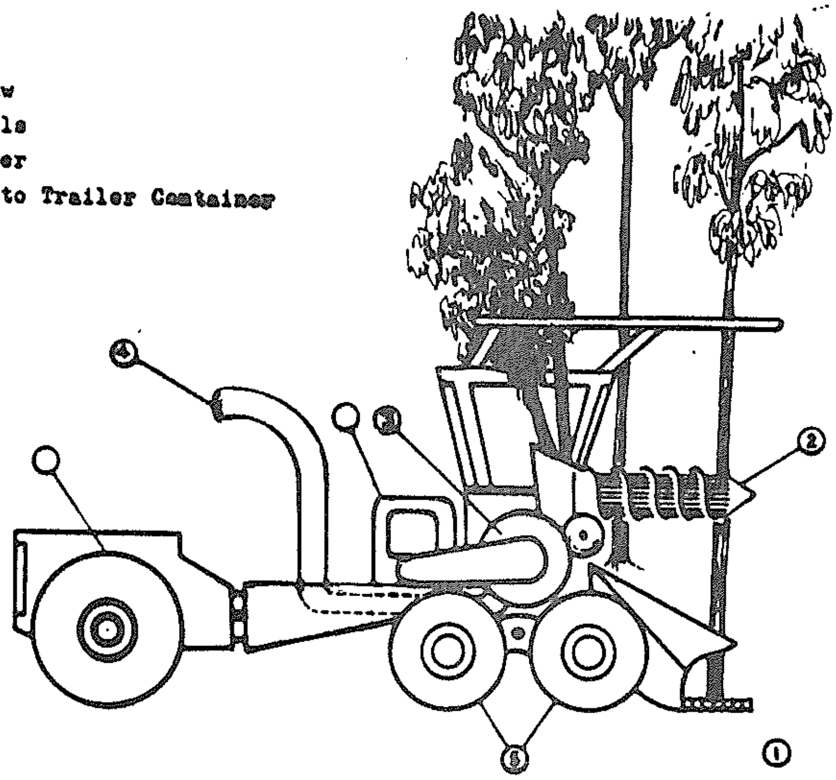

Figure 3. A Machine Concept for Continuously Harvesting Eucalypts Grown On Short Rotation

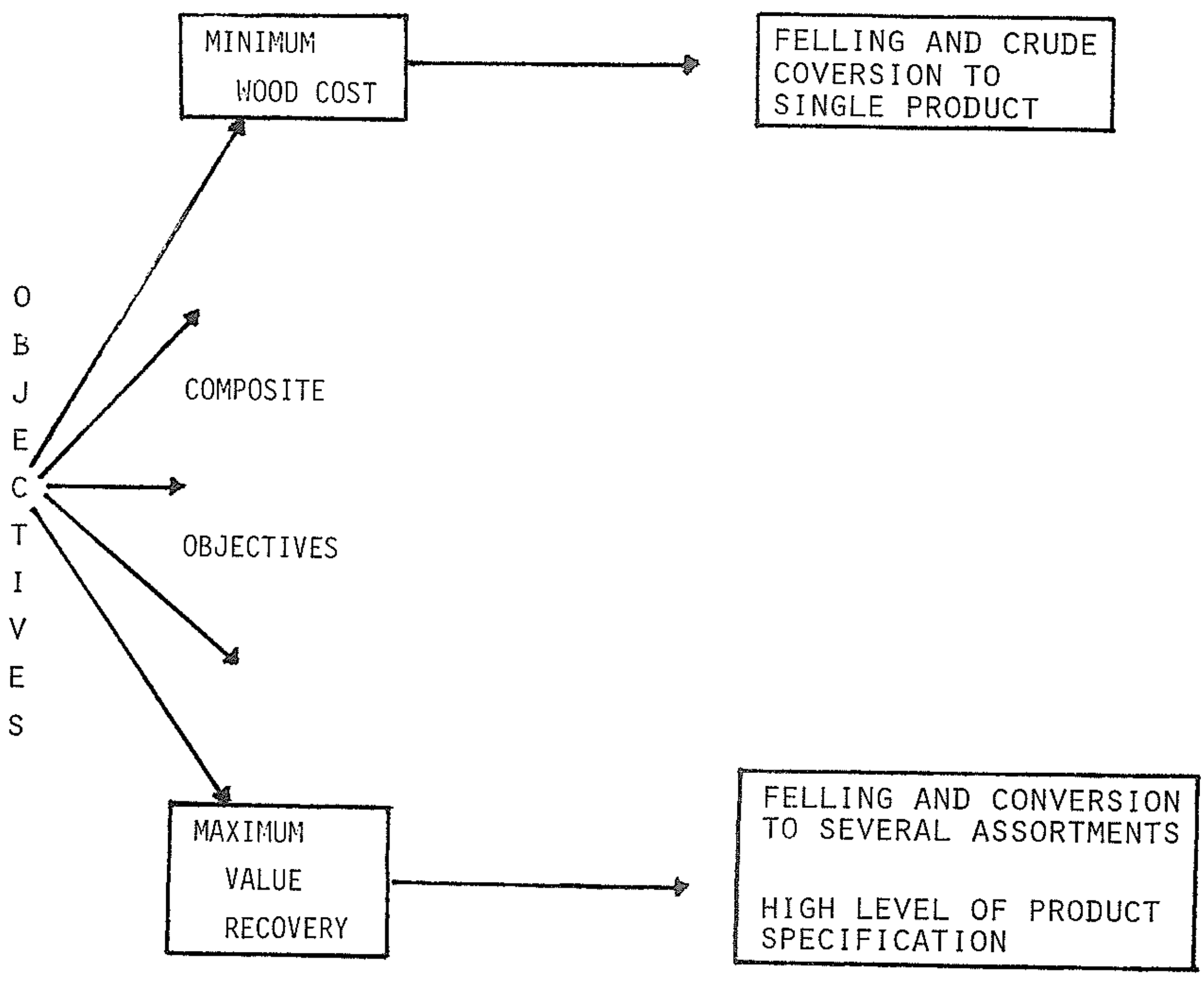

Figure 4. Management Objectives in Smallwood Harvesting

decision making equipment, a bucking saw, and a log sorting system. Perhaps this is not for New Zealand, but it is a concept that is gaining considerable hold in Europe, and to a lesser degree in North America. It can be guaranteed to obtain maximum value recovery from the forest to give a very high capacity to market products of a high standard. In addition it gives a lot of information on costs and productivity, which is a great aid to management. The management of mechanised operations is esssentially part of the problem of introducing mechanisation. This is a system which in itself is a great aid to management.

Emphasis has been placed on the need to understand the basic processes involved in smallwood harvesting and that priority be given to these in the development of logging machines and systems has been stressed. These aspects have been emphasised, they are so often overlooked in the push to mechanise. Success in harvesting smallwood will not be achieved by simply mechanising - it will be achieved by looking to the basic processes involved.

MANAGEMENT AND COST IMPLICATIONS OF MECHANISED SMALLWOOD HARVESTING

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Introduction

Forest managers have, in theory, a wide range of options available when choosing a logging system. (12,13) In practice, this range may be considerably limited, and may in fact be restricted to the machinery and men present in the area at the time required. Whatever combination of machines and men is chosen, there will be managerial and cost implications. This paper looks at some of these implications, based on the experience of a number of harvesting operations.

There are many reasons for choosing a mechanised system to harvest smallwood, although the reason most often quoted is one of costs. Pressure to mechanise is largely directed towards harvesting small-sized trees for pulpwood because this is the sphere in which the cost/price squeeze is most acute.(20) Recent costs of "small-wood" production have increased far more rapidly than other logging costs. This is due mainly to the high labour content of "small-wood" operations. Productivity per man has not kept up with the escalation in wage rates and using the same methods can not be expected to improve.(10) Other reasons given are that smallwood will form a greater proportion of the total wood used in the future, the demand for this type of wood will increase, as will the supply from forest owners, and there is a shortage of adequately trained and motivated labour.(6)

Before proceeding, it is necessary to recognise the problems that are present when discussing this topic. Firstly, "smallwood" may mean different things to different people. Researchers in the northwest states of the U.S.A. have classified smallwood as any tree under 50.8 cm d.b.h. or logs averaging less than 0.7 cubic meters in volume.(4) One New Zealand author defines smallwood as "roundwood in which most of the individual pieces would fit into a diameter range from 7 cm to 25 cm".(10) An Australian author has suggested that smallwood be defined as "wood with dimensions smaller than those of wood of normal market use" (8), and this may be quite suitable for our use.

"Harvesting" is another term that may have various meanings, as there are distinct differences between salvage logging in cutover areas and the primary logging or thinning of standing small trees. Thinning may be carried out in a number of ways as well. The implications of mechanisation will change in degree, depending upon which specific operation is being discussed.

The degree to which a system is mechanised is another variable which should be clarified. The conventional chainsaw/skidder operation of today was a great step forward in mechanisation in the late 1950's and early 1960's. Logging systems in use today may be completely mechanised, or may have various inputs of machinery and men interspersed along the production line. The implications of mechanisation will depend on the degree of mechanisation adopted.

In many ways, New Zealand is much more suited to mechanised smallwood harvesting than many other countries with a longer history of logging mechanisation:large areas of plantations, a history of intensive silviculture, stands with very little variation in tree size, suitable terrain in many areas, a limited number of species to be harvested, etc. In discussing one species, Terlesk stated that "mechanised harvesting of ponderosa pine has great potential. The piece size is suitable, terrain causes little restriction to machine movement, a large resource and high demand are present. The processing plant is geared to accept material poorly prepared by traditional standards. Labour is keen to make the transition from the forest floor to the cab, managerial expertise is present, and back-up maintenance facilities are provided. Virtually all the ingredients for implementing a highly mechanised system are available."(19) The fact that the mechanised system introduced to carry out this operation is no longer in use, and has been replaced by the more conventional chainsaw/skidder operation, is reason enough to look into the managerial and cost implications of mechanising smallwood harvesting.

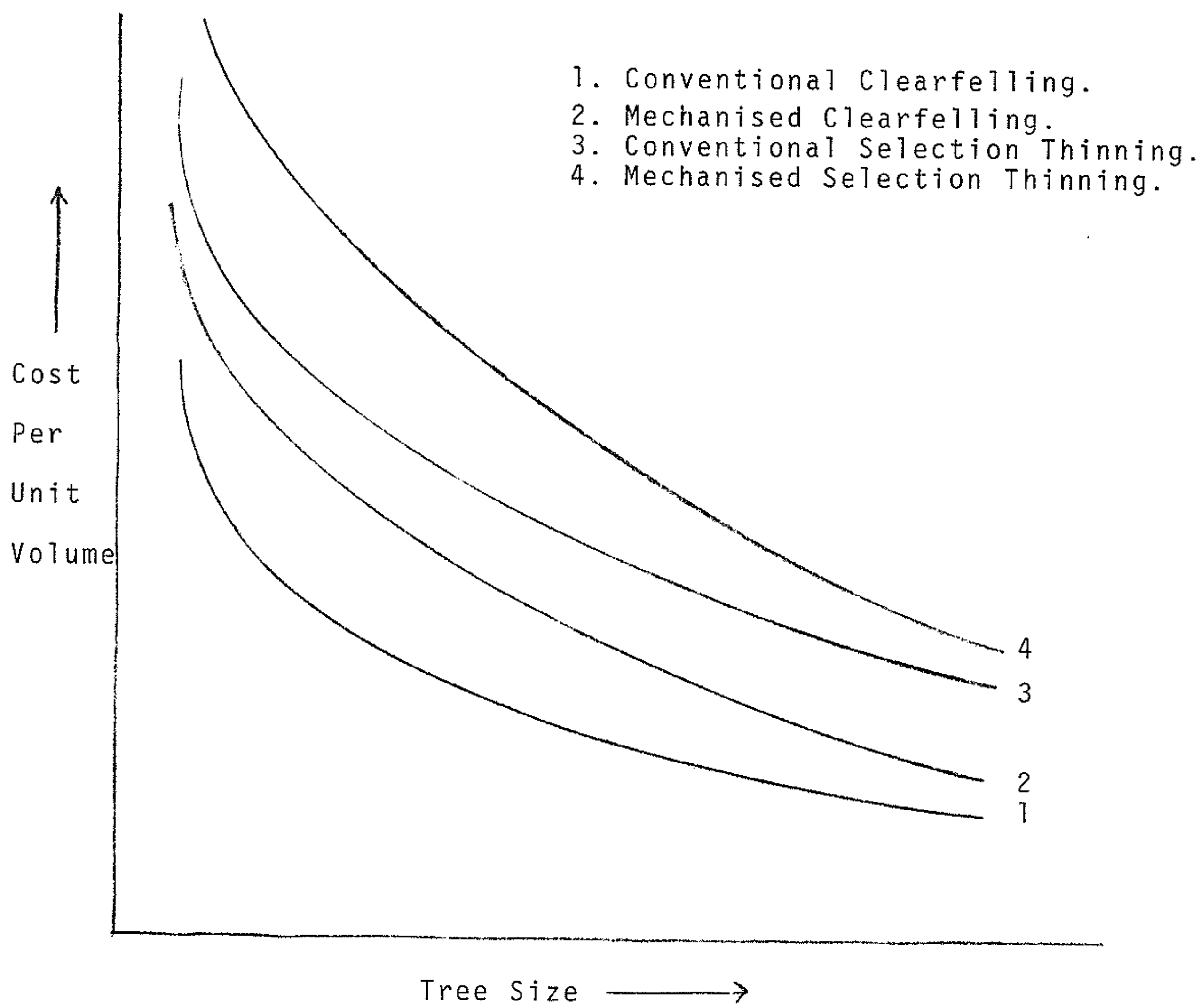
Implications

1.For Costs:

As stated earlier, the escalating cost of harvesting smallwood by the conventional chainsaw/skidder (or forwarder) system is one of the main reasons for choosing to mechanise. In fact, it is usually a combination of economics and labour shortage that makes mechanised systems appear attractive. "The introduction and promotion of sophisticated logging equipment was based on cost reduction. The one man who was not convinced of this was the wood production manager -- when the equipment assigned to him failed to produce as advertised. However, he was committed to eventual mechanisation because of a decreasing labour force and the need for year-round production independent of the weather."(3) "The factor limiting the degree of mechanisation is not the state of technology but economic feasibility. In some cases, the labour shortage is forcing employers to use mechanised methods even though labour-intensive methods would be more economical if the labour were available."(15) These quotations should bring home the fact that, generally speaking, mechanised operations are <u>not</u> cheaper than conventional methods, and the experience of many companies would bear this out.

It must also be borne in mind that in the areas where mechanisation has had a long period of development, labour tends to be the most expensive component of the man-machine system, and this has given the surge to mechanisation an extra boost. Whether this is true of New Zealand has not been clearly determined; there are indications, however, that machine costs are rising at a more rapid rate than the cost of labour. (19)

The problem with harvesting smallwood by chainsaw/skidder system is the low return for time invested. In other words, low productivity and thus high cost per cubic meter -- a reflection of the importance of tree size. Once this is understood, it must be accepted that mechanised systems are also very sensitive to tree size, and for many reasons, perhaps more sensitive than conventional systems. The graph below illustrates the approximate relationships involved.



Generally speaking, attempts to substitute a mechanised system in place of a more conventional system, <u>without altering the operational or managerial characteristics</u>, has only resulted in higher costs, and the failure of many systems. These operational and managerial changes are discussed in the next section.

2.For Management:

(a)Expensive, sophisticated machinery will result in expensive wood unless production is at a maximum. It is not enough for loggers to produce more with the new system than with the old; they must produce at the maximum for the new system, even though it means two 8-hour shifts per day, 5 or 6 days a week. Many overseas operations are sheduled to work this way, in order to get the most out of the machinery.(17)

(b)To maintain this pace, and reduce downtime, field work-shops have been necessary in some instances to carry out repairs (and maintenance) when required, on the spot. Thus competent mechanics and welders become part and parcel of the logging system, and in some cases become involved in the gang bonus scheme. Service groups generally become more important in mechanised logging. Regardless of the woodlands accounting system, these back-up services add to the cost of the wood produced, and must be taken into account as such.

(c)Machine availability* and utilisation** must be kept high in order to keep costs down, and everyone, from top management to field supervisor to mechanic must support the operation in order to increase productivity and reduce downtime. (14) Low machine availability and utilisation have been responsible for many sophisticated logging systems being phased out, but it must be remembered that availability and utilisation are not diseases, only symptoms. The real problem lies with management organisation and operator conscientousness. Planning and control of the operation must be intensified. More and better records of the operational details will be required.

(d)Spare parts availability may become increasingly important, and for very sophisticated machinery,this may involve a considerable storehouse of parts. Research by the Pulp and Paper Research Institute of Canada (5), has shown that sophisticated logging equipment may not follow the usual trend of increasing repairs

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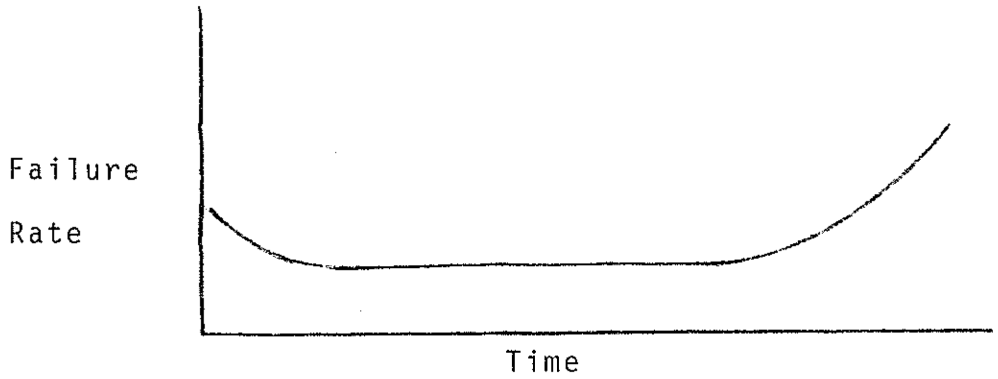
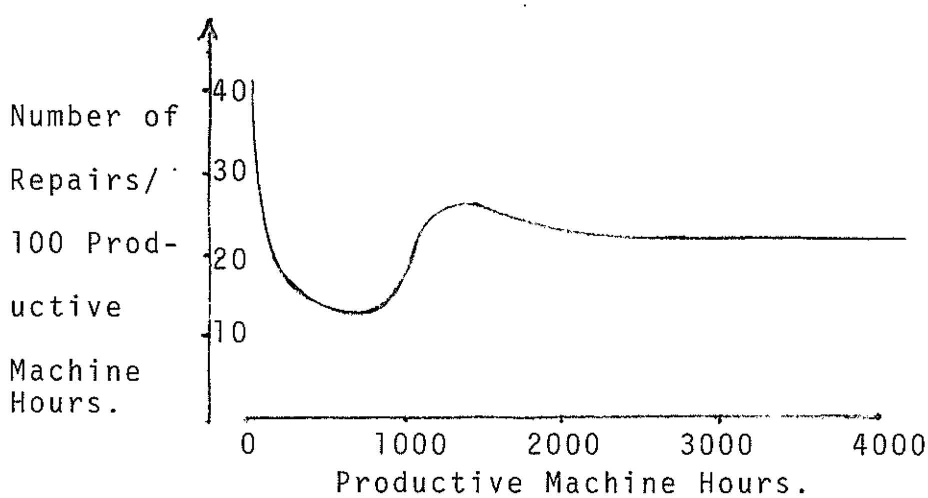
*$\frac{\text{Scheduled machine-hours - Maintenance Downtime}}{\text{Scheduled machine-hours}} \times 100$

** $\frac{\text{Productive machine-hours}}{\text{Scheduled machine-hours}} \times 100$

with age (bathtub curve), but may require considerable attention very early in its operating life, with impressive but short-lived results, followed by a short period of more frequent repairs which level off and stay relatively constant for a much longer period.





(e)Operating flexibility may be reduced with the adoption of a mechanised system. The cost of shifting machinery from one work site to another will be higher. Once a system is operating, it is unwise to stop or alter it to deal with changes in tree or stand characteristics. The percentage of cull wood which passes through the process can increase markedly. (16)

In order to make mechanised systems economic, they tend to be put in the best stands. This may result in relocation of the more conventional systems to the poorer stands, and this will only aggravate the problems these conventional systems have at present.

(f)Most mechanised thinning operations have been carried out in plantations as geometric or row-thinning systems, as opposed to a true selection thinning,(1,2,18), and it is certain that the adoption of mechanised thinning operations will bring the logging planner and the forest planner much closer together than in the past. The work done by FRI on planting stands with mechanised harvesting in mind is a prime example of what can be done in this regard. The conflict between harvesting aims and silvicultural techniques is a full topic in itself, and has been discussed at length by a number of authors.(7,11,21,22)

3.Pertaining to Labour:

Mechanising harvesting operations has, as one of its aims, a reduction in the labour input required. Ironically, the replacement of manual methods by mechanised systems have shown how important the human element is, for studies have shown that operators can differ in their output by as much as 100%, when using the same machine under identical conditions. Operator characteristics such as coordination and depth perception, and labour motivation, become even more important than in more conventional operations.

As well, it should be remembered that switching to a totally mechanised harvesting system will not ensure an end to a labour shortage. Some companies in Canada, because of the remoteness of their operations, have failed to attract enough labour to man their sophisticated machinery.

Lastly it is important to note that one of the present attractions of logging to the labour force is the fact that the men can work at their own pace, without the pressure of close supervision (9). This attraction may be lost with a switch to a sophisticated mechanised system, especially if operating it involves a great deal of repetitive motions. A highly-mechanised logging system may require a different type of worker, and the logging industry may find itself in direct competition with other industries for operators with appropriate motivation and skill.

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- SESSION 5 -

EQUIPMENT PROMOTION EVENING

Chairman: Bob Gordon, LIRA

Equipment is a vital part of smallwood harvesting. This session thus provided for equipment suppliers to briefly promote any new products that they offer for application in smallwood harvesting operations.

The schedule of participation was as follows:

Organisation	Promotion	Representative
Dalhoff & King (NZ) Ltd	John Deere harvester system	R.Watson-Paul Branch Manager, Rotorua
Waratah General Engineering Ltd.	Hitachi delimber-feller buncher	J.Barnett Sales Manager, Tokoroa
A.A.Edwards & Sons Ltd.	Kockums harvesting equipment	G.Edwards Sales Manager, Tauranga
Cable Price Corporation Ltd.	Hitachi feller-buncher and Wilhaul yarder	J.Clayton Branch Manager, Rotorua
R.C.MacDonald Ltd.	Bell logger, Sifer delimber, Igland winches and Lotus/ Timbermaster haulers	R.Talbot Manager Forest Division Auckland
Ward Hill Ltd.	Komatsu tracked loader and Iwate Fuji skidders	T.Hefferen Manager Technical Servic Rotorua
Ashworth Zetor	Bushwacker skidder	C.Ashworth Manager, Tokoroa
Cookes Consolidated Services Ltd.	Strops and rigging	K.Edge Sales Manager, Rotorua
Gough Gough and Hamer Limited	Caterpillar D3 tractor	B.Brittain Field Sales Manager Auckland
International Harvester Company of NZ Ltd.	International front-end loaders	B. Henwood Manager Logging Sales Auckland
Wemco Engineering and Manufacturing Co. Ltd.	Wemco merchandiser	R.Wilson Managing Director, Rotor
Morbark Pacific Ltd.	Morebark chippers	H. Fleming Manager, Rotorua

- SESSION 6 -

LABOUR

Chairman: Geoff Wells, LIRA

"TECHNIQUES AND EQUIPMENT FOR IMPROVING PRODUCTIVITY OF BUSHMEN"
JOHN GASKIN, Logging Development Officer, Logging Industry Research Association.

"TECHNOLOGY, THE WORK ENVIRONMENT, AND INDUSTRIAL RELATIONS"
BARRY SMITH, Research Sociologist, Forest Research Institute

"TRAINING"
MIKE NEWBOLD, Logging and Forest Industry Training Board.

SESSION 6
PAPER (a)

TECHNIQUES AND EQUIPMENT FOR IMPROVING PRODUCTIVITY OF BUSHMEN

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Logging Development Office
LIRA.

INTRODUCTION

Figures from the National Planning Model, 1979, show a projected increase of 8229 for the required number of bushmen over the next 25 years. This is based on the reduction of piece size and the productivity remaining the same. There are two possibilities for increasing productivity; increased mechanisation, expensive and limited to relatively flat country; or improving our present motor-manual operations.

Our present manual operations centre around the chainsaw - felling, delimbing, and crosscutting. By improving techniques in these areas we may thus improve productivity. This area is also the most dangerous and accident prone. Productivity can thus be increased by a reduction in accidents. Finally, reducing fatigue contributes to better productivity and to reduced accidents, to say nothing of creating a better work environment.

All the techniques and equipment described in this paper are designed to make the bushmans job safer and less physically demanding, while ensuring improved and more productive extraction.

BACKGROUND

In a 1979 LIRA survey it was found that the felling techniques commonly used by bushmen gave limited control of the felling direction, and in thinnings resulted in a high incidence of hang-ups. Many scarfs were not aimed in the right direction, 57% of all scarfs were overcut, many scarfs were sloping, and there was a big variation in size, shape, and thickness of the hinge wood. All these factors contribute to a lack of felling control. Felling aids were not used and there were barbaric methods of dealing with hang-ups.

Trimming was in nearly all cases executed by walking down the stem using a 80 - 100 cc chainsaw with a long bar. This is undoubtedly very hard on the fallers back, leaves him vulnerable to accidents by kick-back or falling, and results in a rough trim standard. The only time a faller walked alongside a stem was if it was too small to balance on or if it was on steep country.

This survey was used as background information by the Swedforest Consulting team which LIRA contracted to investigate and develop a safer, more efficient felling and delimbing technique for New Zealand. A great deal of this paper is based on that research and development. I would like to point out here that it was not a straight transferal of Swedish felling and delimbing systems, but a combination development of techniques suitable for N.Z. conditions.

TECHNIQUES AND EQUIPMENT AVAILABLE

1. CHAINSAWS

Currently our smallwood operations use 80 - 100 cc chainsaws with varying bar lengths of 46 - 60 cm. The reason given for using this type of combination is that it is considered easier to walk on the log and trim using a longer bar, and that "the more power - the more timber".

1.1 Lighter Saws

As was mentioned above, the common saws used today are in the 80 - 100 cc range. The weight of these saws is 8.3 kg - 9.9 kg. The same job could be done using saws in the 60 cc range with a weight of 7.8 kg (40 cc for first thinnings, weight 5.40 kg). The weight difference may not appear significant on paper, but by the end of the day 0.5 to 1.1 kg can make a vast difference. (These chainsaw weights are based on Husqvarna chainsaw specifications.)

1.2 Chainsaw Design

Chainsaw manufacturers are placing a great deal of emphasis on better designed chainsaws, both ergonomically and engineeringly. Some of the aspects of this are listed below:

1.2.1 Better designed body to facilitate easier use, i.e. smooth body so it can be carried without digging into the operator. Safety attachments for safer operation - chain guards in case of chain coming off or breaking, better balance saws to make them less fatiguing to use.

1.2.2 Anti-vibration mounts - over recent years these have come a long way. Most professional saws now have the motor and bar completely suspended on good rubber mounts.

1.2.3 Heated handles. Working in an 8° frost, the first hour is absolute agony. Many saws now have a means of combating Raynards disease and making life a bit more pleasant for the operator.

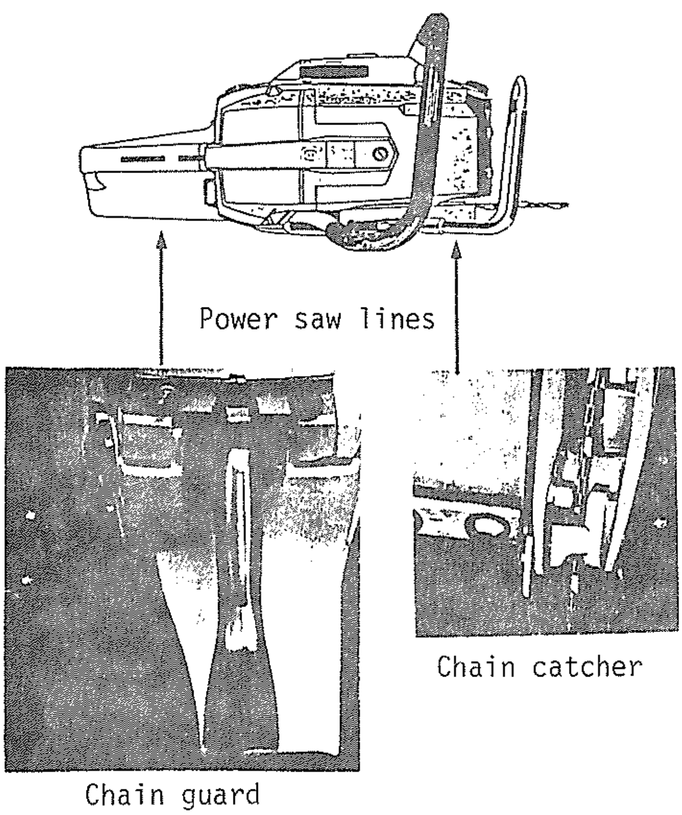


Figure 1 - The Chainsaw

1.3 Shorter Bars

In many instances there is no need to carry around a 46-52 cm, or even 60 cm bar when 38-40 cm will do just as well. Besides making the saw lighter it is also safer as there is less protrution which, while carrying the saw, can get caught in undergrowth causing a fall with a possible cut.

1.4 Mitts Verses Chain Brakes

If a faller wishes to wear a pair of gloves to save the wear on his hands or to keep his hands warm, he finds it very difficult to do so with a saw equipped with a mitt. Also, a chain brake removes the chance of human failure i.e. often fallers forget to wear the mitt - on a saw fitted with a chain brake it is there all the time. Having the left hand free allows the trimming technique described later, easier.

1.5 In-Field Maintenance

Many fallers become frustrated when small breakdowns occur. Many of these can be avoided by better in-field maintenance, i.e. allowing ¼ of an hour each day to clean saws and check that bolts are tight. Chainsaw mixed fuel has oil in it which hastens the fouling of air filters, so a mixture of water and detergent should be used to clean the air filter. The condition of anti-vibration mounts, the chain, and the bar, should be checked and the bar turned each day.

2. FELLING TECHNIQUES

The top and bottom cut of the scarf and the backcut are the three most important cuts a faller makes. They determine the speed of extraction, the resulting damage to the residual stand, and whether or not he goes home at night. If they are executed properly it is reflected right through the operation. If they are poorly executed he becomes responsible for reducing the efficiency of the operation.

2.1 Scarf

This governs the direction in which the tree will fall.

2.1.1 Top cut or face cut of the scarf should always be cut first. The angle should be no less than 45°- this allows the faller to look down the cut and sight where the bottom cut should start. Also, by having a face cut steeper than 45° it allows the tree to be virtually on the ground before the scarf closes. This makes better directional control.

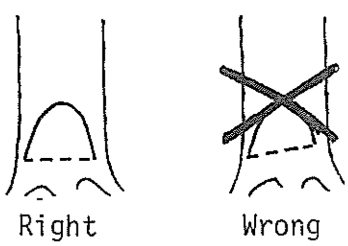
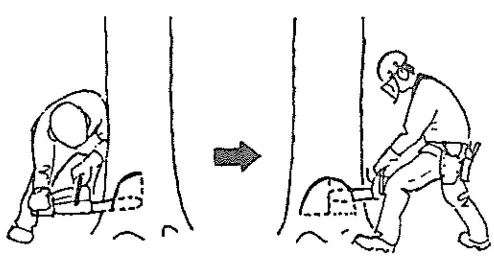
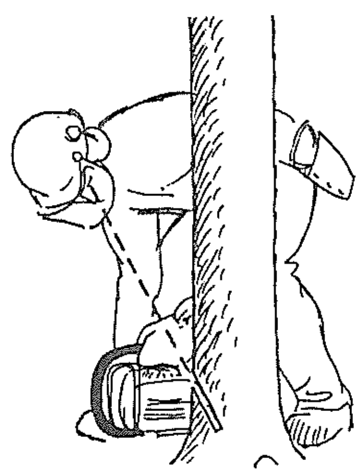


Figure 2



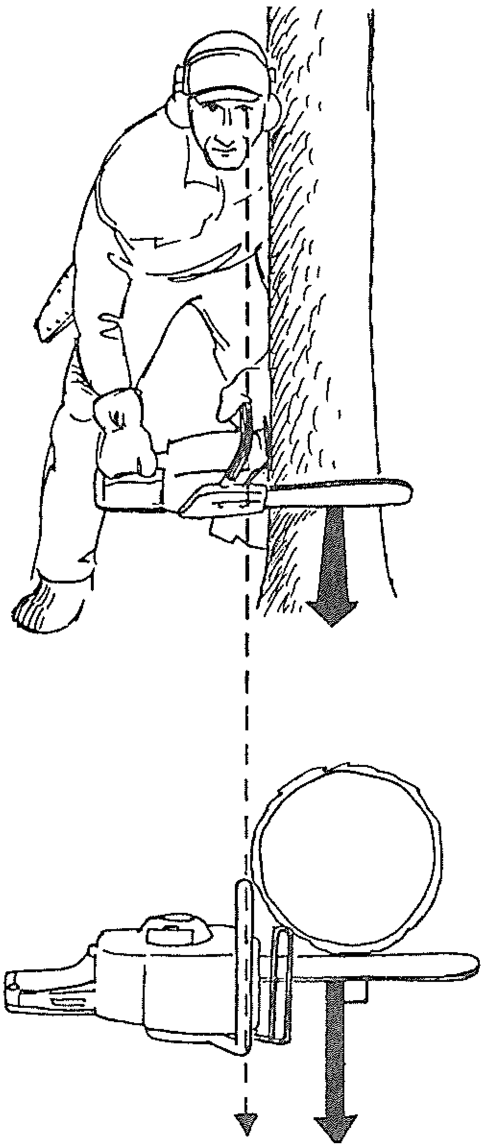
Cutting scarf on a large tree

Figure 3.



Faller sighting the bottom cut through kerf

Figure 4.



2.1.2 The bottom cut should be cut so as to meet accurately with the top cut. By looking down the kerf of the face cut it is easy to see when the bottom cut meets up. This removes the dangerous overcut situation.

The depth of the scarf should be from 1/5 to 1/3 of the tree diameter. Most professional saws are equipped with sights, and fallers should know how to use these sights, and use them all the time. This gives better directional felling. The faller can, if he wants to, lean against the tree while making the scarf cut, thus allowing him to partially rest. Further discussions on scarfing and the reasons for cutting narrow scarfs, occur later in the section of this paper dealing with felling aids.

Figure 5. Faller sighting the scarf while leaning against the tree

2.2 Backcutting

The traditional method of backcutting is to have a bar longer than the tree diameter, put it against the tree somewhere behind the scarf, and cut. This is the standard method irrespective of tree characteristics. In this paper I will deal with five technqiues of backcutting which should be known and used by bushmen. All these five techniques are appropriate when using a shorter bar.

2.2.1 If the tree diameter is less than the length of the bar and if the tree only has a slight lean, the easiest method is to cut straight through from the back ensuring than an even amount of hinge wood is left, as shown in Figure 6 opposite.

2.2.2 If the tree diameter is less than the bar length but has severe lean in the direction of fall, the best technique is to bore in behind the scarf at the same level or slightly above, leaving even holding wood, and cut straight back out. This means that the tree falls only when the cut is completed and reduces the likelihood of the tree splitting up thus damaging the most valuable area of timber, the butt.

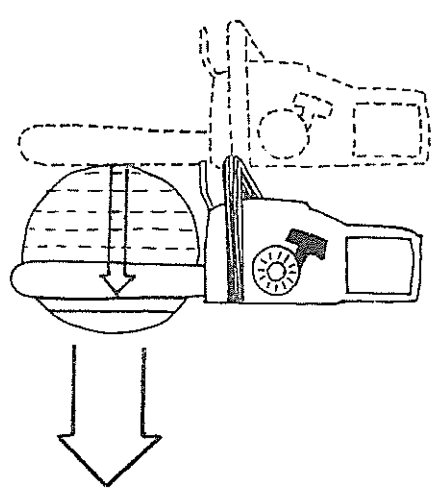


Figure 6. The backcut for a tree with a diameter less than the length of the bar

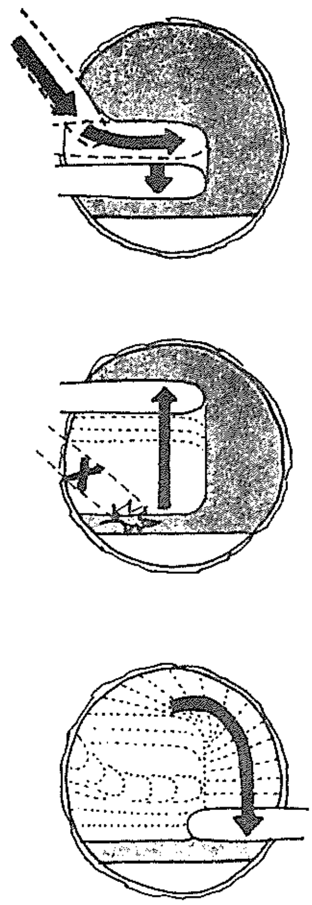


Figure 7. Backcut for a tree with a diameter greater than the length of the bar

2.2.3 If the tree diameter is greater than the length of the bar but not greater then twice the length, the technique best suited is to bore in behind the scarf until slightly over half the tree is cut, then to move around the tree finishing on the opposite side to that started. This gives better control over hinge wood and reduces the chance of cutting too much off one side of the hinge wood. (See Figure 7.)

2.2.4 If the above tree has a severe lean, in the direction of fall, the best technique is to bore in behind the scarf cut slightly over half the diameter, then cut straight back until there is about 50 mm of wood left. Remove the saw and do the same on the other side. The last 50 mm can be cut from the back towards the scarf or from the inside out. The reasons for this are the same as for 2.2.2.

2.2.5 The last method of backcutting dealt with in this paper is the case where the tree diameter is greater than twice the length of the bar. In this case, the bar is inserted into the scarf cut and as much of the centre of the tree as possible is cut out. The bar is then bored in behind the scarf and leaving 65 mm of the hinge wood, the cut is made the same as for 2.2.3. This technique is slower than any of the others and would possibly only be rarely used. (See Figure 8.)

The reasons for using these techniques for backcutting are; better control over hinge wood thus better directional felling; better recovery of butt wood, with practice a faller learns to know exactly how his saw cuts and how much wood he has cut (this is sadly lacking at present); reduces the chance of cutting through one side of the holding wood thus making it safer; by having better directional control it reduces the incidence of hang-ups and improves extraction.

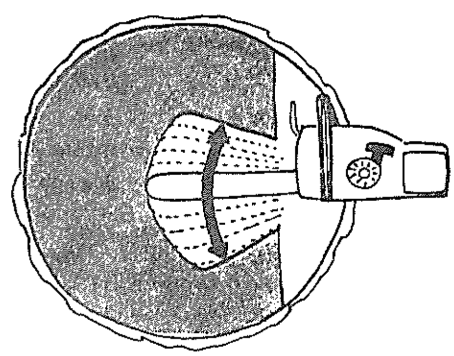


Figure 8. Backcut for a tree with a diameter greater than twice the length of the bar

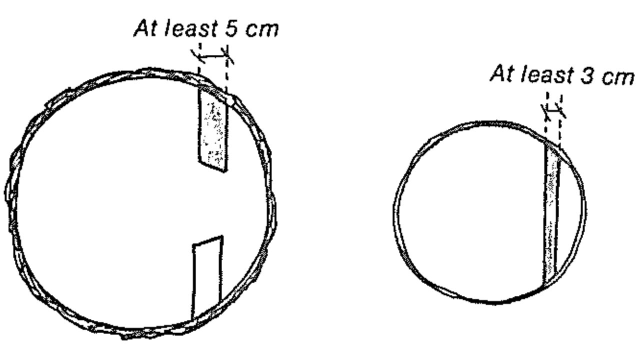


Figure 9. Resulting holding wood

One area which has not been covered here is the case of the tree that is leaning back. This will be dealt with in the section on felling aid

3. TRIMMING

With up to 65% of the fallers time in first and second thinnings being spent trimming, it is obviously an important area. Trimming by N.Z. bushmen, unless on very steep country, or working very small tree size, is carried out by walking down the stem using the tip (area most prone to kick-back) of a long, up to 60 cm, bar with the faller's back bent to resemble a staple. This is both physically demanding and extremely dangerous. The resultant trim quality usually necessitates employing an extra man to do a final trim on the skids.

3.1 Lever Technique

This technique of trimming employs a short bar, 38 cm long, with the faller walking alongside the log. The leverage principle is used, which means that the saw does the work rather than the operator. The saw is rested on the log or on the thigh, thus taking the strain off the operator's back. The legs are bent and the back kept as straight as possible. If done properly, this technique gives a far higher standard of trimming than conventional methods. All branches are cut off flush with the stem. To achieve the best results with this method, felling techniques have to be altered slightly. It is easier to undertake this system of trimming if the tree can be lifted off the ground. This can be done by felling trees across one another.

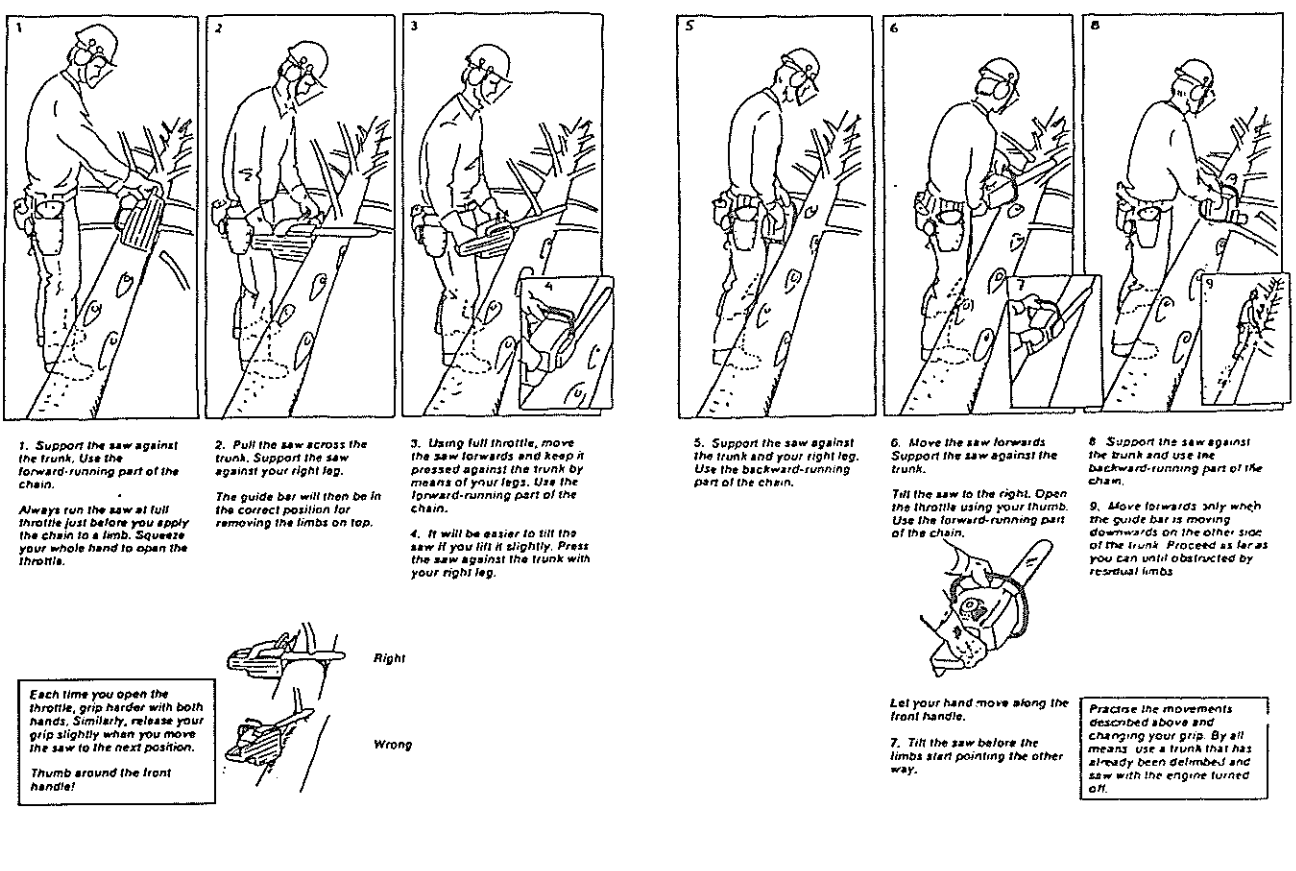


Figure 10. Delimbing Techniques

3.2 Felling Bench

The second technqiue discussed in this paper uses an artificial aid to achieve the required working height to facilitate easy trimming. The aid used is the felling bench, made of R.H.S.steel - a made up bench weighs 16 kg and costs approximately $80. The bench is placed about 3 metres in front of the tree and the tree is then felled across the bench. Once the stem has been trimmed it can, to à certain extent, be bunched for extraction,by see-sawing it on the bench to the required position. The bench has certain limitations; slope can only be worked on 15° or less; the bench must be positioned correctly otherwise it looses its effectiveness; ground conditions must be even with as few hollows as possible. The bench is a popular aid in South Australia where the outrow system is employed and all timber is cut to length in the bush.

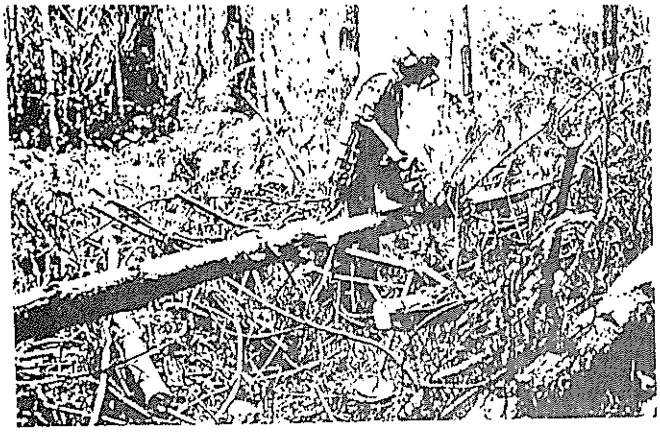


Figure 11. The Felling Bench

The important aspects of both of these trimming techniques is the emphasis placed on using shorter bars on saws (lighter units), protecting the fallers back by keeping it as straight as possible, using the thigh muscles (which are the strongest in the human anatomy) and making the saw work rather then the operator.

4. FELLING AIDS

This section deals with aids for felling difficult trees, or getting down hang-ups. Currently the technique employed for dealing with these situations is to drive the hang-up or difficult tree down, or in the case of a difficult hang-up, to cut short lengths off the butt of the tree until it comes down. Another commonly seen method is to leave the hung-up tree and get a machine to pull it down when the extraction is carried out - possible three weeks later. This means that the skiddy has to trim the log.

4.1 Felling Levers

There are many felling levers currently available overseas. However, in N.Z., only two can be readily purchased. One only recently arrived on the market.

4.1.1 Husqvarna felling lever - weight 1690 grams, length 790 mm. This lever has a double section which gives a maximum lift of

3 tonnes when 100 kg is applied to it. The lever is ideally suited to both first and second thinnings, Douglas fir thinning and minor species such as ponderosa pine, Corsican pine, etc. Special backcutting techniques are required and it is essential that the scarf is placed well forward on the stump to increase the lever's effectiveness, by altering the hinge point. The lever's primary use is to tip over trees that are leaning back. It obviously has a limit to the amount of lean it can cope with. It can also be used to get down hang-ups by using a cant-hook, or just the lever, as illustrated below in Figure 12. The lever costs about NZ$45 and is available from Husqvarna agents or H.H.Shillings Co.Ltd., Auckland.

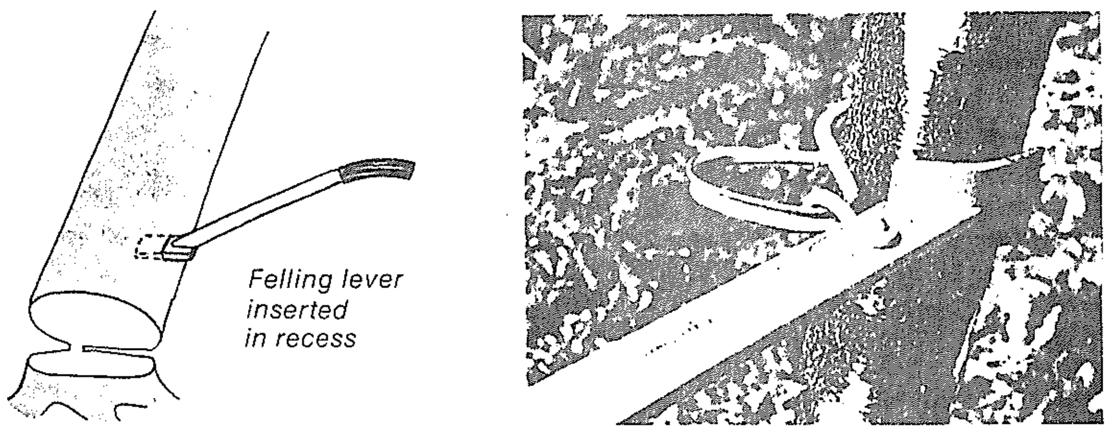
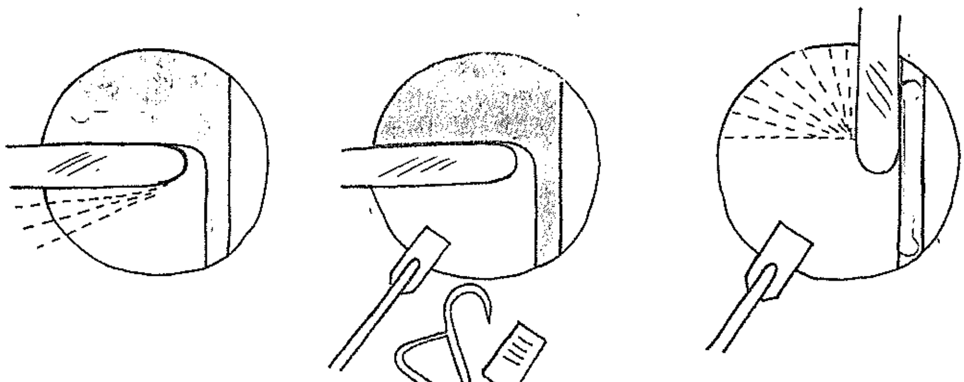


Figure 12. The felling lever and cant hook

4.1.2 Sandvik felling lever - weight 1580 grams, length 810 mm. This is a single acting lever with a capacity of 1 tonne. It is lighter and simpler than the Husqvarna. It is ideally suited to first thinnings only. Technique for using it and ability to get down hung-up trees are the same as for the Husqvarna. The lever costs NZ$16.50 and is available from Sulco Distributors, Wanganui, or Jonsered Chainsaw agents.

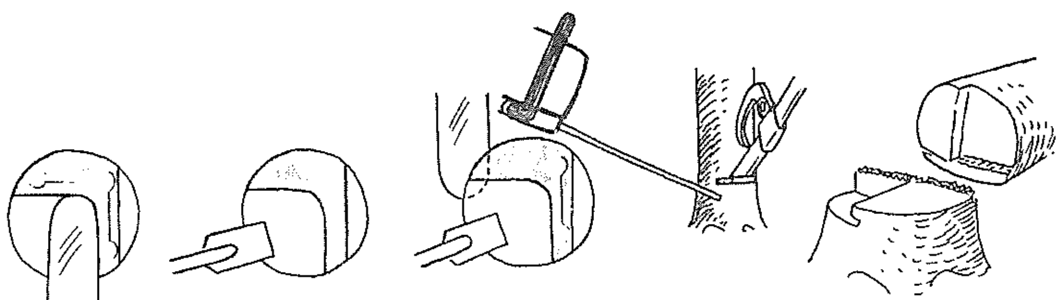
4.2 Air Bags or Felling Cushions

These are commonly used overseas and are available in N.Z. There are two bags available, one lifts 3 tonnes, the other 8 tonnes. They are used in the same manner as the felling levers. The advantages of the air bags over levers are that they can be carried on the faller's belt and are thus with him all the time. They are considerably lighter than levers, weighing only 360 grams and 600 grams respectively. The disadvantages are that the saw has to be equipped with a valve attachment which requires good maintenance and that they are more difficult to insert into the backcut. They are also more expensive, $60-$70 for the valve attachment and 3 tonne bag. They are made by Nordfor and are available from both Sulco Distributors and H.H. Shillings. The techniques for using levers and air bags are shown in Figure 13.



1. *Move the saw along an arc, with the nose as the centre point, and stop when the saw is at the back. The tree will now be supported firmly on two sides of a square, with the holding wood being one of them.*
2. *Now, with plenty of time, you can insert the felling lever, or felling wedge or cushion in the case of larger trees. When using a wedge, use the felling lever to knock the wedge into position.*
3. *You now have a new side support for the tree and can calmly complete the felling cut and bring the tree down by means of the felling lever or felling cushion.*
   Take care that the nose of the saw does not damage the holding wood.

In the case of small-diameter trees (20 cm or less), it is difficult to insert the felling lever behind the guide bar without incurring the risk of the chain striking the lever.



1 2 3 4

1. *First, saw through one half of the tree until you reach the holding wood.*
2. *Remove the saw and insert the felling lever. The tree is now properly supported.*
3. *Next, when sawing through the other side of the tree, make the cut a few centimeters below the lever. The cuts should overlap, but do not insert the bar too low down, or you will remove the support for the lever.*
4. *Then all you have to do is use the lever to bring down the tree.*
   Small trees fall faster than large ones.

Figure 13. Techniques for using levers and airbags

4.3 Wedges

Although not as great an application in smallwood as in larger timber, wedges are still the least expensive and easiest to use of all the felling aids. The use of a wedge to insert into a backcut before the tree finally sits back would make it easier to push over with a pole and thus reduce the chance of straining by attempting to push it over by hand. Wedges can also be used in conjunction with felling levers to obtain more lift.

4.4 Turn Band

This is used for rolling hung-up trees down. It is a low cost item,

($9.00), simple piece of equipment which has application in both first and second thinnings and minor species. The band is made up of seat-belt webbing, 1.77 m long, with a hook attachment on one end and an eye on the other. The hook is placed against the tree, the band is then wound around this, and a piece of wood is placed through the eye to act as a lever. The band weighs 310 grams and has a pouch which enables it to be carried on the belt. They can be locally made as I don't think they are available in N.Z. made up from Sweden.

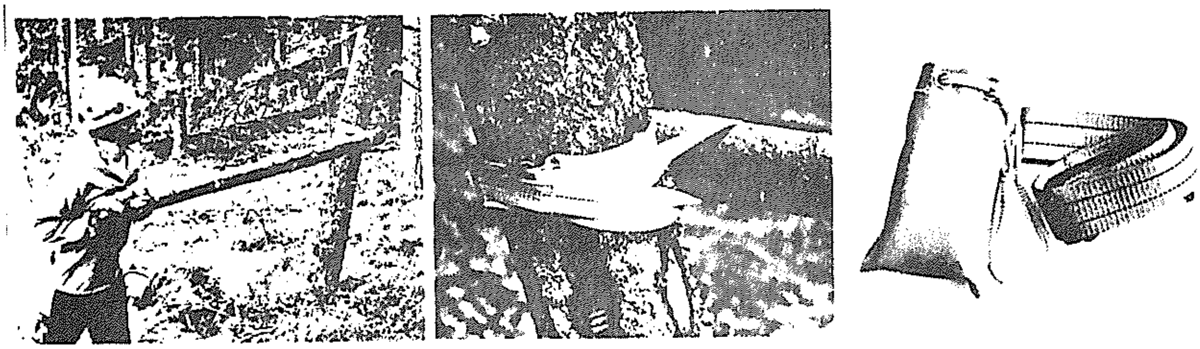


Figure 14. The Turn Band

Use a pole to lever the tree.

Figure 15. The Pole

4.5 Pole

The last felling aid dealt with in this paper is definitely the cheapest, least sophisticated, but still has a widespread application. To obtain one of these all the bushman need do is take his chainsaw, find a head of a tree approximately 2 m long, 60 - 80 mm at one end and 30- 40 mm at the other end, and trim it. The application of this pole is shown in Figure 15. As you can see it is mainly used for getting down hang-ups and pushing over the easy trees These are available in most N.Z. forests!

These are a few of the felling aids available. There are many others, more expensive and sophisticated,as well as many that are cheap and simple. From those listed, the two I consider to be essential to any good faller, are the Husqvarna lever and the turnband. Not only does the use of these make felling safer, but it also makes the extraction and skid phase easier.

DISCUSSION

In this paper I have dealt with only a very small part of improving productivity, namely in felling and trimming. There are numerous other aspects of equal importance which form part of the overall picture. There are two which I consider to be quite important that are worth a mention here - safety clothing and helmets. This is a subject briefly touched on by the Swedish consultants and also one of which many people have spoken of in the past. LIRA obviously has to devote some of its time and resources in this area in the future. Such things as safety helmets, ballistic trousers, aprons or leggings need to be investigated. There are other items such as gloves, which keep hands warm as well as protect them from cuts, boots that are lighter and last longer than the ones presently available, etc.

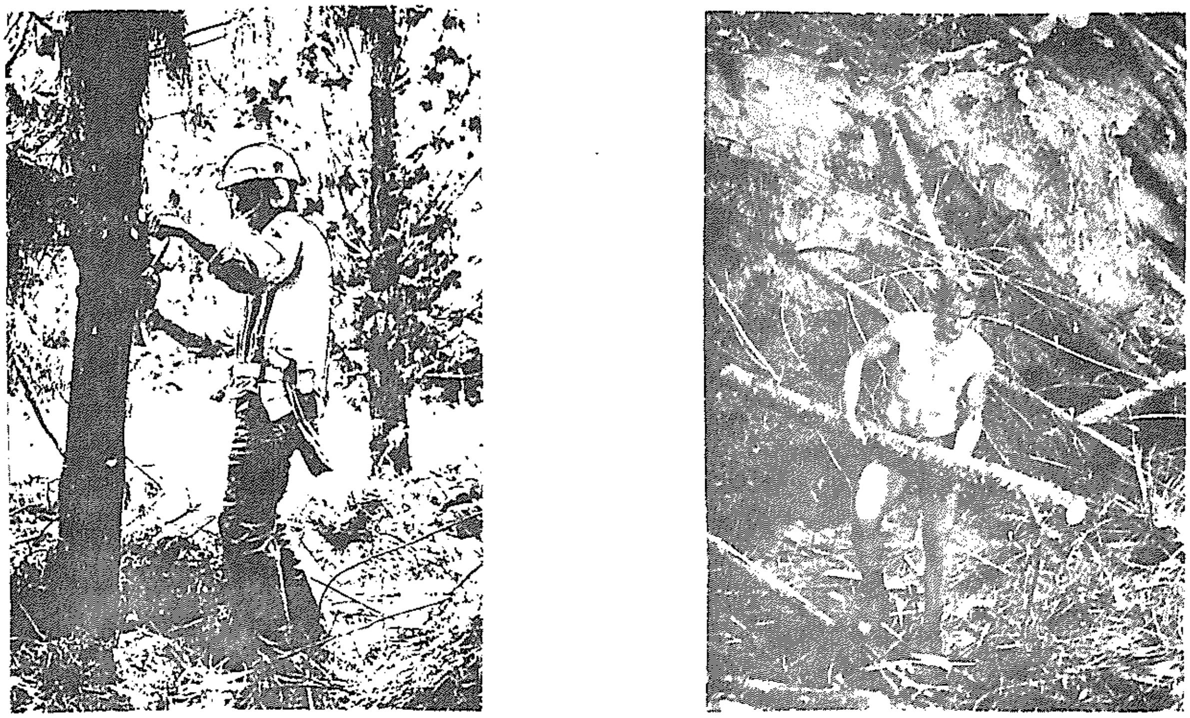


Figure 16. Safety Clothing for N.Z. Bushmen - What do we need?

The other area which is of paramount importance is that of training. All the research time and money in the world is no substitute for getting the message across, as does a good training system achieves. It is all very well convincing management, but lets go to the bushmen that are working in the 8° frost etc., and help them.

Finally, what we need are bushmen that are smarter, not harder.

TECHNOLOGY, THE WORK ENVIRONMENT, AND INDUSTRIAL RELATIONS

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I should like to take a brief look at some of the Sociological research into the area of technology and the work environment, particularly regarding industrial relations. Although the research results do not apply specifically to the harvesting industry they nevertheless have implications for the management of harvesting systems.

Industrial Conflict - Some General Points

Industrial conflict frequently occurs because some workers feel dissatisfied with certain aspects of their work environment. This dissatisfaction manifests itself in a number of ways - yet for various reasons we tend only to view the 'industrial strike action' with any real concern, ignoring the other symptoms of industrial discontent. Undue emphasis on strike action and failure to recognise other forms of dispute are faults of society generally and (more important) management (Fox, 1971). We cannot afford to overlook the less spectacular factors such as absenteeism, high turnover, and accident rates as these often reflect the level of industrial harmony which exists. These forms of "conflict expression" are of course based on "individual" rather than "collective" action. Ironically it is "collective" action on which management tends to concentrate, primarily because it is seen to involve greater expense and a higher degree of visibility than individual action. Yet at the national level the number of 'accident caused' lost working days is far greater than the number of 'strike caused' lost working days. It is not unreasonable to suggest that organisations might better prevent confrontations with their work force by monitoring a number of tension indices and using them as "cues for intervention.

Regarding this issue (Fox 1971) makes a conceptual distinction between "substantive" and "procedural" conflict. The former concerns itself with the disharmony which arises from dissatisfaction with areas such as wages, social and physical characteristics of the work environment, job security, "fringe" benefits, and so on. This sort of conflict has been the prime focus of the various groups involved in the field of industrial relations, simply becuase it is seen to engender a large number of industrial disputes. These disputes are usually solved by making some alteration to the total work environment. Often the ability to make such alterations lies directly within the scope of management.

"Procedural conflicts" however are of a different order. They involve disagreements over the ways in which decisions are reached and actioned within the industrial and organisational setting. They become particularly important whenever organisations change their approach to production. This may be in terms of the technology employed, or the way work tasks are allocated - or both. These sorts of conflicts complicate the industrial relations scene because the means to a solution do not always fall within the scope of existing management structures and procedures. In fact it is the very nature of these structures and procedures that is being questioned in this type of dispute. In addition industrial difficulties are often compounded when - in order to facilitate a solution - disputes of a procedural nature are converted into issues of a substantive kind. This is seldom successful since a residual element of conflict remains - and thus the solutions can only offer temporary relief.

Correct and open diagnosis is essential if we are to avoid the industrial situations coloured by mutual doubt and suspicion which arise from inappropriate solutions. It is pertinent to ask at this point how the patterns of industrial conflict relate to the systems of technology which characterise particular work settings.

Technology and Social Relations

Writers on this theme suggest that technology provides the limits within which certain attitudes and patterns of interaction develop, although it is generally accepted that the specific patterns of interaction depend on the way management handles its work force. For example, (Blauner, 1964) relates the level of "alienation" experienced by the worker to the type of technology present in the workplace. Industries are categorised according to the extent to which production is mechanised and the products standardised. While "craft" industries are charactertised by minimal standardisation and high "human input", "machine minding" industries tend to display a higher degree of standardisation and mechanisation. It is in the "assembly-line" situation however that the highest form of standardisation and work "rationalisation" occurs. In the mass production setting the feeling of alienation is most developed with workers sensing a lack of control over their immediate work environment and finding little sense of purpose or self expression in their work activity. With the "process" industries (e.g. the chemical industries) it appears that this trend towards increasing alienation and worker discontent is partially checked.

Looking at the work group (as opposed to the individual worker) Sayles (1958) suggests that there is a link between the type of technology and the way in which conflict surfaces within an organisation. In the case of the "craft" industries, workers are more likely to feel a sense of "belonging" to a clearly defined occupational community that enhances the unhindered development of social relations within the workplace. Machine minding and assembly line industries on the other hand tie people to the machine. This makes the establishment of self selecting social relationships more difficult with the result that the potential for social discontent and conflict is increased.

However, it is not only the characteristics of worker attitudes and workgroups that have been explained in terms of technology type. The work of Reeves and Woodward (1970) suggests that technology is a major factor in determining the form of control exhibited within an organisation. For example, in 'unit' or 'small batch' technology control tends to be "personal" whereas in "process" industries, control is more likely to be "mechanical". In other words, it is what the "computer" says rather than what the "boss" says that is important, although in both cases the criterion on which control is based is usually clearly defined. In the "assembly line" situation however, there tends not to be any agreed upon control criterion, that is control tends to be "fragmented" rather than "unitary". It could well be this fragmentation that predisposes these sorts of organisations to industrial conflict and disharmony.

While space does not permit much elaboration it is worth noting that not all studies emphasise technology in this way. For instance, Goldthorpe et al. (1968) offer the view that work attitudes are largely developed outside the workplace. They infer that attitudes and behaviour on the work floor are best explained by reference to non-work factors. In the case of what they refer to as the "affluent instrumental" worker, satisfaction within the work situation seems to be of less importance than the ability to "consume" and to form social relationships within their local communities. However all of the studies noted above refer to environments in which there is technological stability. But what of technological change? What are the implications of this sort of change for the patterns of social interaction and the level of industrial harmony.

Technological Change

It is to be expected that changes in technology will affect the established pattern of social interaction within an organisation; not only by way of inducing possible redundancy, but also by bringing about a need for the redistribution of tasks within the organisation. Problems of status and power also come to the fore in that technological changes can result in a rearrangement of the relative rewards received within the workgroup. In addition, changes in the technological base can influence the extent to which workers are able to "self-select" members for their immediate work environment. Further to this, the need to import "new" skills to man the "new" technology may destabilise existing relationships, this resulting in lower worker satisfaction.

Thus technological change should not be seen as being necessarily the best way to solve "productivity" problems. I am not being over cynical when I suggest that the only people ensured of some reward in all of this are those involved in supplying and financing the installation of the relevant technology. It is also clear from research that the way in which change is introduced is a key variable in determining the level of industrial harmony and the extent to which change is resisted (cf. Mumford and Banks, 1967). Effective consultation and communication with the work force would seem to be essential if the "transition phases" are to be less problematic for both management and worker.

Management of Harvesting Systems

The themes discussed above allow a number of points to be addressed to the harvesting industry generally and smallwood harvesting in particular. It is of course the smallwood environment that is most conducive to further mechanisation. However, a few cautionary comments and "recommendations" are in order, and it is on this note that I will conclude this paper.

(1) Currently, the harvesting industry might be best described as a "craft" industry. Training is mostly gained in an informal way (Wells, 1980). To a large extent the worker is able to "self select" the members of his/her work environment. The standardisation of the "product" tends to be relatively low and there is considerable "human input" in terms of specific skills and knowledge.

(2) The good industrial relations record of the industry (certainly in terms of "strikes") is in part due to the degree of worker autonomy implied in (1). However absenteeism turnover and accident rates are still high and thus there is a need for management to carefully monitor these particular phenomena in order to identify those factors which contribute to these rates.

(3) If the trend towards increased mechanisation is something the industry wishes to encourage, for whatever reasons, it should realise at the outset that the further introduction of machinery could well result in the harvesting industry losing the "craft" like qualities referred to earlier. Instead one may witness the emergence of an industry that is characterised by a "machine minding" approach to production. During transition periods, the patterns of social interaction within the immediate work environment are likely to alter as status and power shifts occur within the work force. These shifts may come about through management emphasing certain skills by way of differential rewards and/or by the organisation "importing" skills not already found in the current work force.

(4) In periods of change, particularly where technology is involved, management should be sensitive to the distinction made between "substantive" and "procedural" disputes. The level of industrial harmony during these periods, will be largely determined by the way in which decisions regarding mechanisation are reached and acted upon. This will be especially true at a time when the possibility of redundancy creates considerable anxiety within the work force.

(5) The extent to which an industry can <u>flexibly</u> cope with its industrial relations scene depends in part on the "value" of the "product" in question. In the forestry setting, this value is largely determined by the "products" ultimate use. In situations where this value is relatively low, as it is in smallwood case, the ability to deal with the demands of the work force may be reduced. This inflexibility can lead to obsessions with "productivity levels" and increased supervision rather than with improved co-ordination (Kolodny, 1979).

(6) Even though a move to further mechanisation is likely to improve certain aspects of the work environment, management should develop, wherever possible, methods by which effective consultation with its work force can be introduced and maintained during discussions on the pros and cons of increased technology. In this respect, the relative economic <u>and</u> social advantages and disadvantages of both capital and manpower investment will require frank and open discussion if we are to ensure that human concerns are never lost sight of in the drive towards increasing technological sophistication.

This speaker diverged considerably from his prepared paper. The following notes form the basis of his actual address.

1. Several points of emphasis arose:

- *Technology must be taken to mean the knowledge and skill required to run the 'hardware', and not just the hardware itself.*
- *Technology provides the limits within which the patterns of worker relationships develop.*
- *Conflict is likely to occur if a 'change' in the technology is not handled properly.*
- *This conflict will manifest itself in a number of ways, e.g. absenteeism, turnover, strikes, sabotage, accidents.*

2. As we do not have time to treat each of these in detail, we will have to confine ourselves to one major experience of conflict. The one we will emphasise is labour turnover, as this has obvious practical implications for:

- *Continuity in work planning*
- *Cost of maintenance servicing*
- *'Cost' of the investment in training either on or off the job within the harvesting industry.*

3. Research shows that the major 'correlates' of turnover are:

- *Length of service (the longer a person stays employed the less likely he is to leave).*
- *Age (the younger the workforce the higher the turnover).*
- *Level of employment (the greater the number of job opportunities, the higher the turnover).*

The logging industry faces problems here because the work involves a healthy, young workforce. This requirement may change if there is a move to further mechanisation, but this will introduce new problems of its own.

4. In general terms research has shown that major'determinants'of turnover are:

- *The level of 'integration', which is the extent to which the workforce may participate in 'primary' relationships in the workplace. If this is higher then turnover tends to be lower.*
- *The degree of 'centralisation', which is the extent to which decision making is concentrated within the hands of a few people, usually management. The higher the degree of centralisation, the higher the labour turnover.*
- *The degree of 'communication', which is the extent in which information is transmitted to all parts of the work system. The higher the degree of communication, the lower the labour turnover.*
- *The level of pay. Research results are confusing here, but many studies suggest that increases in pay reduces turnover. It must be rembered though that ' amount of pay' is not the same as 'satification with pay'.*

In the logging industry the level and degree of 'integration' and 'centralisation' characteristic of the work organisation would tend to favour lower turnover, however, the last two could be problematic. The 'communication' factor lies within the hands of the management. In the end only they can do something about this. For example, greater recognition could be given to the 'informal leader' within the work gang, and emphasis could be shifted from the 'supervision' to the 'co-ordination' of the work process.

The 'pay' factor is a little more difficult because of the inflexibility which results from the 'low value' of the resource being handled. This may change if in the future there is greater competition for the smallwood resource, say between *pulping and energy interests. The logging industry has some of the elements in its favour as far as labour turnover is concernecd - it is over to the management to concentrate their efforts on those factors which are more of a problem. Certainly I will be concentrating more research effort in this area.*

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SESSION 6

Paper (c)

TRAINING

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Logging and Forest Industry
Training Board

Introduction

It is a fact, but one not generally considered, that logging and the production of logs for one use or another, is New Zealand's oldest industry. Ship spars were first exported long before gold or any agricultural product.

Unfortunately it can also be said that the logging industry is one of the last in New Zealand to organise itself in the areas of training and recognition of skills and experience.

Hence it has also been stated*1 that "the present work force can be characterised as being of the age of prime physical fitness, poorly trained for their present job, prone to accidents, liable to show a high rate of turnover and holding their job in relatively low regard".

Perhaps for these reasons then, there is a strong consensus of opinion within the industry that a comprehensive training scheme is needed in order to -

- improve the work performance of those engaged in the industry
- improve the motivation and job satisfaction of the work force
- reduce the accident levels and increase the safety of logging operations
- plan ahead for the increased work force which it is envisaged will be needed within the next decade

It was with these broad principles in mind that the Steering Committee for Logging Industry Training was formed in 1977 and as a result of its subsequent impact through a group training scheme in the Bay of Plenty, the Logging and Forest Industry Training Board was established in late March 1980.

The Current Situation

Apart from Forest Service Woodsman Training Schools, to a limited degree in the N.Z. Ranger's Certificate and 3 or 4 major companies, formal training of loggers is practically non-existent.

The Group Training Scheme involving Tasman Pulp and Paper, N.Z. Forest Products, N.Z. Forest Service and Fletcher Forests has achieved some degree of success in as much as it has defined standards of training and levels of skill and experience. The approximately 400 loggers within the Bay of Plenty holding Loggers' Certificates have attained some or all of these various levels. In all instances some degree of training has been involved, even if it was only thorough familiarization of the Bush Safety Code. Certification is voluntary, thus when a logger applies for a certificate he puts himself voluntarily into a training situation whether he actually realises this or not. The ready acceptance therefore of logging certificates in the Bay of Plenty would indicate also a ready acceptance by loggers of training. This is the crux of the matter and the pivot on which

*1 (G.C.Wells - A Survey of the N.Z.Logging Work Force) any training programme succeeds or fails, that is, the willingness of those to be trained to participate.

It is not intended to elaborate further on the Logger's Certificate here except to say that its value to both employer and employee is considerable. It might be appropriate however to mention that one company who has encouraged certification amongst its own and contracting loggers since early 1978, reports that of the last 217 lost time accidents in their operation, only 7 have been experienced by holders of the Logger's Certificate.

Training in Small Wood Operations

It is generally considered that small wood operations have a higher accident rate and can therefore be accepted to be more dangerous than large wood operations. It is for this reason no doubt that the A.C.C. funded L.I.R.A./ Swedish consultants investiagion into felling and limbing techniques, was mainly concerned with round wood operations. It is possible that if any improved techniques in handling small wood arise from this study and they are acceptable to the industry, the Logging and Forest Industry Training Board will consider their inclusion in training programmes.

The Group Training Scheme does not generally have any different training policy from one type of timber or operation to another, the principles being the same. The Logger's Certificate however does differentiate between thinning and clear-fell, age of trees, species, terrain, etc and loggers must prove their competence to be certificated in specific types of operations.

Although it has yet to be considered, it is envisaged that the Logging and Forest Industry Training Board will need to give due consideration to the problems associated with small wood production and the training required. It is generally accepted that the techniques of extracting small wood differ from clear-fell operations, e.g. difficulties manoeuvring extraction machinery, higher rate of tree felling required, greater proportion of time spent on limbing, preparation of logs in the bush rather than on the landing

Future Training Requirements

There are many opinions on the growth of the logging industry and the manpower requirements that will need to be faced up to. Almost every week recently new afforestation and timber use projects have been put forward. One certainty however is that someone will have to do the logging and additional people will have to be found to do it.

The traditional methods of training in the logging industry whereby a new chum learned from a more experienced man will never be replaced entirely. This method has got us through the last 100 years but will it be good enough for the future or even the present for that matter.

The Logging and Forest Industry Training Board's responsibility will be to recognise the requirements of the industry and do somethod about it. Definite possibilities are instigating

- the establishment of more group training schemes based on the Bay of Plenty experience

- employment of regional logging training officers to assist small operators and administer group training schemes

- establishment of basic introductory courses for new men in the industry
- seminars and courses for increasing the skills of those already employed in the industry
- training of trainers, to enable experienced loggers to pass on their knowledge and experience to others
- promotion of the Logger's Certificate and its availability throughout the industry.

Conclusion

Traditionally, but also unfortunately, training in many industries is often one of the last management considerations and the first to go when things are tough. For any training programme to succeed, employers and management must give its full support to those responsible for the training.

The Logging and Forest Industry Training Board is very much in its infancy and will therefore need to rely heavily on the good will and assistance of both employer and employee to be effective.

It is important that any training should be of the type that industry wants and it is to this end that I request those involved to look seriously at their needs and advise the Board accordingly.

- SESSION 7 -

SPECIAL PROBLEM AREAS

Chairman: Bob Gordon, LIRA

"SMALLWOOD HARVESTING FROM STEEP COUNTRY"
VIV DONOVAN, Research Officer, Logging Industry Research Association

"ACCUMULATING SMALL PIECES IN LOGGING"
JOHN GALBRAITH, Manager, Wood Supply Dept., N.Z. Forest Products Limited

"SMALLWOOD HANDLING AT THE MILL"
CHAS KERR, Tasman Pulp & Paper Co. Ltd.

"ENERGY IMPLICATIONS FOR SMALLWOOD HARVESTING"
JOHN TUSTIN, Forest Research Institute

SESSION 7
PAPER (a)

SMALLWOOD HARVESTING FROM STEEP COUNTRY

V.F.DONOVAN
Research Officer,
LIRA

Many factors influence the economics of handling smallwood on relatively easy terrain. With smallwood harvesting on steep terrain, the difficulties and costs can become even more critical, although there is a source of motivation that is free and very energy efficient - gravity. This paper looks at some of the techniques, influencing the criteria and requirements of steep country smallwood handling. The paper deals only with smallwood radiata pine from thinnings and clearfelling and not salvage from large tree breakage. Steep county is classified as slopes over 20°.

SYSTEM SELECTION CRITERIA

Often steep country has only the degree of slope as a common factor. The shape, length, roughness, aspect, access, soils, and undergrowth on individual slopes are all important factors which influence the logging systems selected, or which influence the efficiency of any particular system.

SLOPE

Shape - Slopes can be basically concave, convex, or straight. In most cases the concave slope is the most desirable for cable methods because more clearance can be gained between the cable and the ground. Convex slopes may require multi-span cable systems.

Length - This is important as it not only determines the selection of equipment but also affects the operational efficiency of the job. The longer the slope the more arduous is access for workers. It is more difficult to maintain lift if cable methods are used and it is slower for each cycle of the operation.

Roughness - Intervening cross-ridges, gullies and generally broken slopes are the most difficult to plan for and work. Progress for workers and logs, up or down the slope, are often impeded and special techniques need to be adopted.

Aspect and Undergrowth - These two factors are often related. In N.Z. the degree of undergrowth can depend on the aspect,with southerly facing slopes often being damper and more heavily clad. Undergrowth is a hindrance to fallers and affects all other parts of the operation regardless of what extraction system is adopted.

Soils - Soil type can be critical in determining the logging system. The stablility of the soil and whether it will support intensive tracking patterns plus any other environmental precautions must be considered prior to logging.

Access - Although not a physical feature it must be considered when looking at an area to be logged. Planning of access to a logging area must consider the options of logging systems available and egress from the logging site. When considering gravitational methods for extraction, access must be below the country.

In many smallwood harvesting operations on steep country, the problem is often not how to extract the wood to roadside, but how to efficiently handle it from there, either into stockpiles or for load-out

FELLING AND LOG PRESENTATION

Both of these requirements are critical elements in harvesting smallwood from steep country. With young radiata pine virtually every branch needs to be cut off, and although it is most desirable to do this on the slope, this can be difficult and arduous as the slope steepens. Small trees with branches intact are often difficult to break out with low powered equipment, and they make handling at the landing a problem. Delimbing at the landing or at any other stage in the extraction phase, can interfere with the extraction cycle and be a major influencing factor for reducing daily productivity.

Felling should be organised to take best advantage of the extraction, in terms of both maintaining high production and preventing residual crop damage in thinnings. When cable logging downhill in tree lengths, the trees need to be felled downhill towards the extraction track in a herringbone pattern. Logs will be choked by the tops with extraction starting at the bottom of the slope. Felling square to the extraction line will lead to breakage of the trees and damage to the crop when breaking out. Felling parallel to the extraction line also leads to problems in getting logs clear and it may mean the breaker-out having to pull rope uphill into the thinned bays for some distance. Uphill cable extraction, where the tree butts are choked, must also be felled in a herringbone pattern. The butts of trees felled can be further away from the extraction line, and this results in longer lateral slack-pulling distances.

Felling aids, such as felling levers or small wedges, are available to make directional felling easier. These devices, when used correctly, can also reduce hang-ups, thereby increasing the productivity and safety of fallers. A fallers performance should not be assessed in isolation, but based on how effective he is in setting up optimum sized drags for extraction.

There is no easy way of delimbing young radiata on steep country. Operators need to be careful and safety conscious, wear good footwear, and should use other leg protection. Many fallers fell two trees and trim the two together , rather than scramble up and down the slopes for individual trees. Fallers have little need to use large powerful chainsaws in small-tree steep-country logging. A 60 cc saw with a 38 cm long bar is usually sufficient. A lightweight saw with short bar allows better and safer control over the saw and it will be less fatiguing.

Three options are available for log presentation, depending on the end requirements and logging system used. These are shortwood - either pulp or posts (up to 2 m lengths); long length logs i.e. a tree cut to several logs; or whole-tree lengths.

SHORTWOOD VERSES LONG LOG OR TREE LENGTH

Any shortwood system on steep slopes is very labour intensive. Pieces must be carried across the slope to the extraction line or stacked into bundles. This is extremely hard physical work and is particularly impeded by the degree of slope and undergrowth or slash on the ground. Often stands are thinned below prescription when a shortwood system is adopted because men are reluctant to struggle with the larger butts or pieces across the slope, and therefore, the bigger,perhaps malformed, trees are left standing. Shortwood systems on steep country should not be considered where the undergrowth is heavy.

Long log, compared to tree length presentation, allows more direct handling of the pieces, once landed at the roadside. A disadvantage is that more pieces must be extracted and that more lateral rope pulling is required to reach the last log cut out of a tree.

GRAVITATIONAL EXTRACTION

Extracting logs from hillsides by gravity is probably one of oldest methods of logging ever used. In this paper three different free descent techniques are discussed.

WIRE SKIDDING

This is a simple system for extracting low value wood down concave slopes with gradients from 20-35°. Distances to 300 m could be skidded provided the slope and clearance was sufficient, although half that distance would be more common. Extraction tracks must be cleared down the slope at right angles to contour so bundles of shortwood have unimpeded travel. The system is based on the simple rigging of a live skyline, which is fixed at one end and tensioned at the other. The bundles, which should not exceed about 200 kg, are attached to the slackened line, which is then tightened causing the bundles to slide freely downhill. Disposable skidding blocks can be used and these are broken by a wedge fixed on the line at the lower end, thus dropping the load. Up to 200-300 pieces per hour can be extracted by this method. Further information is available in LIRA Report Vol.3 No.12, 1978, or N.Z.Forest Service publication 'Gravity Extraction of Thinnings from Hill Country Woodlots, 1969'.

Variations and modifications of this basic system have been tried overseas and are reported on in LIRA's library. One is using a small pulley with a chain attached to freewheel logs down the line. Up to 20 pulleys are on the line with two used to support each load. The last pulley has a return line attached, which is used to pull all 20 pulleys back up the slope for re-use. A further extension of this is using a small portable winch to pull logs across the slope to the extraction track. A small swivel block is attached to the suspended skyline to give lift to the portable winch line. The logs are then lowered by the free descending pulleys. Also being developed is this free decent gravity extraction over intermediate supports.

CHUTES

Gravity extraction using chutes made from various materials have been used within N.Z. and overseas for a number of years. Recently, heavy industrial 6 metre long alkathene pipe, cut lengthwise into half or third rounds, has been used. This is a very effective means of extracting short-pulp or short roundwood. The sections of chute can be bolted together and supported on the slope by ropes tied to trees. Cull trees 4-6 rows adjacent to the chutes are felled, trimmed, cut to shortwood lengths, carried across the slope and tossed into the chute. A minimum slope of 15° is required for logs to travel down the chute. Downhill travel is extremely quick, depending on the degree of the slope, but the wood is left in an untidy heap at the end of the chute, and this needs to be man-handled into stacks if a loading system is to uplift them efficiently. On chute logging, a two-man gang have averaged 14.7 tonnes per day with a maximum of 17 tonnes per day. Approximately 2 man hours are required to stack one day's chuting.

HAULER EXTRACTION OF SMALLWOOD

Lightweight haulers have been used in N.Z. for a number of years for thinnings and small tree clearfelling. Details on work done by the N.Z.Forest Service experimental logging unit at Golden Downs in the mid-1960's, was reported on in a paper by R.H. Robinson at the LIRA 1978 Cable Logging Seminar, and will not be dealt with here.

In the last 4 years, newly designed skyline machines have become available and have been operating mainly in 11-17 year old radiata thinnings. These are the Timbermaster, Wilhaul, and more recently, the experimental Lotus. A range of thinnings systems have been adopted including tree length uphill and downhill extraction with single span or multi-span, using intermediate supports. Uphill and downhill trials extracting shortwood in bundles have also been undertaken, as have trials extracting longer length logs. The results from this work have been written up in the following publications:

Uphill tree length extraction

LIRA Machinery Evaluation Vol.2 No. 3 1977
"Timbermaster Skyline Hauler"

F.R.I. Economics of Silviculture Report No. 107, By A.A.Twaddle, 1977
(Unpublished)
"Strip Extraction Thinning by a Timbermaster Skyline Uphill Setting"

Downhill tree length extraction

F.R.I. Economics of Silviculture Report No. 113, By A.A. Twaddle, 1978
(Unpublished)
"Strip Extraction Thinning by a Timbermaster Skyline Downhill Setting"

Shortwood extraction by hauler

LIRA Report Vol.3 No.8, 1978
"Shortpulp Extraction With Timbermaster Skyline"

LIRA Technical Release Vol.1 No.3, 1979, By D.Lamberton, N.Z.Forest Products Limit
"Shortpulp Extraction With a Small Hauler (A Further Trial)"

Lotus development trial (Various systems)

LIRA Report Vol.4 No.7, 1979
"Lotus Experimental Skyline Hauler (A Progress Report)"

LIRA Report Vol.4 No.12, 1979, By M.McConchie, F.R.I.
"Lotus Experimental Skyline Hauler (Production Trial Summary)"

LONG-LENGTH SMALLWOOD EXTRACTION WITH HAULERS

Some of the lessons learnt to date from small hauler extraction are:

- Most elements uphill and downhill are similar, the main exception being choking logs and breaking out. More lateral slack-pulling is required for uphill extraction to reach the butts of the trees in the thinned bays. Also, it is more difficult to choke butts than tops. In downhill extraction most of the trees are felled with their tops in or close to the extraction line and less slack-pulling is required.

- Small haulers generally have high availability but low utilisation. This is often as a result of a need for frequent line shifts.

- Crew experience is important for reducing delays.

- Poor log presentation can seriously influence breaking out and the hauler cycle, especially if the machine operator is required to do extra trimming on the landing.

- With cut log lengths, usually more can be extracted per haul but longer choking time is required.

- Heavy slash can affect the breaker-outs move-in and move-clear time.

- Lightweight chokers often cause delays when tangling around the carriage and skyline. Careful machine operation when taking the slack out of lines can reduce this occurring.

- On uphill extraction, incoming logs can tangle with the previous drag at the landing causing some delay. Interference often occurs between haulers and secondary machines clearing logs from in front of the hauler. A knuckle-boom crane fitted on the hauler can also cause some interference, although it can be used to good effect to hold logs while they are unchoked. Downhill extracted logs can usually be cleared by a secondary machine without interference, as the ropes are well clear of the stockpile. In downhill extraction however, the inhaul can be slower if it is necessary to carefully lower the trees into a stockpile. The unhook time is also affected if the skiddy or operator has to climb onto a high stockpile.

- Logs landed downhill into a stockpile can overrun and damage the machine. If it is a tight situation the stockpiles can be a nuisance if they block the road.

- Average tree size greatly influences daily production. For example; at 0.2 m^3 tree size it is difficult to exceed 30 m^3 per day (tree length logging); at 0.4 m^3 tree size production up to 50 m^3 can be achieved - all other things being equal.

- Intermediate supports with small haulers offer significant advantages. Slopes with intervening ridges or a profile where deflection is limited or non-existent, can be hauled when intermediate supports are used. Approximately 40-60 minutes is required to rig an intermediate support. A heavier carriage is required than the normal system. Further details on intermediate supports is available in LIRA Report Vol.4 No.4, 1979.

SHORT-LENGTH SMALLWOOD EXTRACTION WITH HAULERS

Trials have been conducted at N.Z.Forest Products Limited with the Timbermaster and Wilhaul skyline haulers to evaluate the production potential of these machines extracting short-pulp. The trials indicated that between 55 and 60 tonnes per day could be extracted with these machines and this could be increased if the roadside handling of the produce was improved. Some of the lessons learnt from these trials were:

- Undergrowth and slope very seriously affect the cutting and stacking production of the shortpulp cutters. Production ranged from 5.5 tonnes to 8.4 tonnes per man day. The steep slopes (in excess of 30°) affect the ability of cutters to safely carry and easily stack the shortpulp.

- Extraction lines at 12 m centres proved satisfactory. 20 m centre lines were too far for the cutters to carry each piece.

- For effective breaking out, the bundles must be stacked directly under the skyline. Damage to crop trees occurred when bundles were stacked off to the side.

- The weight of the bundles of short-pulp must be within the designe capacity of the machine. With the Wilhaul this was 0.95 tonnes and with the Timbermaster 0.8 tonnes. An advantage of this method is that the optimum haul size can be achieved on each cycle.

- For good control of bundles during downhill extraction the hauler needs an effective haulback brake. The Wilhaul proved to be better than the Timbermaster in this regard. However, both machines allowed the best control of the incoming load during uphill extraction.

- A lock-in carriage (Christy) did not prove any more effective than the normal Timbermaster/Wilhaul carriage system.

GROUND SKIDDING SYSTEMS

Recent Canadian studies* have been comparing the use of small crawler tractors for extraction off steep country with skidders and with cable machines. Although logging costs for the skidders and the crawler tractors are very similar, the small tractor advantage was that much less soil disturbance occurred because a smaller width track could be formed than with skidders or large crawler tractors. Other advantages of small tractors, listed from the studies, were:

- They are more versatile than wheeled skidders or cable machines.
- They can log a total area without other machine assistance.
- They are cheaper to operate than cable systems.

(This comparison is only valid provided the site can withstand an intensive tracking pattern without environmental implications.)

The study results concluded that the small tractors were most suited on side slopes greater than 16°. Slopes less than that could be logge by skidders without tracks. Small tractors were considered a viable alternative for logging steep country as an alternative to other ground skidding machines or cable systems.

CONCLUSIONS

This paper has listed recent experiences for logging smallwood off steep country. The brief inclusion of details on the recent Canadian study using small tractors is because very little has been done on this in N.Z. in recent years. In many situations, such as farmers smal woodlots, small tractor extraction operating off tracks may offer a more economical alternative to hauler or other methods.

*"*Skidding with Small Crawler Tractors" By B.McMorland. FERIC Technical Report No. TR-37, March 1980*

Regardless of the extraction system, gravity can be used to good advantage when handling smallwood. The alkathene chutes offer a low cost method and have great potential in N.Z. Free running wire or skyline gravity extraction systems also offer low capital cost methods which should be given more extensive trials.

Small haulers, such as the Timbermaster, Wilhaul, and Lotus, have proved viable for logging uphill and downhill. Average piece size extracted is the most critical factor influencing daily production. Intermediate supports are a valuable means of extending the capability of small haulers.

SESSION 7
PAPER (b)

ACCUMULATING SMALL PIECES IN LOGGING

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INTRODUCTION

The problem of an almost exponential rise in the unit cost of handling products, as the piece size of product being handled decreases, is common to materials handling in any industry.

In the simplest case, for a machine or system which handles a constant number of pieces per unit time, the output is directly proportional to the piece size handled, and the cost follows a hyperbolic function.

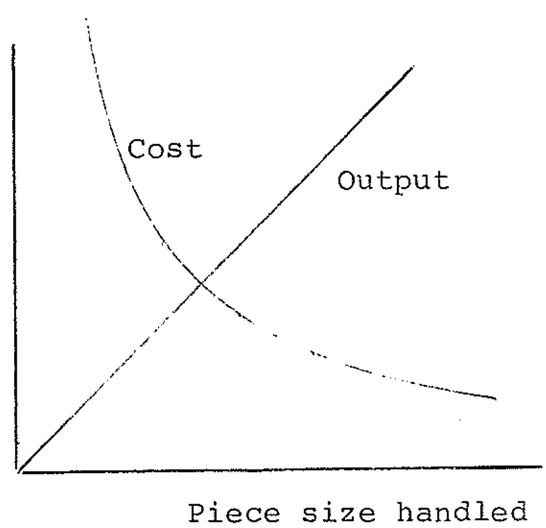
i.e.

$$\text{Output} = \{\#\ \text{pieces per unit time (a constant)}\} \times \{\text{piece size}\}$$

$$\text{and Cost} = \frac{\text{Machine cost per unit time}}{\text{Output per unit time}}$$

This relationship is illustrated in fig. 1.

Fig. 1



The three main approaches to reducing the effect of decreasing piece size are:

1. Reduce the system operating cost as much as possible by sizing the system to suit the piece size handled.

2. Reduce cycle times by improved system engineering and training and motivating operators

3. Accumulate a number of small pieces to form a larger unit load for further handling.

This paper examines the problems and methods of accumulating small stems in logging operations.

The beginning and end points of materials handling in the harvesting and loading phase are: the single stem on the stump measuring 0.1 to 0.2 tonne, and the truck payload of approx. 24 tonne consisting of 120 to 240 accumulated stems.

A large variety of methods of accumulating small pieces in logging are practised and some of these are outlined in table 1.

Table 1 Examples of Smallwood Accumulation in Logging

1. Manual	- Shortwood, 1.2 to 2.4 m, hand carrying and stacking		
2. Motor - Manual	- Bunching winches	- Nord for 'flying saucer' - O.S.U. pre-bunching winch - Rosin pre-buncher	
	- Extraction winches	- Single drum plus chokers - Double drum plus chokers	
3. Mechanical	- Grapple bunchers	- Small grapple skidders - Bell Logger - Clam-bunk skidder - Forwarders	
	- Feller-bunchers	- hydraulic boom type - front end loader type	
	- Multifunction (including bunching)	- Kockums 875 processor - JD 743 - Koehring shortwood harvester - Windsor harvester	

1. Manual Accumulation

Most manual shortwood systems involve some degree of manual accumulation of the product by the cutter to improve the efficiency of the extraction phase.

The size of the stack of shortwood and its position relative to the extraction route is determined by the type of extraction machine.

A 50 to 70 KW skidder requires a stack of 1.25 to 1.75 tonne, conveniently placed so that the skidder can back right up to the stack. The stack must be placed on one or two runners to enable the winch cable to be passed around it. The manhours required to build a stack are strongly influenced by the stocking (in stems per hectare) of the trees being logged, the size of the stems and their product bolts, and the slash hindrance. Presented with such stacks, the skidder extraction phase is very efficient; with short terminal times to choke up and to unload the bundle of shortwood and a consistently-sized payload. Productivity is unaffected by stem size.

The productivity and cost of a typical shortwood system is illustrated in fig. 2. The figure graphically illustrates the trade-off between the costs of accumulation (the cutting phase is separated into the fell, trim and top and the cut and stack operations) and the savings in subsequent handling.

Comparing the total cost curve with a true hyperbolic function indicates the effect the accumulation approach has had.

Forwarders require smaller stacks, normally sized to suit the crane and grapple capacity (0.5 t plus). Placement of the stack is less critical but must be within 4 to 5 m of the extraction route. As a result, accumulation for a forwarder is relatively less affected by stocking and conditions underfoot, and affords higher cutter productivity.

Forwarder productivity is affected somewhat by stem size since, as stem size drops, the distance between stacks increases and the forwarder spends more time moving while accumulating a load.

The productivity and cost of a manual shortwood/forwarder extraction system is shown in fig. 3. The increase in cutter productivity in building smaller stacks is mostly offset by the additional forwarder travel at smaller stem sizes as noted above.

In comparison with the manual shortwood/skidder extraction system the forwarder system shows a small relative advantage as stem size decreases.

Accumulating bundles of shortwood for a cable thinning operation was tried (LIRA, 1978) but the increase in extraction machine productivity was not sufficient to offset the cost of cutting and accumulating shortwood on steep slopes.

2. Motor-Manual Accumulation

Motor-manual accumulation includes the use of single or double drum winches, either independent bunching winches or winches attached to extraction machines.

Independent bunching winches such as the Nordfor "Flying Saucer" and the pre-bunching winch developed at Oregon State University for cable thinning are used to pre-bunch longer log products or tree lengths for more efficient extraction by a larger secondary extraction machine. These two types of pre-bunching winch pull themselves about using their own winch line. Radio control is an important feature in their productivity.

Pre-bunching winches mounted on a carrier, such as the Rosin buncher and the small extraction machines operating at Tumut, Australia, are also used.

The general principles of pre-bunching are that the pre-bunching unit must be low cost and work over short extraction distances, and that the main extraction machine is a high production unit, generally working over long extraction distances.

Fig. 2 PRODUCTIVITY AND COST - Short Pulp Cutting and Skidder Extraction

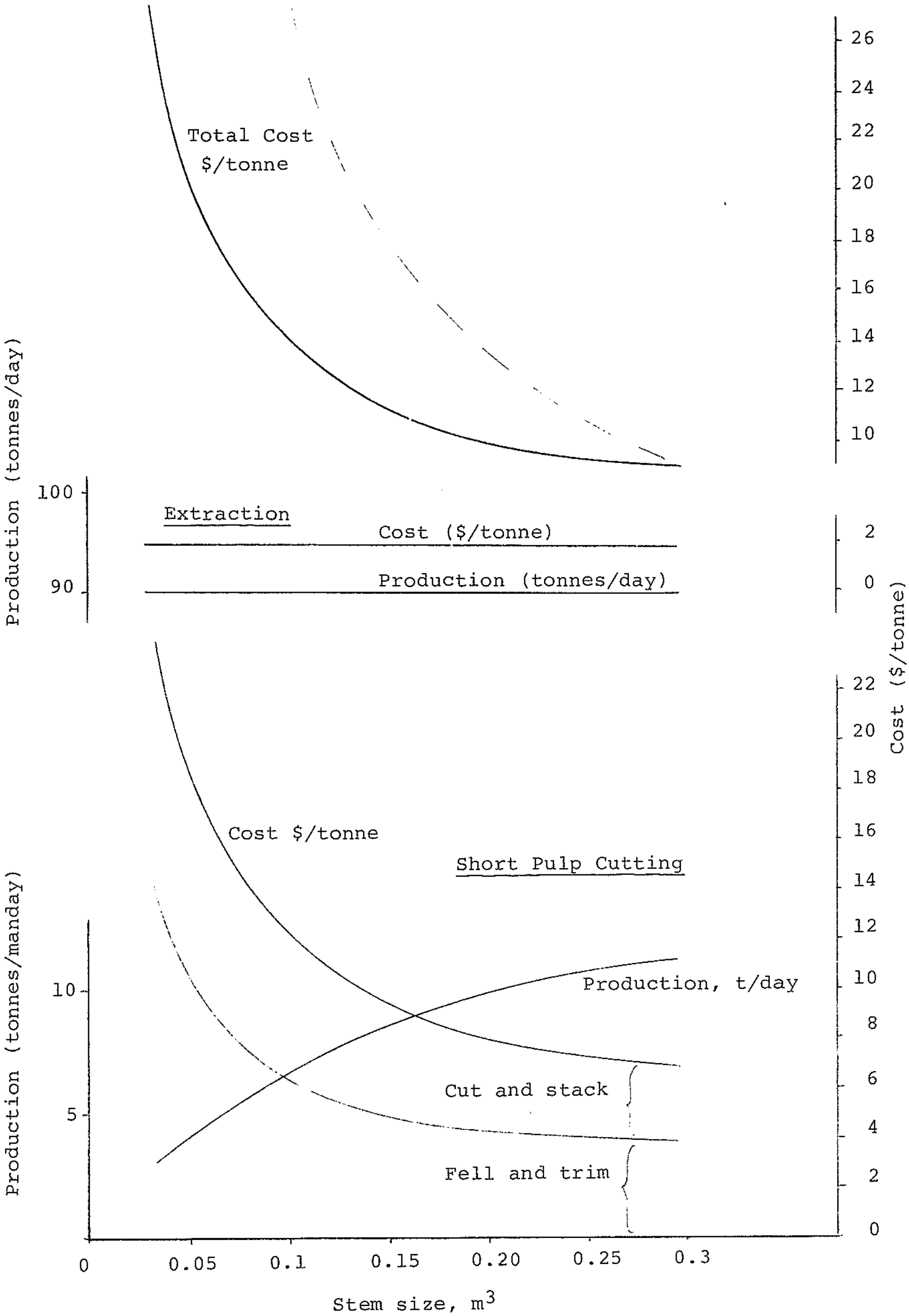
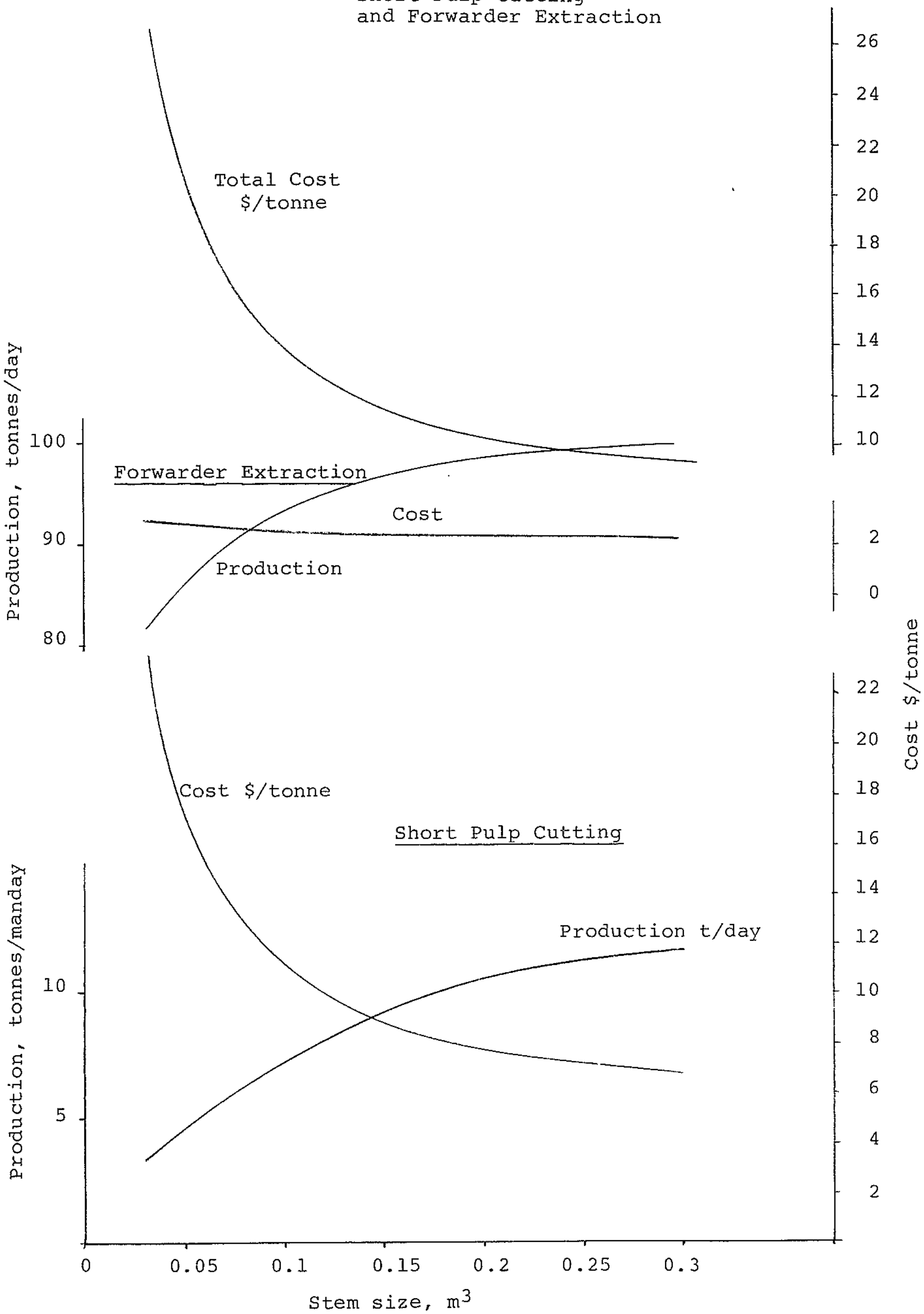


Fig. 3 PRODUCTIVITY AND COST
Short Pulp Cutting
and Forwarder Extraction



Single-drum winches mounted on the extraction skidder or crawler are of course the most common method of accumulating small stems in New Zealand. Six to eight chain or wire chokers can be used - more than 8 tends to cause tangling. Normally the extraction machine waits while the winch line is pulled out and the chokers set. This operation, although simple and straightforward, consumes ca 40% of the machine cycle time. Pre-setting chokers will reduce this time and generally improve the productivity of the bunching operation.

The productivity and cost of a manual felling/agricultural tractor extraction system is shown in fig. 4. The system is more sensitive to piece size than the shortwood systems examined. (This relative disadvantage will increase if the long length wood needs to be slashed before joining the shortwood in a drum debarker - since the productivity of slash-decks, fixed or mobile, is also very sensitive to piece size.) Closer analysis shows that the problem is in the limiting number of stems that can be hooked up. Above a piece size of approx. 0.15 m^3 the maximum average drag size that can be skidded by the tractor is the limiting factor. Below 0.15 m piece size the number of stems that can be hooked on is limiting and production becomes proportional to piece size.

Double-drum winches allow more stems to be accumulated behind the extraction machine and show a clear advantage when extracting very small stems.

3. Mechanical Accumulation

In mechanised harvesting operations accumulation of small stems is of utomost importance. Capital investment and hence fixed costs are much higher than in the manual and motor-manual systems, and handling of small stems one-by-one has unacceptable cost results.

In feller-bunchers for example, the first approach to accumulation in the felling phase was to add small arms to the single stem felling head to allow one or two additional trees to be collected in the head before swinging or manoeuvring the head to the bunch. This is generally as far as the hydraulic knuckle-boom type of feller-buncher has progressed due to weight restrictions on the felling head. With the front-end loader type of feller-buncher, however, there has been a recent trend to heads which can accumulate up to 12 small stems. The Rome accumulating shear recently demonstrated at FIME is a good example of this.

The evolution of small stem feller-bunchers and the resulting effect on productivity is outlined in Table 2 (Davidson).

Fig. 4 PRODUCTIVITY AND COST - Felling and Long Length Extraction with Agricultural Tractor

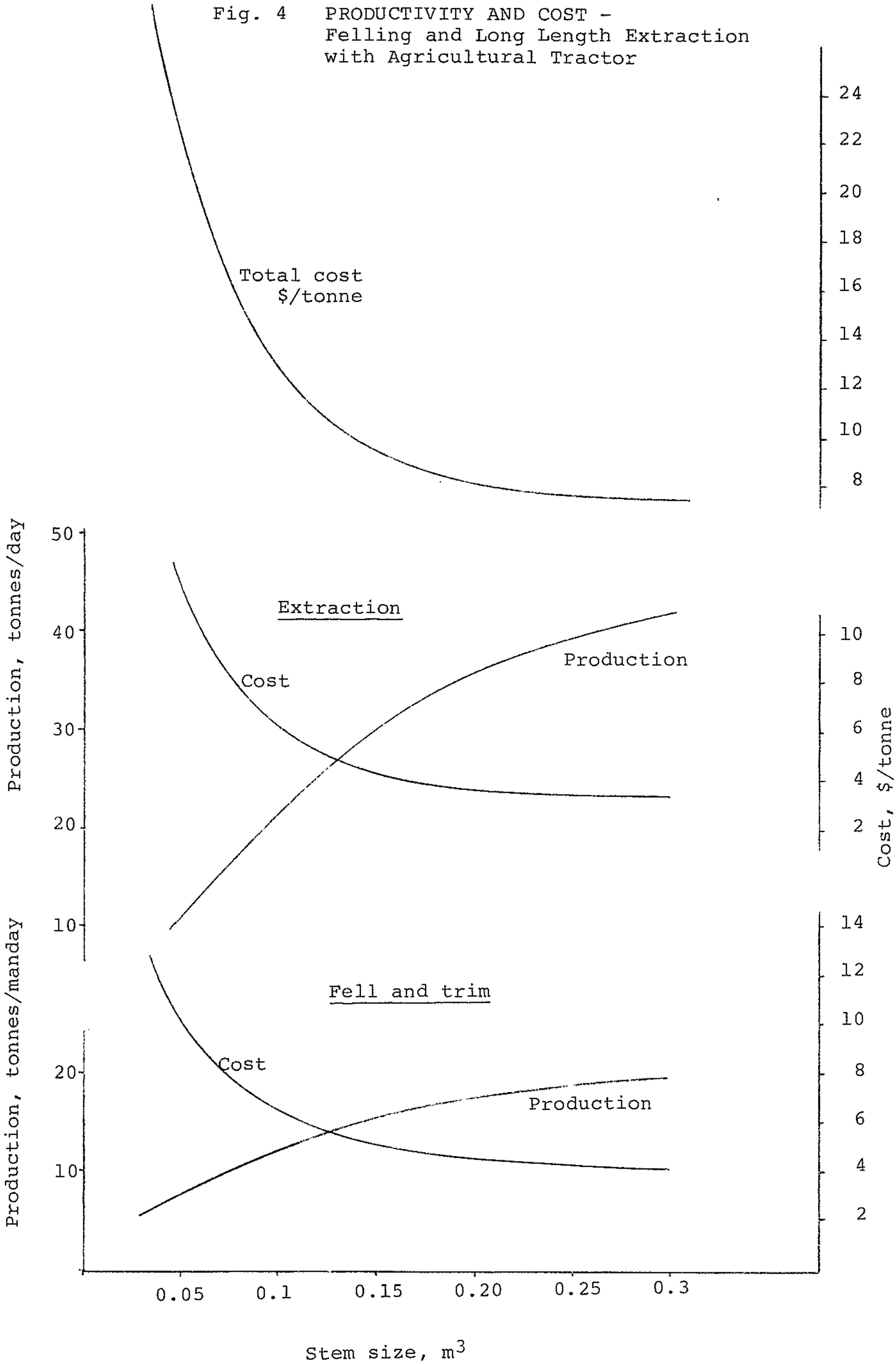


Table 2 Evolution of Feller-Bunchers for Small Stems

Feller-Buncher	Accumulating Capacity (stems)	Productivity (stems/sch.hr.)
Bobcat with Morbark Shear	2	55- 80
Bobcat with Allen BB Shear	4	70-100
JD 544 with Rome Shear	10	115-175
Hydro-Ax Swathcutter	12	150-280

The productivity of the JD544 with Rome accumulating shear is illustrated in fig. 5 against stem size (from Tufts, 1976). Comparison with the theoretical single stem handling production and cost curves shows how much progress has been made.

Grapple skidders and forwarders are further common examples of machines which mechanically accumulate stems or shortwood.

An interesting development in accumulating smallwood is the Bell Logger from South Africa. Originally used for handling sugarcane, this very simple machine is now used extensively in the forest industry for bunching, skidding, sorting and loading. The machine is well suited to accumulating small pieces either for extraction by itself or by a secondary machine (Taylor, 1978).

The development of very large feller-forwarders in Canada probably marks the ultimate in small stem accumulation to date. The Koehring Feller-Forwarder, for example, fells and accumulates a payload of up to 25 tonnes of full trees on its back before forwarding them out to roadside. Such machines are designed for clearfelling of small stems and forwarding long distances off-road and have no obvious application in New Zealand.

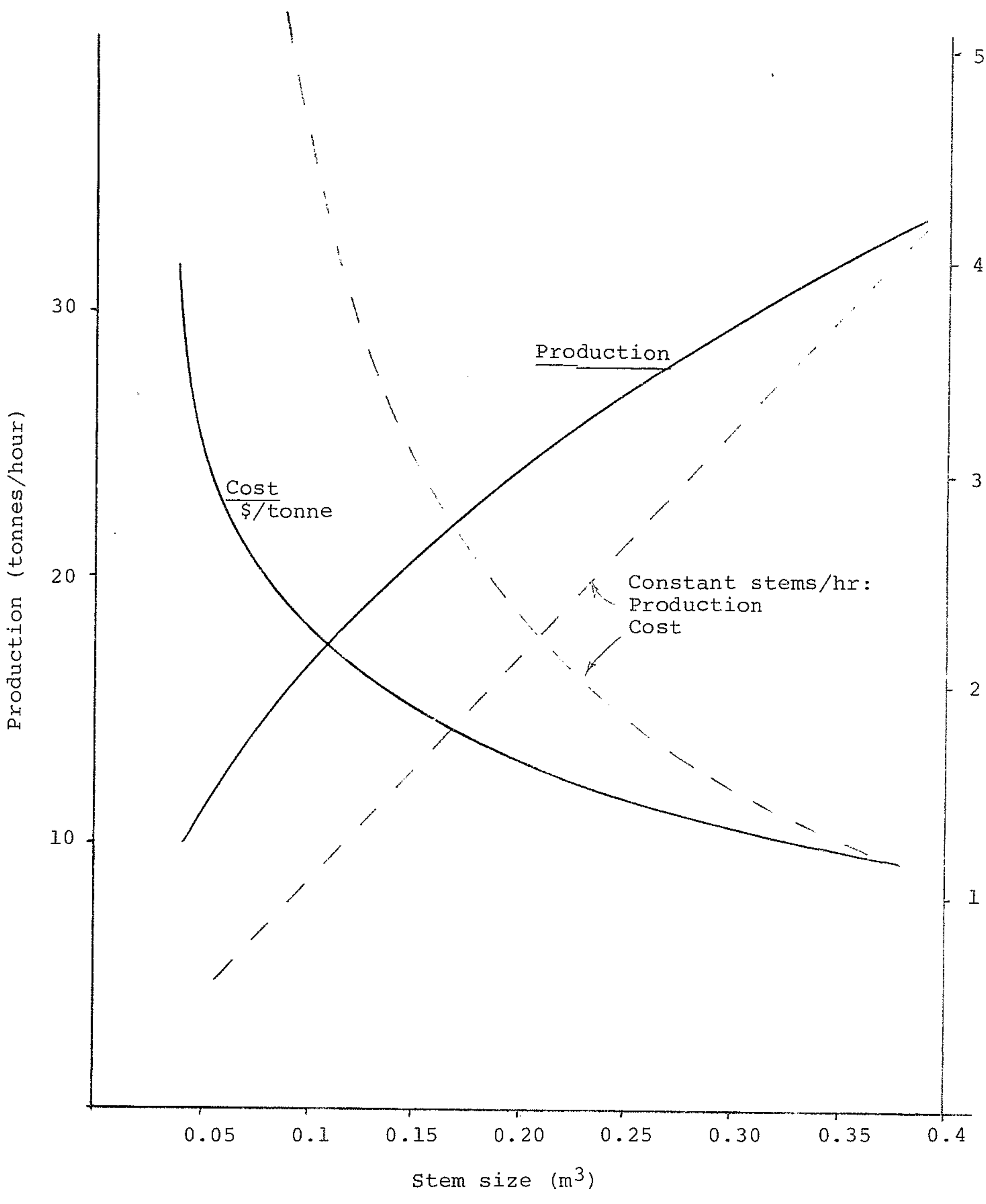
Probably the only machine concept with the potential to achieve a constant productivity regardless of stem size is the continuous shearing type of feller-buncher investigated by Newnham (1972) and others. In this concept the machine moves forward continuously and trees are sheared off and moved across the front of the machine to be deposited in windrows or bunches. Coupled with grapple skidders and flail delimbers, such a system offers perhaps the only hope of a harvesting system with productivity and cost independent of stem size.

Conclusions

Accumulating a number of small stems together in the stump area to make a larger unit load for subsequent handling has been an effective method of reducing the costs of harvesting small stems. In choosing a system, the costs of accumulating stems must be weighed against the efficiencies of subsequent handling.

On a stump to chip basis, shortwood systems, with manual accumulation at the stump, appear more likely to contain the costs of logging very

Fig. 5 Productivity and Cost: JD 544 plus ROME ACCUMULATOR SHEAR



small pieces (less than 0.1 m^3) than long length extraction.

The development of accumulator heads for feller bunchers has made considerable progress in recent years. However, much of the benefit of bunching whole trees will be lost if stems need to be singly handled in subsequent delimbing and/or processing operations.

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SMALLWOOD HANDLING AT THE MILL

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In this context I have defined "smallwood at the mill" as excluding post and pole material, sawlogs and fuelwood. It therefore falls into the categories of pulpwood or panel product furnish.

The wood handling sections of the mills will therefore have to prepare:

(a) uniform length roundwood billets for mechanical pulp from stone grinders or

(b) chips for mechanical pulp from refiners or

(c) chips for chemical pulp from digesters or

(d) chips for fibreboard from refiners or

(e) flakes for particleboard.

There are variations in some of these and some mills prepare multi-purpose furnishes, but in all cases the roundwood must be debarked, and for an annual throughput of more than say 100,000 cubic metres there is no doubt that drum barking is the most efficient and cheapest way to do this.

In the New Zealand situation smallwood is synonomous with tops and thinnings of P.radiata and it is important to understand that this material has:

- a low density

- a high proportion of juvenile fibre (in fact in most cases it is all juvenile)

- a very high moisture content

and it therefore poses technical problems to some users, for example:

- its high moisture content gives rise to drier limiting conditions in particleboard manufacture

- it produces low yield, low strength chemical pulp

and therefore it normally has to be prepared as part only of the total plant furnish - i.e. it has to be mixed slowly and uniformly.

It is also important to understand that all other things being equal the landed cost at the mill will determine whether or not smallwood is acceptable. Smallwood is inevitably fairly high cost material before it leaves the forest and its handling problems together with its technical characteristics do not help its acceptability.

What are its handling problems? First of all, smallwood breaks more easily than larger roundwood so handling should obviously be minimal.

There is usually a good deal of malformation - inevitably so with radiata thinnings - so linear movement in long lengths is difficult.

Piece size is small - probably down to 10cm small end diameter so piece by piece linear movement will result in very low production rates.

I do not think any of us in New Zealand can claim to have ideal smallwood handling equipment - we are generally using harvesting, transport and handling equipment designed for and much better suited for larger logs - probably from 25 plus year old plantation grown trees.

Briefly then we should look at what might be the ideal design for dealing with P.radiata below 30 cm in diameter - i.e. the tops of all trees (they'll always be there) and thinnings (one way or another they'll be there too).

Assume we require a throughput of say 200,000 m^3 per year and assume we require debarked short lengths (for grinding, or chipping or flaking) and assume also the raw material arrives in mixed 5 m. to 8 m. lengths.

The criteria then are:-

(a) gentle handling to minimise breakage;

(b) slashing to provide short lengths (accurately if they are for grinding);

(c) drum barking - because it is the cheapest and most efficient.

Our equipment needs become:-

(a) an unloading method that lifts the whole packet at once - gantry/grapple, or large stacker;

(b) a feed deck on which that whole packet can be deposited and spread so it does not jackstraw;

(c) a cherry picker or unscrambler or pinstop and kicker to feed the slasher;

(d) a trough and single saw type slasher if the lengths are not critical and a multiple saw slashdeck if they are;

(e) an infeed conveyor to the drum barker that also has the ability to accept shortwood delivered direct from truck without any rehandling;

(f) a drum barker with a variable rotation speed and variable outfeed gate so fluctuations in delivery can be coped with.

From this stage on the design is dependent on the end use of the wood, and the waste from that wood.

All this may be summarised by the statements that from a mill point of view there are not too many problems with smallwood if one has the appropriate equipment, but of course the consumption rate must be high - probably above 100,000 m^3 per year - before that equipment can be justified.

ENERGY IMPLICATIONS FOR SMALLWOOD HARVESTING

J.R. TUSTIN

Forest Research Institute

Introduction

The oil crisis has forced many countries, including New Zealand, to examine their energy future. The objectives of these studies are invariably:

(i) to seek independence from Middle East oil production and price increases

(ii) to establish, as far as possible, energy security by focussing on domestic production

(iii) to ensure safe, long term solutions by a transition towards non-nuclear, renewable energy sources such as hydro, geothermal, wind, solar and biomass (agricultural or forestry crops).

These goals have led to a wide spectrum of R & D activity in the oil deficient countries. No two countries have the same set of resources available for exploitation or energy opportunities available for development. None the less, woody biomass from forestry is seen as a potentially important element in the energy plans of many countries, including Canada, USA, Sweden, Finland, Brazil and New Zealand. This focus on wood for energy not only offers the grower another market but also frequently raises a smallwood harvesting challenge for research and management. The result is a new generation of activity in such fields as:

- the use of "pre-commercial" thinnings
- salvage of cutover residues
- swathe harvesting of "unmerchantable" stands
- Development of roadside chipping units
- merchandising (centralised processing and sorting) of whole trees
- investigations of "mini" rotation crops and their harvesting, transport, storage and preparation for processing.

New Zealand's situation

In common with other oil-dependant nations, New Zealand's main energy problem relates to transport fuels. There are no significant oil fields, although a number of promising areas remain to be explored. Natural gas and coal reserves are substantial but finite. They can help to "buy" lead time for a switch to renewable sources. Woody biomass is seen as one option for the production of alcohol fuels for transport. The Energy Research and Development Committee has examined 11 crop processing routes producing ethanol, hydrogen, methane and methanol. All of these fuels can be used in various ways as a transport fuel, either as a complete substitute for gasoline or in blends as a partial replacement for gasoline or diesel. At this stage production based on fodder beet or radiata pine feedstocks look the most promising.

National Wood Supply

Figs 1 to 4, provide an overview of the national afforestation effort and wood supply situation. The main points are:

- Plantation forests currently oover only 3% of the country's land surface. At the projected rate shown this will rise to 7% by 2015. Radiata pine is the predominant species because it grows very well in a wide range of climates and soils. Figures 1 and 2, represent a "likely" scenario derived from the NZ Forest Service 1977, "National Forestry Planning Model". The ultimate size of the plantation estate is a subject for future policy.

- The effect of the planting pattern is to generate a very large wood supply, surplus to domestic-demand for conventional forest products (e.g. sawn timber, paper, particle board and plywood). In practice there are many permutations of felling strategies. Management objectives are usually aimed at sawlog crops in 25 to 30 years. Felling these stands earlier is feasible, but involves a sacrifice of log size and quality. These in turn adversely impact costs and market flexibility so should not be entertained lightly.

- Conventional forestry is based on the harvesting of stem wood to a specified merchantable top diameter (often 10 cm). The rest of the tree, including bark, is waste. Figure 3a shows the stem wood supply to the year 2015. The effect of harvesting all the above ground biomass, i.e. branches, needles and bark as well as the stem wood is shown in Fig. 3b. This is the hypothetical upper limit of biomass supply in the absence of major changes in management strategy. (e.g. energy forests grown on an 18 year rotation). Research indicates that if the needles are left unharvested the loss of key nutrients is minimal.

- Future wood supply is largely concentrated in seven major project areas. See Fig. 4. These are identified on the basis of land availability, suitability for radiata pine afforestation and proximity to export ports.

Implications for Harvesting

At least part of the large and expanding wood surplus is potentially available as a feedstock for liquid fuel production. How this resource is allocated between potential users is dependent, among other factors, on the price they can afford to pay for the parts of the tree which meet their input specifications. For liquid fuels production, the wood specification is expected to be relatively undemanding. In some processes all of the tree is potentially usuable. The main factor is a cheap delivered cost for the feed-stock. This is especially important in that feedstock costs are expected to be a large proportion of the total production cost of alcohol fuels. Liquid producers will compete most intensively with the wood pulp industry and export chip industry for raw material. A key issue is the price competing industries can afford to pay for various parts of the tree. Research results indicate that the cheapest way to produce biomass for liquid fuels is as a by-product of sawlog crops. (Untended energy forests will be much more expensive Forest and mill residues are the most promising feed stock options but "waste" thinnings also present an opportunity if costs are low enough. Alcohol fuel production from wood should facilitate more complete utilisation and improved allocation of the various tree components between competing end-uses.

Energy Ratios

The energy ratio picture is highly favourable for both ethanol and methanol. From wood to ethanol we expect a net gain of at least 7 times the energy input, while from wood to methanol the gain is at least 11 times the energy input. Inputs included in these figures include the energy in growing and management, nutrient replacement, harvesting, transport, wood preparation, and conversion to liquid fuels.

GROWTH OF PLANTATION FOREST AREA AND NATIONAL WOOD SUPPLY

Fig. 1
New Planting 1925-79 Projected New Planting To 2015

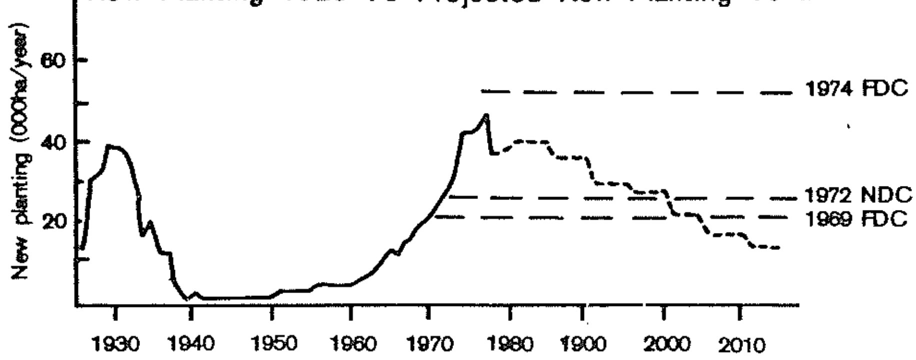


Fig. 2
Growth of Exotic Forest Area Since 1925 and Projected Growth To 2015

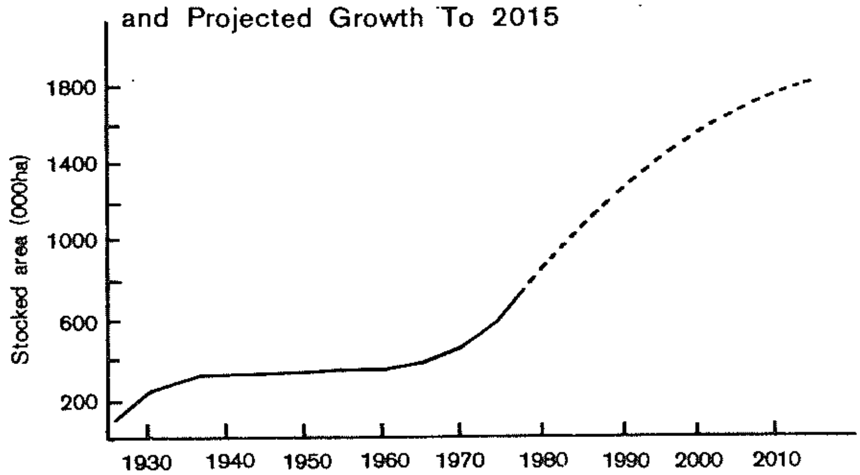


Fig. 3
Projected wood supply from scheduled pattern of harvesting

(a) Merchantable Stem Wood Under Bark

(b) Above ground biomass

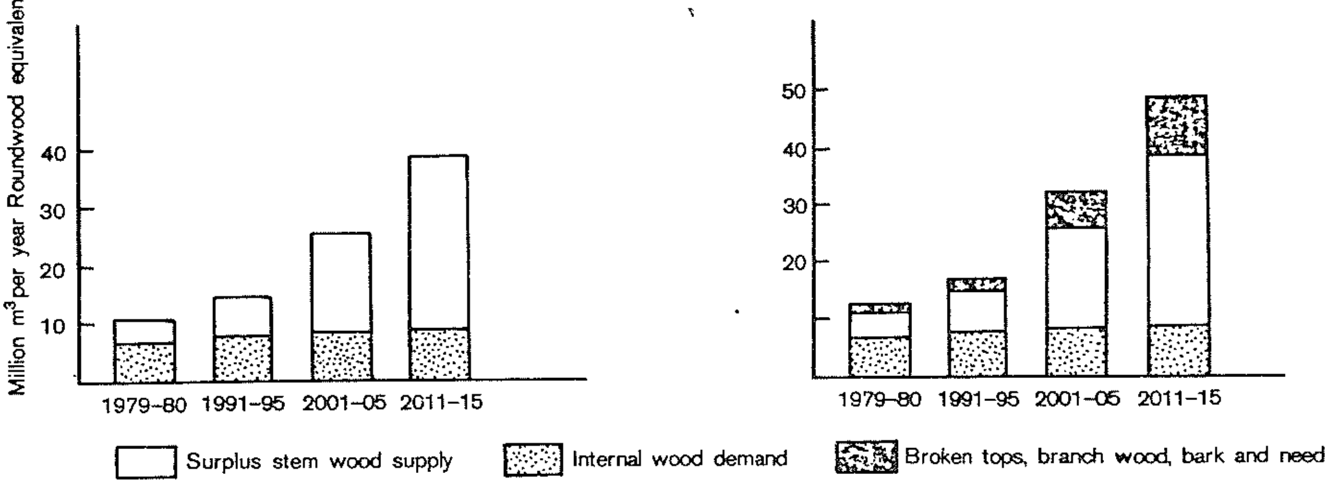
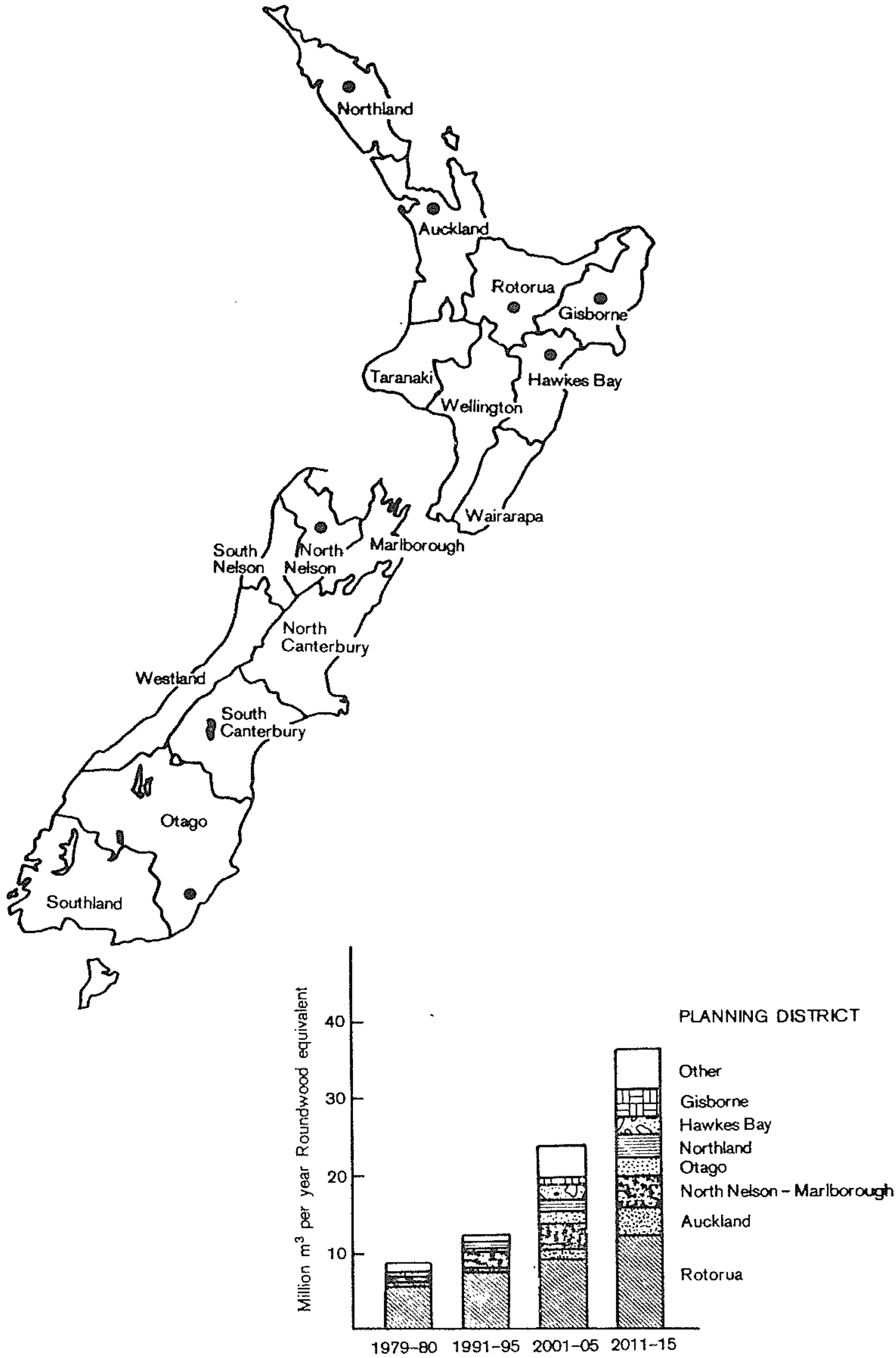


Fig. 4

WOOD SUPPLY* BY MAJOR PROJECT AREAS

New Zealand Forest Service Planning Districts



* Merchantable Stem wood under bark for scheduled pattern of harvesting

● Major Project Area

- SESSION 8 -

GROUP DISCUSSION TOPICS

Chairman: Geoff Wells, LIRA

Introduction

The subject of smallwood harvesting covers a very wide range of topics. The range is far too wide to be covered in full during the course of this seminar. Also, some topics which have been brought forward during the past few days have not been explored extensively, because of shortage of time.

This session was designed to cover some of this material - either for the first time or more extensively than before. It will also allow full participation by group members in their discussion - indeed the success of each discussion depends upon how well the group members participat Unfortunately each participant can discuss just one topic. However, everyone will hear each of the group chairmen sum up their group deliberations.

Topics discussed and individual chairmen were:

Delimbing	- *BOP GORDON*
Labour	- *JOHN GASKIN*
Low Capital Cost Methods	- *CHRIS BAIGENT*
Agricultural Tractors	- *MIKE WATSON*
Machine Size vs Tree Size	- *TOM JOHNSON*
Small Haulers	- *VIV DONOVAN*
Loading and Transport	- *RON WREN*
Posts and Poles	- *BOB BOYLE*
Harvesting Logging Residues	- *JAMIE FRY*
Whole Tree Chipping	- *HARRY FLEMING*
Mechanisation	- *DENNIS NEILSON*

DELIMBING - *BOB GORDON*

Before we started talking in detail about delimbing, we looked at it in a general sense, and the main point that came out was that we were spending a fair amount of money as an industry in looking at delimbing as a problem. One possible suggestion we put up was that some of this money could be rechannelled back to the foresters or the university people to consider other methods of getting branches off trees, not necessarily using the logging process. A suggestion was, for instance, to look at the breeding stocks of trees that naturally shed their branches. There were also a few other suggestions thrown up, like chemical delimbing research, etc. Now whether or not some of these things are feasible we don't know but as loggers we would like to know.

We then talked about the manual delimbing approach. The main things that came out here were; that it's heartbreaking work doing it with a chainsaw (we've already had this stressed to us), there is a high accident rate, generally it is a low production rate operation, and there is a high turnover of people involved in straightout delimbing. Our main suggestion to try and overcome these problems was that its important to vary the work of people involved in delimbing. This is where the shortwood system shows up as having advantages, where guys are not only just trimming trees but they are felling them, cutting them to length and stacking them - thats one suggestion. Where people are having to work behind say a machine that is felling and they are knocking the branches off, then try not to let them see 2 or 3 acres of trees lying on the ground in front of them - keep them working around corners so they can't see. There are also still some serious ergonomic deficiences with chainsaws, particularly noise, and once again, these point to the need to vary the work of the guy who is having to use the chainsaw. Another important point brought out was that there is no job prestige for the people involved with handling chainsaws in this country, particularly in smallwood operations. This is unlike the situation in North America so the points brought out by one of the papers today on certification of loggers, providing awards and appropriate pay, are pretty important to providing some incentive for these guys you're going to ask to manually trim trees. The rate of trimming trees can be significantly increased by rough delimbing and the options available for doing a rough delimbing job have got to be seriously considered, both in the manual sense and in the mechanised delimbing sense.

For the second half of the session we discussed mechanised delimbing, which is a big subject. Firstly, we need to know more about the trees that we're going to delimb if using machines, so its back to the foresters essentially. What are the typical tree sizes, what are their branch characteristics, tree lengths, this type of thing. If that data is known in this country let us get it in front of the people who are being asked to build machines to delimb, that would be a big step. The group agreed that in mechanised delimbing, there are the two different approaches, that is the sophisticated more costly single stem delimber, or the low cost multi-stem delimbing arrangement. Both possibly have a place, however in New Zealand there seems to be a need to get the industry people together on an overall basis, machinery suppliers, loggers, and people who are interested in mechanised delimbing. Get them together and thrash out this subject of mechanised delimbing, not only in terms of the equipment or the techniques that are going to be used, but on training implications, implications on importing equipment and on local development. Hence we figured there was a need to rejuvenate the mechanised delimbing topic as a LIRA research field, and the interested people together to try and overcome some of the problems outlined in this Seminar.

<u>LABOUR</u> - <u>*JOHN GASKIN*</u>

1. What important points have emerged so far from the Seminar relating to logging labour in smallwood harvesting?

Logging of smallwood is very labour intensive and the labour is required to do physically demanding work.
If the demand for smallwood develops as projected it is going to create a great number of jobs.
Labour can be attracted because individuals can see results for their efforts.
It provides an environment which suits particular individuals.

2. How can men best be recruited to what seems to be less popular and more difficult work?

Make it more attractive, i.e. more money, more socially acceptable.
Use publicity to show how skilled the job is, how they can work with little or no supervision.
Build up a career system - aim people at becoming contractors or supervisors.

3. How can or should people be trained for this kind of work?

"CAREFULLY"
Management must understand the need and accept the obligation to train.
Identify the needs - adapt these needs to suit the particular area.
Establish programmes - all the elements are available - pick out what is wanted.
More involvement in training by machinery companies and chainsaw agents.

4. What can be done to make the work environment "nicer"?

   Make a safer more palatable environment - little can be done with the physical environment, you can't switch off rain or stop frosts.
   Understanding and acceptance of the benefits of protective aids and equipment.

5. What methods could be used to motivate men?

   Informal leader should get recognition rather than the ineffectual leader or supervisor, there is more respect for this man.
   Three other points are :
   1. Money
   2. Security
   3. Job satisfaction.

6. What further research needed?

   In all these areas, especially labour recruitment and training.

<u>LOW CAPITAL COST METHODS</u> - *<u>CHRIS BAIGENT</u>*

I guess this is the one that everyone's waiting for; the something for nothing department. One answer is to lease machinery, this gets away from having to provide a lot of capital. We broke the topic down into haulers, skidders and other methods. On haulers we discussed the Igland winches, which cost $8,000, and bolt straight onto a secondhand machine. The advantages are that it converts readily from skidder to highlead hauler systems. In Nelson, H. Baigent and Sons have made up a small hauler. We made something out of a hydraulic drive 15 hp Kubota engine for $6,000. It runs on the endless rope principle with a capstan drive. We talked about power saw mounted haulers and I see Fletchers have a small engine hauler on skids. In the skidder line we talked mainly about secondhand machinery such as secondhand farm tractors, that sort of thing. As long as they have a good engine they can be modified to suit.

In the other systems we talked about chutes; $1,700 for a set of 60 metres of chutes which have had 1000 tonnes of wood over them with no signs of wear as yet. Feeder chutes are a possibility; we could have several lines feeding onto the main one chute. We discussed the skyline (the gravity one) that Ralph Robinson recently wrote a report on. New Zealand loggers like big noise, big horsepower, big capital investment machines. An alternative method with a capital cost of between $600-$1,200, no blown hoses, no half-baked mechanics, no noise, and an on-ride logging cost of less than $5 per cubic metre is the draughthorse. Mules are used in South Africa where they cost about $360 per animal.

As far as research goes, for low capital cost we are looking to the backyard innovator where a guy is doing his own thing. Research would have to encourage and assist him there. The other thing is that when talking about second hand machinery, and some of these other items, you have to consider the effects of R & M costs and downtime which would have to be weighed against the capital cost to eventually come out with a cost per cubic metre, for proper comparison.

AGRICULTURAL TRACTORS - *MIKE WATSON*

There is a proverb that says you should never expect a boy to do a man's job, and I think that's very true. In this case we are really only asking a boy to do half of a man's job. There was a general feeling that if you choose the right half then you stand a pretty good chance of getting a good result. In fact, agricultural tractors are used quite widely in Europe and Australia and there are a few being used very successfully in New Zealand. Were there is failure it may be because really people have expected too much from them. Obviously, the main attraction of the agricultural tractor is the low capital cost: it seems to be between $22-28,000 but there is another interesting reason, quite a realistic one, and that is that low capital cost does enable a man to get started in business. It's very true that most of them get out fairly quickly and go on to more sophisticated equipment.

We then touched on forest conditions under which you would expect agricultural tractors to work. There was a general feeling that you shouldn't take them above about 10° slope or you'll start getting a lot of troubles, although there were some optimists who have been trying to go much steeper than that. There seems to be a very definite feeling that the main problem in conditions was not so much lack of power but lack of traction and we talked about various possible research topics here. Double wheels were mentioned but their width was thought to be unattractive. The possible use of half tracks, which are used in Scandinavia and the possibility of easily extendable steel spikes, like those used in farming, seem to be worthwhile research topics.

Maintenance was discussed. There are sometimes very quick failures, particularly in vulnerable front axles and often it is essential to re-inforce them. If this is done then there seems to be no reason why you cannot expect to get at least 3000 hours, and at the end of that have a good chance of a high resale value on the tractor for farm use. Tyres can also be vulnerable. One of the big advantages mentioned was the availability of spares because the large number of other tractors in the country and also the fact tht operators tend to be familiar with maintenance of farm tractors. Most of them seem to have grown up with them from a very early age and that seemed to be rated quite highly. We touched briefly on safety aspects and there was a plea for not using trailers. There is a need for some clarification on what is okay for safety canopies in the bush situation. This is fairly well known but people should understand that the agricultural canopies and frames are only for roll protection and do not provide any head protection.

Finally we talked about attachments. There was felt to be a very definite need for a wider range of winches to be available in New Zealand and it would seem that there is a worthwhile market potential there. It is starting to be filled but there is a feeling there is room for more choice for the operator. There was also a request for research on use of grapples instead of, or in conjunction with winches. Finally, there was a request for research work to be done in the application of attachments for highlead operations.

There was a general feeling that there is a place for agricultural tractors but be careful not to try and use them in conditions where they are not suitable.

MACHINE SIZE vs TREE SIZE - *TOM JOHNSON*

General Comment: The particular group from the outset was divided clearly into those doing the advising for those doing the job and being paid for it, and those who represented the payers. The difference of opinion was clear and often unresolvable in the time available. The notes attempt to show both points of view and the reasons.

Dealing with the provided questions in order:

1. Has any information relating to this topic come from the Seminar so far?

   There was information in general terms provided by previous papers and demonstrations, but not specific enough for those present in discussion group.

   Alternatively, there was clear demonstration that machine size should be matched to kilowatts.

   Gaskin - advocating smaller saws particularly in smaller wood.

   Terlesk - described results from a succession of studies but also commented that the principles had not been accepted by loggers as yet.

   Galbraith - pointed out that you can increase kilowatts in small wood but only make it pay if you accumulate bigger loads.

Tustin - clearly demonstrated with slides from overseas small machines towing highly loaded trailers, carrying what by N.Z. standards is just slash and rubbish.

Most of the field trip showed the above, smaller machines in smaller wood. When kilowatts were used there was a greater degree of accumulation, and mechanisation towards improving the accumulation rate.

Humphreys - from Australia, described the same principles again but starting from high up the kilowatt and tree size scale. Their Australian decision was also helped by other factors.

There was some doubt expressed by the group about moving into small gear with only a limited life for smallwood ahead. They did not think smallwood would retain its importance once bigger wood became more available. Refer Kirkland's keynote address. Time only will tell.

2. <u>Small machines should mean less stand damage in thinnings operations. Is this generally true? Does it hold for both tracked and untracked stands?</u>

Smaller machines generally cause less damage but require better operational layout. One operator had moved to bigger gear and not increased damage. One thing is clear, it is not the machine which causes the damage but the total train length of machine and load. Hence the relatively larger home built forwarder (Forest Products, Clarkin) showed less damage, than skidding long lengths with a smaller skidder.

Operator skill and room to work in (regime when thinning) have more influence than kilowatts and machine size. With outrows the group considedred bigger machinery can be used (in terms of damage). Other factors are slope, terrain generally, and geometry of the machines.

3. <u>Does a relatively large rebuilt or reconditioned skidding machine produce smallwood cheaper than a new small machine?</u>

Within the group there was an immediate conflict. One contractor had reconditioned a bigger machine, another bought a new and bigger machine. Both however were concerned with downtime and availability and little interested in smaller gear. On the Australian scene there was just no second hand gear available so the choice was simple, it had to be new for developing new operations. The question of size however, was passed over during the discussions.

The comment was made that smallwood operators are generally starters in the game and also younger rather than older. Capital therefore or lack of it, takes on large proportions. Skill and the desire to save by fixing older gear is not in short supply, in this situation.

Some figures were produced:

A 76-100 kilowatt skidder costs in 1980 $72,400.

On its own, capital related costs represent 54%, operating costs 32% and fuel 14%. However when these are combined with the other costs of operating an average logging unit, i.e. labour, transport, saws, accessories etc, the percentages drop to:

Capital related	15%
Operating	9%
Fuel	4%
Other items	72%

It means that reconditioning old gear which costs half the price of new gear, leaves only a 7½% area in which to work and you may still not have got a satisfactory level of reliability. There seems to be little point in using a machine with a capacity of 60,000 tonnes per annum in smallwood regardless of cost unless it produces 60,000 tonnes or near that amount of smallwood. Relative wood value could influence this situation.

4. "Right" machine should give the lowest production cost. The main factors in this argument are: Capital cost and machine life, repairs and maintenance, load size and speed. Each of these points need exploring for the various options of large small and rebuilt machines for smallwood harvesting operations.

The group really fell to pieces in discussing this one. For openers, in the Australian scene production cost in no way contributed towards selection of the "right" machine. It was also suggested that the "right" machine was the one which the payers were prepared to pay for, for any number of good reasons.

However, it was generally agreed by the group that bigger machine size is quite O.K. provided only that it is possible to get a sufficient load on its back in short enough time. Again it must be remembered what the particular machines capability is in its own optimum wood size.

The group considered Galbraith's paper set this out clearly and provided excellent guidelines as to principles to follow. The group agreed the "right" machine should be selected or built on the basis of a combination of purchase cost, operating cost, load size and annual production rate in any given situation.

It was noted by a member of the group that nobody on the seminar had advocated using a secondhand Madill hauler, on smallwood operations though the equivalent in skidders was advocated in combination with other machinery on the basis of availability and labour cost. Time did not permit pursuing this particular discussion. A member of the group pointed out the problems faced by successful contractors. What should they do with surplus money, that is after they have bought a new house, carpeted it, obtained a car, boat and caravan and probably a trip overseas, albeit to F.I.M.E.. Joking aside, there is a strong temptation to re-invest in his own operation and if he is going well there is a strong chance that it will involve increased kilowatts even if the kilowatts are not strictly necessary.

5. Consider the problems of loading out from smallwood operations and whether or not a fleeting stacking and/or loading machine is required and its effect on productivity, and cost.

It was agreed another group was handling this topic, or should be.

6. Are there any points needing further research and development in the area of matching tree size and machine size in smallwood harvesting.

Areas for further research. The group felt tht basic data about the topic under discussion, machine size vs tree size was particularly scarce causing much of the discussion within the group. In particular the following is required:

(1) How can big loads be carried?

(2) How can these bigger loads be accumulated?

(3) These factors balanced with the time taken to accumulate loads.

(4) Relative fuel consumption and cost.

(5) Working out a means of achieving machine balance, between machines, between manpower and machines.

(6) More work is needed on the silvicultural aspects of logging smallwood in particular.

(7) It was suggested that this groups particular topic should be the subject of a seminar of its own.

SMALL HAULERS - *VIV DONOVAN*

The Small Hauler Group looked at several things. First was ways of improving productivity or utilisation of small haulers. There were two thoughts that were pursued. One was improving the actual haul size of the machine and the other was the manipulation of the crop as a means of improving the utilisation of the hauler. The Group discussed extracting shortwood off steep country. Although it had been stated that this was not economical, the trials that had been done to date were in situations where there was heavy undergrowth and on very steep slopes (35°+). Also, there were problems of handling the wood in front of the hauler. This system appears to still have possibilities if the stands are selected, such as areas of less undergrowth and perhaps not quite so steep. However, there is still a problem to overcome handling wood in front of the machine as large volumes are accumulated in a short time. The hauler required for shortwood logging must have good tail rope breaking ability to maintain control over the bundle as it is brought in. This applies for both uphill and downhill logging but particularly downhill. This problem during the shortwood trials was not overcome. The manipulating of the crop was seen as a very long term project. Some concern was expressed at the amount of land that is taken out of production when using a very wide mini-clear-felling. The Group however felt that this was something worth pursuing and were pleased to see that F.R.I. were doing this work.

The second thing the group discussed in detail was roadside handling of the wood and here it looked at secondary machines and also other types of machines that could be used. Firstly, the Group looked at swing yarders which have the ability to lay logs beside the machine for some other machine to load out from that position. The cost of these imported swing machines is very prohibitive so the Group discussed the possibility of the 30RB type crane being used as a two-drum skyline in a gravity configuration and using Christy carriage. A secondary machine in existing thinning systems amounts to about 12% of the total cost of the operation so there is considerable money tied up in that aspect. Whether a secondary machine is needed or not, depends on whether extra roading is put in. If a small hauler can operate off the edge of a well formed road, then a secondary machine is not needed. If you are not willing to put in extra roading then you have to have a secondary machine and this is the difference between our New Zealand situation and what they are doing in Queensland. Another thought mentioned was using the slasher and loading straight up from under the hauler or from a stockpile that the hauler ahd left, straight into multi-lift bunks. There could however be some operational problems using a slasher in this manner.

The Group looked at new developments and new concepts for improving small hauler productivity. The Group felt that going to higher capacity machines with increased line speeds may not necessarily overcome the time consuming problem such as rope shifts and breaking out.

One further new concept that was mentioned was looking at somewhere else to do the trimming rather than have men doing this in the bush. This would entail extracting whole trees and a secondary machine pulling them away through some type of delimber. The idea here is making the delimbing part of the job a lot safer and in a better working environment.

Finally, the Group discussed a few things to see if they could get any concensus on where further work was required with small haulers. The first was slack pulling carriages. The Group thought that this was an area that perhaps should be further pursued. They would allow managers to increase the distance between skyline strips. The interlock principle for small haulers was another area the Group thought should be pursued. More work needs to be done on interlock, especially as far as systems layout is concerned. Ways of reducing shift time is something else the Group felt needed more work. Although shift time is down to about 15% of the total time, when small haulers are operating over short distances, it becomes a very important part of the operation. More work is also required on wood handling at the landing. Finally the group decided that further work is required on felling and delimbing, particularly directional felling.

LOADING AND TRANSPORT - *RON WREN*

This Group looked at Loading and Transport which included fleeting and stacking in the bush. Probably the most important point concerning fleeting and stacking was that in handling smallwood, forest management practices dictate that the smaller the piece size the smaller the landing. The forest planners forget that it is still necessary to get the 24 tonne or the 34 tonne rig into the bush, and the loader to have a quick turn round and get the rig out again. This was one point that we thought should be carefully thought about in forest planning: keeping a large enough landing available for the operators to work in. In loading generally there are sufficient types of loaders to meet most situations but occasionally the loaders require modifications to do a specific job. The mixed log type provide the biggest problem with loaders.

On transport, we discussed whether the trailer manufacturers ever think in terms of giving us the right axle spacing to meet our correct loading on the road. We were informed that probably there is not sufficient volume of traffic in logging in New Zealand to warrant a manufacturer giving logging special consideration. Road User charges were playing an important part in determining the cartage rate, more so than previously before. Axle spacing is the most important factor in determining the allowable load. In the transport of small wood, three basic systems are available: one was in line down the truck length in short lengths, the second is accross the deck up to 2.4 metres in length, and the third is the full log length.

Some thoughts were expressed on the safety of short pulpwood loading and it had been noted by a few of the group members during the field day that some of the load leaving the bush were not loaded as well as they may have been. The heights of loads are often in excess of requirements and quite often short logs were found to be sticking out the side of the bolsters.

We discussed the use of heavy versus light staunchons in order to increase your payload. Long length loads may need to be topped and tailed in order to get a decent payload. Some operators, of necessity, use their truck for multiple systems, posts, pulpwood and logs without being able to specialise in one load for one truck type.

POSTS AND POLES - *BOB BOYLE*

Our group had two operators involved in logging posts and poles. One was in Ponderosa and one in Corsican. They have found no difficulties in the logging or the dimension requirements of posts and poles. Occasionally in the Ponderosa there are the odd butts left behind on the cutover which are too short for pulp and he is not cutting battens. In the Corsican operation, battens were being cut out and the whole tree was being utilised. The contractor working in Corsican was shortly going to finish that and move into thinning Radiata pine at 12 years old. He could see a lot of problems coming from the inferior trees that had to be taken out. There would be a lot of wastage left behind from those trees that could not be used for pulp and would have to be left on the ground. This would probably reduce his output considerably compared with Corsican.

Processing as far as cutting goes, in a small operation this should be done in the bush but in a larger operation the long lengths should be extracted and carted away from the forest and peeled off the forest. In a small operation the peelings and the shavings can be used in the forest on the skids or on roads but generally the peeling should be done off the forest and kept well away from it, as it creates a problem for re-establishing the forest.

Suitable equipment for a small operation that may last only a short time is a farm tractor for extracting the produce. For a larger operation, with a five year contract or more, the conventional skidder would be a better machine for extracting the timber. Production rates and costs would be very similar to the ones from NZ Forest Products Ltd where they are taking out pulp in shortwood. On a large operation where sawlogs are also being cut costs would be lower as the costs of post production would be covered by selling sawlogs.

Areas where research and development work could be usefully applied were in future roundwood supply. There was concern that after the Corsican is removed and a lot of the Ponderosa gone, there will be very little suitable area for roundwood production. Perhaps the foresters could give some thought to areas that could be specially grown for roundwood, by not thinning at an early age and maybe closer spacing.

HARVESTING LOGGING RESIDUES - *JAMIE FRY*

Residue is "smallwood" arising from "bigwood" operations.

Residue is made up of cutover and landing waste. Cutover waste is on average about $30m^3$ per hectare. However it can be found occasionally as high as $100m^3$ per hectare. This residue is made up of short random lengths covering a range of diameters. It is unevenly spread across the cutover. It is therefore difficult to accumulate. Landing waste is often buried in a mixture of small pieces and branches. It is very difficult to assess the volume of landing waste in slash piles.

On the cutover:
The group felt that a 2 stage logging operation appeared to be the most economical way of handling the residue. This meant that the large machine of the first stage became more economic as it only handled large piece sizes and the second stage became more economic because of the larger volume per hectare resulting from the first stage operation. It was suggested that one contractor should control both operations and so dictate the pace. Some members had experienced problems when a separate contractor was used to collect residue. As the residue contractor worked closer to the clearfelling gang he tended to be fed wood by that gang.

Machinery

The most suitable machine appears to be the forwarder. However there is also a place for skidders and agricultural tractors. This immediately restricts the operator to working flat and rolling topography only. The group was of the opinion that anything not picked up by a hauler on the first operation was too expensive to salvage.

Forwarders may require pre-stacking of residue. This is very labour intensive. The forwarder must be capable of carrying the random lengths found on the cutover. One advantage of the forwarder is that it lifts the wood clear of the ground and so dirt is not forced in broken ends. This means that broken ends do not have to be cut off and the residue volume is not decreased by additional docking. Bins and large trailers were also suggested but load compaction is a problem in bins, and large trailers require big prime movers.

Landing Operations and Transport

Forwarders can unload onto preload trailers. However the payload would only be 15-16 tonnes as the random lengths would not give a complete load.

Mobile chippers or hoggers could be used to produce chips for fuel especially if fuel is going to compete for wood supply. Fuel does not require the bark-free chips that pulp and paper plants do.

Bins would be used for the transport of chips.

Costs and Production Rates (1979 costs)

From past trials and paper exercises residue costs $10-$12 per tonne at the landing. Production rates from cutovers with 40-50m^3 per hectare are 3-4 loads per day (45-60 tonnes). If the salvage operation is near to a mill the cost at the mill can often be cheaper than arising from further distances.

Further Research

The machinery is available to handle residues to the landing. Research is needed to look at transport of residue or chips, Utilisation plant handling of residue and potential markets for residue.

Observations

The new generation of highly managed radiata plantations may not produce the volumes of residue that have been experienced in the past as it may not be so prone to breakage and shatter.

Felling techniques and mechanical harvesting may also reduce breakage and thus residue volume.

Good skid supervision and the use of computer programs such as MARVL will also reduce skid waste.

WHOLE TREE CHIPPING - *HARRY FLEMING*

Our jury had to sit in judgement of whole tree chipping in New Zealand and because there has been only one in New Zealand, regrettably our verdict was guilty, with a strong plea for mercy because it wasn't the defendant's fault!

Question 1 - what are the problems of product acceptability and what are the potential uses for chips in New Zealand? Whole tree chips are not acceptable to the only New Zealand papermakers who tried them. The particular whole tree chipper was not equipped with the since developed debris separator and although the pulpmills screening equipment could cope with twigs and bark and chunks and greenage found in unseparated whole tree chips, it could not cope with bark adhering to chips. This debris increased maintenance cost in pulpmill machinery, and cooking costs also increased. The cost of chips was too high, something in the vicinity of 20% above conventional woodroom chips and sawmill residue chips. The biggest cost factor was in contract chip transportation.

Question 2 - where should chipping take place, at the stump or at the landing or at a central processing yard or at the mill? Whole tree chippers do not go from stump to stump and you cannot cart whole trees down the main highway to a mill, so chipping must be carried out at the landing.

Question 3 - what are the best ways to load transport and store chips? Either end or top-load chip vans should be used at the landing for direct loading from the whole tree chipper. Due to the difficulty in scheduling chip trucks, to arrive at the whole tree chipper as and when required in the right number at the right time, there is some economic wisdom in stockpiling at the landing and loading out with a bulldozer blade or mobile elevator. There is also economic wisdom in top loading to enable multi-purpose trucks to be used as opposed to speciailised endloaded chip vans.

How should whole trees be handled for whole tree chipping? The logical place to do chipping is at the landing, so the normal constraints of conventional logging apply, such as ground conditions, topography, and so on. If it is important to keep trees clean for chipping clambark forwarders could have a potential.

Question - what is the potential for whole tree chipping, in New Zealand logging operations? - The Group decided that whole tree chipping of smallwood in New Zealand is obviously looked at only by end user logistics and forest owner insistence. The last question asked for areas for research and development. The main potential use was residues for fuel, extractives and so on. So research could be carried out on getting residues from stump to the whole tree chipper.

MECHANISATION - *DENNIS NEILSON*

Our discussion started with an indication of the feeling of the Seminar and it was a general concensus of opinion that there is a definite lack of enthusiasm for getting very involved in mechanisation of smallwood handling. There has however been some variety of opinion on that. There is a feeling that in New Zealand there is not the area of flat and rolling country which would be amenable to mechanised logging of smallwood. There has been some criticism of the attempts to become involved in mechanised harvesting. Some organisations may have acted more on instinct thatn on proper planning. Generally in New Zealand we have attempted to modify large wood logging techniques to smallwood and bring in mechanisation at the same time. The Australians on the other hand have spent some years in what we would call very small wood and they have been through various systems developed from smallwood operations at the beginning rather than trying to come dowm from a larger operation.

There was a feeling that the lack of security of contracts in New Zealand in some areas has really prevented contractors from spending money and time and effort in developing mechanised systems. As far as the future is concerned, while the current ratio of labour rates to machine and fuel rates holds as it does in New Zealand, there will not be a rapid movement into mechanisation, and certainly not into full mechanisation, in smallwood logging. However with the large increase in general logging volumes available in New Zealand we will almost certainly run into a shortgage of labour which could change the situation quite independently of cost structure.

There are possibly particular areas in New Zealand where silviculture systems may be more suited to mechanisation. The forests of Canterbury for example may be better suited to growing smaller piece size crop because of the wind problems and so there are certain regions in New Zealand that may move to mechanisation more quickly than others.

We had a look at the parts of logging systems which may be mechanised if we accept that full mechanisation may not be desirable. It is quite clear that in smallwood the delimbing problem is the one that is the biggest problem financially, with 60-70% of the time cost of felling and limbing and bucking being spent in the delimbing process. While that is the area where mechanisation should be introduced, people are not confident that we will get successful, mechanised delimbing systems in smallwood quickly in New Zealand, certainly from a cost saving point of view. Probably the most successful area of mechanisation in New Zealand thus far has been in the fell-buncher operation. There is a reduction in the price differential occurring between more conventional skidders and forwarders that may head us towards a more serious look at forwarder operations in smallwood harvesting. Loggers in New Zealand often tend to ignore some of the indirect costs when they are considering mechanisation versus manual operations. For instance the roading costs in particular could be reduced quite considerably by introducing forwarders and having a much less dense road and skid network.

We had a look at the implications of mechanisation in terms of investment, R & M, labour availability and training. It is generally considered here at the Seminar, and in our group, that in New Zealand the capital cost of mechanisation is the one item that scares people away from moving further in that field. We have heard of the Australian experience where major forest companies in fact take a lot of the risk by bringing in new equipment, trying it out and if it's successful passing it on the contractors. It is the major companies which are taking the risk and not small contractors or even medium or large sized contractors. That system of operation has many advantages: it allows systems to be tried by operators who can afford some wastage and afford to take the risk as well as have the capital available in the first instance.

As far as repairs and maintenance are concerned the high cost of R & M is something which puts people off moving towards mechanisation. Organised preventative maintenance programmes have probably been lacking in New Zealand, although some operators overseas have gone too far the other way and are insisting on too much machine downtime for repairs and maintenance which in fact goes past the optimum cost. It is generally conceded that the owner operator has a distinct advantage over large companies in operating mechanised gear from a repairs and maintenance point of view because of the lack of organisation in most large outfits and the time wasted. While we apply incentive programmes for production loggers there is a lack of incentive for good maintenance people amd mechanics. There should be more emphasis given to incentives to encourage higher productivity in the repairs and maintenance field. There may be in New Zealand a lack of good skilled mechanical labour for the servicing and repair of mechanised equipment. While there is a short term surplus of labour in New Zealand, that is not going to continue and there is a definite need for training. In spite of the fact that we have probably a lack of skilled people in the country, this would generally be a secondary consideration for a company or a contractor who was seriously considering going into mechanisation.

As far as further research needs are concerned, we treated that in a general way. There is a real need for co-ordination between regions in New Zealand just to identify the possibility and needs of various regions for particular types of mechanisation. Perhaps more emphasis should be given to bringing senior Research and Development engineers from overseas to New Zealand. They could really get down to the grass roots to design for New Zealand conditions rather than trying to fiddle ourselves or bringing out field engineers just to look at small problems. Perhaps LIRA could be involved in organising something along those lines.

- SESSION 9 -

DEVELOPMENT REQUIREMENTS

Chairman: Jim Spiers, LIRA

Introduction

Our objective in holding this seminar on smallwood harvesting was to review the available information, to air some of the lessons learnt from experience, and to explore some new concepts and ideas. We have certainly assembled a lot of expertise and experience. They have presented to you a lot of detailed material and we have only allowed them a short time to bring out the main points from their papers. Therefore, the value that you will get out of this seminar will depend to a large degree on the amount of referring back to that information that you do - how well you absorb it will mean how much of the lessons you can apply.

You have had a chance to discuss, debate, and absorb facts and theories and now we want to look at the directions that this industry should go in the future, and what LIRA should do to help achieve desirable objectives. Thus, to help identify some of these salient points, a panel has been assembled which represents the customers for LIRA's research. The panel members will translate what they have learnt from this seminar into what now needs to be done to cope with the problems of harvesting smallwood. They will centre their presentation around what this industry, or any sector of it, should be doing and what they think LIRA should be doing.

Panel members were:

Sandy Hampton - Robert Holt & Sons Ltd.
Trevor Minchington - Canterbury Timber Products Ltd.
Harry Fleming - Morbark Pacific Ltd.
Peter Olsen - P.F. Olsen & Co. Ltd.
Bill Kerruish - CSIRO, Australia.

SANDY HAMPTON - Robert Holt & Sons Ltd, Napier

I intend to speak briefly on three aspects. My position involves growing trees as well as logging so I am able to appreciate that in fact the profitability of growing the crop is dependent on the cost of production. You have smallwood, and you have to face the problems.

I suggest that perhaps we should look at growing the crop so it is in a condition that you can efficiently and economically handle . I believe this is possible on the reasonably good sites which radiata pine occupies in the Hawkes Bay. It is possible to thin and low prune at year 4 or 5 from the original stocking down to 650/700 stems per hectare and let this crop grow through. At 12 to 14 years we have achieved an inch a year on our crop element and at that stage we consider thinning. The thinning schedule has to have some flexibility built into it to enable large areas to be covered. By delaying this thinning piece size is increased and the rubbish has gone. The value of the wood has increased by virtue of the fact that it may comprise sawlogs and because the costs of production are lower.

We can consider log or tree length extraction or extraction by cable, keeping in mind that if stocking is important you may delay thinning to year 15 or 16, at which stage the stand will be almost fully stocked. A plea has been made for more professional plans. To my way of thinking, we have never had planning and we are unlikely to improve it much anyway. What I am suggesting is that we should look at planning our forest roading network, not simply to facilitate establishment but to facilitate extraction of thinnings. It is not difficult, nor is it costly. When the scrub is down and it is all burnt, it is a lot easier to find landings and make sure your roads are going to get there. I believe that it is wise to plan now to log 15 years hence with the equipment that we now know we can use. It is easy to say we don't know what we are going to use in 15 years time so it is madness planning for it - that is a defeatist attitude and I think it has got to go.

Finally, labour. We have heard today that the industry will require 8,000 men at about the turn of the century. We have also heard that labour will be in short supply. Just a few weks ago we saw figures that were produced by the planners! We saw the figures of unemployment that are predicted. If we can't find 8,000 men for our work, there is something radically wrong. I don't believe that Mike Newbold's Industry Training Board is going to let us down to that extent.

I am sure that the structure is now going to be set up to ensure that at least the High Schools and the good little kids that are available in the High Schools are made aware of our industry.

TREVOR MINCHINGTON - Canterbury Timber Products Ltd.

I am going to cover an area that has not been covered in this Seminar. The emphasis has been largely on thinning but there is another aspect, and that is the clear felling of smallwood in unthrifty stands. In the Canterbury area there are considerable volumes of wood that the NZ Forest Service are desirable of harvesting and re-planting at an early date to get a more desirable species. A lot of this material happens to be ponderosa pine. The height of the trees in general is around 5.4 m for a good tree, with low dbh and in a lot of cases a high number branch whorls with many branches at about 300- 400 mm spacing. We are thus faced with an extremely high labour input no matter what system we use. We are also faced with a wood shortage situation: in normal circumstances the cheapest way of harvesting it would be to use a box of matches, but unfortunately we need the fibre so we can't walk away from it. We have got to find some economical method of handling it.

I have not come up with a method to date and I am hoping that somebody - either LIRA or somebody from this conference - is going to one day drop an idea in our lap that is going to help. The volume involved is not great enough to get involved in specialist gear - we are only talking about approximately 30,000 cubic metres a year for about 3 years at the moment, although it may go on for about five years. Therefore, we have to find some method of handling smallwood with existing equipment that can be adapted readily and cheaply. Whether or not it can be operated economically may not be the final criteria, as the wood has got to come out. More research should be done into the type of gear that could be used for this undesirable wood we've got to seriously look at some method of handling it.

The other area that has not been covered is the wind blow situation. We have had a wind blow situation in Canterbury in both 1964 and 1975. Both wind blow situations were entirely different. The 1964 wind blow basically broke trees off from ground level to anything up to 30-40ft up the tree so the wood had to be recovered in an extremely short time or it was lost. It was tangled and damaged. You could walk in underneath it or even drive skidders in underneath it without touching trees and that required a specialist approach to eliminate as much danger as possible in getting wood out. In the 1975 blow all the trees were blown completely over so they virtually lay down. The experts told us we had three years to get it out. I am still logging that wood from 1975 and I will still be logging smallwood out of it in 1981. We have had to adapt this 1975 situation to an existing logging system, mainly with skidders. In a lot of cases with smallwood, it was not economical with skidders so we adapted ordinary four wheel drive frontend loaders and used them as a system of uplifting wood completely - root and all - and that was the most economic method that we found in that particular wood.

In a lot of these cases you cannot buy a lot of gear to adapt to the special methods for an unknown length of production time because you end up after a three or four year period with a lot of gear that you don't want for future logging. The other problem wind blow creates is that trees are not blown down in nice even patterns. A postage stamp patch is blown and another postage stamp path beside it is left standing. The emphasis is on the material that is lying on the ground so the standing material is left and at the end of the period of recovery you have got to go back then and recover all standing material. So you are faced again with an undesirable harvesting area which does not leave you a lot of scope for planning and it limits your methods quite considerably. Very often these areas are scattered right throughout the forest so there are also a lot of moving problems. I would like to see some research done into this. Because I think it is inevitable that we are going to get a future windblow, particularly in our area.

Very briefly, I want to throw in some comments on the residue problem. I think we have got to determine where the research is required in this because we have heard that we need residue wood for fuel and other uses. First, we must determine what the wood is for and in what form it is required, what is the most economic method for that wood to achieve this and what is the likely cost of achieving it. I think we should also look at the small "gypo" American system and compare that against the integrated method of the larger logging concerns.

HARRY FLEMING - Morbark Pacific Ltd, Rotorua

I now change my hat and become an equipment supplier. What have equipment suppliers learnt from this Seminar, and what do they expect from LIRA? It is good that equipment suppliers participated in this Seminar: indeed they and their equipment are vital to the forest and timber industry. Starting with Andy Kirkland's keynote address, they should have got a clear indication of the importance of smallwood operations in five year increments starting 1980. This Seminar put the ball at the equipment suppliers feet, they should now know what they have got to do with it. Some have not known where the goalposts were, some have been offside, some have been standing flatfooted waiting for somebody to place the ball in their hands and some were heading for the goal before the whistle went. Some are still standing flatfooted, and they will never make the All Blacks. Each equipment supplying company present should be able to categorise himself.

Few if any equipment suppliers offer a smallwood harvesting system. From this Seminar they should have learnt where and when their equipment fits into the main system. Equipment suppliers should have got the message, and got to know the jargon and the economics of the industry that they serve. There is no place in the industry for equipment salesmen hiding under a leaflet without a price.

The second half of the question is equipment suppliers expectations from LIRA. Believe it or not equipment suppliers, in the logging industry especially, are somewhat of a fraternity. LIRA has already categorised logging equipment worldwide including that currently marketed in New Zealand. It has its own ideas on that equipment which it probably relays to New Zealand wood producers, sometimes by make and model. This does not stop us promoting our own equipment outside LIRA's recommendations. I feel it absolutely unavoidable that LIRA refers to equipment by make and model and I know of no equipment supplier who objects to equipment exposure by LIRA. We think LIRA does a great job and we do not want to see too much change as regards their role in exposing equipment to the New Zealand logging industry. As regards new equipment develoments, whether overseas or in New Zealand, equipment suppliers cannot and do not expect a LIRA handout but providing they financially support LIRA, they hope only for a continuation of guidance as to the potential market.

PETER OLSEN - P.F. Olsen & Co., Rotorua

Well, as a representative of the small operator and also a representative of the LIRA Board, it is very difficult to touch on new areas. From the papers and the discussion groups it is quite obvious that there has been a fairly concerted effort to make sure that LIRA is exposed to as much new research ideas as can be considered practical. Their main problem is to avoid being diverted from where the central issues can be fairly identified and maintain continuity and still satisfy the needs of the industry as expressed by an assembly such as this.

Speaking for the small operator, what does show up is that smallwood harvesting suffers from a trade off between market acceptance and price and the cost of providing the product. I think the classic example is the revolution in tawa pulpwood availability. The Mamaku Plateau and a number of farming development areas in the King Country were characterised by very low levels of utilisation until a market was provided for pulpwood by N.Z. Forest Products Ltd. This revolutionised the volume of material that was available. A similar circumstance awaits wood which is suited for energy and it is quite obvious that for the misshapen small piece a big market void still exists. People like Charlie Kerr at Tasman Pulp & Paper Co. deserve full marks for endeavouring to raise interest in getting into areas such as whole tree chips and I know he is aware of the energy potential in wood.

The areas where wood of this sort exist are in small thinnings, and residue on cutovers. Windblown forests are another area where we will continue to find this type of wood. Even intensively managed forests are subject to damage, and Nelson and Canterbury will not be the only regions affected. The other area that has not been touched on is the indigenous area where there is a tremendous volume of wood which is potentially merchantable and easily handled being left, or burnt and creating Ash Wednesdays over Whakatane every other fire season.

The difficulty here is the integration of the extraction technique and the loading and cartage module. It was quite evident from what Ron Wren's discussion group were looking at that they could see difficulties here and the salvage group were making the same comment: you get horrible looking material that cannot be stuffed in a bag or put in a box, and to try and put it on a truck at a landing is very difficult. There is a tremendous case for some form of log chipping into a bin so that you have got a volume which can be carted with a resonable payload and got away at a reasonable cost to the mill.

The item which shows up most clearly if we define the timber we are talking of as around 0.2 cubic metres per piece, is the difficulty with light, small gear of getting beyond that 30-35 cubic metres per day of gang production. That leaves very little hope for getting wood delivered to a mill below say $25 per cubic metre. The contractors complain that they do not get paid and it is obvious that they are not going to be in the forefront of developing new equipment, or new techniques. I think what we are going to see is action from the smaller companies who identify quickly with trade offs between natural gas, oil, coal and the use of wood based industrial fuel. They will soon find out that $25 per cubic metre is not an excessive price to pay, especially with Saudi Arabia talking of $37 per barrel for oil.

BILL KERRUISH - C.S.I.R.O., Australia

I have a couple of points to make. One aspect perhaps overlooked in discussions has been defining wood length. When in New Zealand the talk is about shortwood it is usually 2 metres, we in Australia talk about shortwood of 5 metres. This is something that needs to be given a lot of consideration: it has definite advantages in certain situations. Our experience has been that 5 metre wood, or more specifically wood ranging from 3-5 metres, has a number of very marked advantages from the point of view of wood handling, particularly as you move into a high degree of mechanisation where it does not have to be picked up and carried by a man. This is something I believe you should explore further.

On this meeting itself, it seemed to me (particularly earlier in the meeting and this is perhaps not so marked at this later stage) that we were drawing up into two battle lines: those for men and those for machines. This is very unfortunate because we really should not be talking about mechanisation but talking about developing our harvesting technology. Technology is just another word for practice, our harvesting practice which includes machines and men and of course takes place in the forest. We can only make progress if all three of these are considered. This has been the lesson and experience of the Scandinavian exercises when in the late 1950's and 60's they decided they had to do something because there were no more people there.

Much has been said about the failure of mechanisation. I do not believe it has failed, I believe the needs for a specific kind of technology have changed. In the 1970's everybody wanted wood and the push was for production and more of it, the demand was for the resource so that pressures were on to get more wood out of people almost regardless of cost, at least that is the way it was in Australia. Our practice or technology responded by putting in machines that could shift a lot of wood regardless of costs, which were a secondary consideration. We are now in a very different era, our technology has got to be directed towards different products, different problems and this is going to be the story with getting the resource off the hill that we cannot at present get. Getting smallwood which we cannot at present get because our technology is not appropriate; keeping people on the job because our machine systems are not satisfactory. We must look at the development of our technology and the development of machines that can better serve our objectives, and again a technology that is relevant to those objectives.

Someone once said that there are only two important things that happened in the world: one was the development of agriculture which goes with a stable community and the other was the industrial revolution which let man increase his productivity and subsequently his standard of living. That still applies. If we want to progress we must increase the productivity of labour and capital, and this means developing our whole technology together. Referring to recent reverses in the more dramatic attempts to mechanise, I liken them to agriculture. When I was about that high my father was foolish enough to buy the first haybailer that came into the country. It cost him nearly as much as his farm and I do not think it ever produced much hay. You can buy the same machine today for a fraction of the price and five times the productivity. Forest machines will do the same if we pick the right concepts, if we put the right training and the right people behind them.

Two points cropped up in last nights discussion on machinery. One was from Caterpillar, that they are still trying to make the D3 tractor work after 38 years. They are still improving it, they are still modifying and developing this machine. The other was the comment made in relation to the resources needed to help a contractor get his idea working. I do not know the answer. It takes a long time to develop equipment and our best innovations come from people in the field, something we have got to learn to reconcile. If you look at the development of harvesting technology over the last 20 years, virtually every idea has come from the field, not from logging research organisations, not from the Caterpillar or John Deere. We must find ways of encouraging those innovations and find ways of screening out the good ideas before people get hurt. Then we have to find ways of supporting the good ideas.

- SESSION 10 -

SEMINAR SUMMATION

Chairman: Jim Spiers, LIRA

Introduction

The seminar summation is to be delivered by Mike Watson. He is not involved in logging, he is the Director of the Agricultural Engineering Institute at Lincoln. This organisation services a very similar industry to logging in many respects, and as he has been directing its research programme, he is in a good position to assess the way in which this seminar has gone and what lessons and guidelines have been brought out, to assist LIRA in future research and development in the field of smallwood harvesting.

SEMINAR SUMMATION

(Mike Watson)

Trying to get this seminar into some sort of perspective has been a difficult job. There have, however, been some overall principles emerge. The message came through clearly, that when talking about any operation in smallwood harvesting it is no good just thinking about one bit of it, you have got to take the whole system right from planting the tree to the final utilisation of that tree. Each phase can interact and you cannot take any one piece by itself. Another message that came through is that there are not going to be any simple answers for anybody, whether a forester or a machinery salesman, nobody is going to make your decisions for you. There are so many variables and the position is still so very unclear that everybody is going to be forced to make a lot of the decisions on their own.

One of the most impressive things that I have noticed has been the industry wide participation. There are people from almost all aspects and the input comes from scientists, contractors, forest owners and the machinery people all talking eyeball-to-eyeball. That is a sign of a very healthy industry, as is the fact that all aspects were covered, from lofty high management right down to humble operator problems. The other thing I have been impressed with is the complete lack of secrecy. All the figures and numbers seem to be quite openly put around in a genuine bid to try and help other people so that mistakes do not get made twice. There will always be mistakes and errors of judgement but I think that it is a very healthy sign for the industry when it can talk so freely about good things and bad things. It is the only way you will ever make progress.

In this smallwood harvesting business there is something of a chicken and egg situation. High level decisions need to be based on good reliable information from lower levels about what can and what can't be done and the likely cost that is going to be involved. Unfortunately the lower management has to have this information available long before any work has been undertaken. The situation arises where a lot of confusion exists because few trials have been done, or few experiments have been carried out in order to get this information, and detail is so limited on which these high level decisions have to be made. The other people who have not been directly involved, tend to get confused as to whether people are really serious about these trials and I think this is the stage that smallwood harvesting has been at up till now. You can only really save it by clear statements of intention right from the top and I think that this really is what came through very loudly and clearly from the keynote speakers. They were saying in effect that there will be smallwood harvesting, lots of it, so get your ideas sorted out and get stuck in and start sorting out what are left of the problems. This may possibly turn out to be the single most important thing that comes out of the Seminar: the focusing of interest. Some people had reservations about what would happen after 1990. Are we going to waste a lot of time and effort, and then when all the extra timber comes on stream it could all be wasted. In fact there is a world tendency towards logging small pieces and there seems to be a concensus now that it must go ahead and that it will go ahead. People are establishing some confidence now to start making their own decisions and there is a very definite need for a general framework within which people can make their own decisions knowing that it fits into the overall pattern.

At this stage I would like to pick up one of Bill Kerruish's messages, and it is a most important one. Having got the general framework agreed from a concensus, you must define what your objectives are. Are they going to be minimum cost or maximum value? When you have made these decisions, and this is especially so with planners, it is imperative that the objectives are made known to everybody: contractors, machinery people etc. It may not be possible to sort out all plans in detail but everybody who has a part to play must be put in the picture so they know what the overall situation is. Then they can make their own decisions about what they are going to do. If in fact you cannot state objectives in detail the planners have got to identify the ranges over which things must operate or systems work. This of course raised the point that systems have got to be quite flexible. Highly specialised systems in an uncertain situation are pretty dodgy.

The practical starting point is with the forester. We have heard quite a bit about the problems of deciding how and when to thin, and the pros and cons need a great deal more attention. If simple decisions are not possible, if foresters cannot say we are going to do this this and this in five years time, then they have got to point out the range of conditions under which the equipment will be expected to work. Again, such ability becomes most important in long term planning for equipment.

Changing the crop pattern has been done in horticulture; there is increased mechanical harvesting now with blackcurrants, raspberries and boysenberries, and in every case, the actual growing systems have had to be changed in order to undertake effective mechanical harvesting. It is not easy and it takes a long time to introduce but certainly you are following a very dangerous pattern if you try and design machines simply for existing systems. Usually there has got to be a compromise and I think this is a fairly well learnt lesson and I am sure all foresters are very much aware of this.

I would like now to talk about the role of research, LIRA's in particular. There is a lot of glamour attached to research but I would like to put it very firmly in its place. I see it just as being another service to management. The really important decisions are all taken in industry itself and whether we like it or not we can only regard research as an influence. It is not an end in itself and I think we have to take this as one of the basic tenants when you are doing research. You may or may not be able to influence what people are going to do on the large scale.

Jim Spiers asked me to do this summing up because I have a generally similar job to his and we face similar sorts of problems. One of the objectives in having a Seminar is to help make decisions about what research should be done. I am afraid I do not think there will be any easy answers, like everybody else, the Director will have to make his own decisions about what jobs he has really got to do. What should LIRA be doing on smallwood harvesting: obviously they have made a good start and have looked at the world scene and have got together all the information that is available from a good cross section of all the people who know anything about it. It has been fairly straight forward to this point but it is not quite so clear where to go from here onwards. One thing that they must do is to keep on being a co-ordinating centre and being the recognised place for the exchange of information. If they do nothing else at all they will certainly earn their keep if they only meet that one objective.

What else should they do. Well, they could start looking at some of the individual trouble areas which have been emphasised, like better delimbing equipment, and equipment for steeper slopes. This Seminar has achieved a very useful purpose in defining probably the most important areas that need extra attention. The other thing that they could do is to start trying to push along some of the brighter ideas that have come up. I endorse what Bill Kerruish said: most of the new ideas come from industry itself and not from researchers. The research job really is more to take a broader look and try and sort out the wheat from the chaff. It will be a temptation for LIRA staff to dabble, to play around with some of the new ideas that come in and I think that this is one of the most difficult decisions that any research director has got to make. He must strike a compromise between keeping your feet on the ground and doing short term useful jobs and yet not spending all your time and effort on detail. It is not possible to do everything, the best thing is to try and aim for a reasonable blend.

One side issue is to try and make sure that all the staff are continuing to keep closely involved with the actual practical side of things. Sometimes you may even do jobs simply to keep your hand in the practical side of things and that is perfectly good reason for some projects, but of course you should not over do it. It is a compromise all the way and I think the Director has a very difficult job in trying to balance all the demands on him both from the industry and for the needs of his staff. Trained staff are extremely difficult to get and it is quite a difficult job to keep them engaged in directed research work, unlike university work where a person can do things he is interested in. I would like to give a pat on the back to LIRA staff, from what I have seen everything they have tackled so far has been done extremely enthusiastically and I think they have done it very well.

This leads on to machinery development which has been covered pretty well. There seems to be something of a watershed now, people are just not certain how deeply they should continue with mechanisation. There are no easy answers. As far as LIRA are concerned they have only 4 or 5 people so there is a very definite limit to what they can do practically. It would probably be very unwise of them to try and start any major development themselves. There is often a temptation (and sometimes they will come under pressure) and it is up to their management to try and give them the backing not to get too deeply involved in any undertaking which obviously 4 or 5 people and a few thousand dollars a year cannot have any hope of pushing right through. Their main job is to co-operate with industry and monitor all the experiments that are going on.

The big question is: who pays for this sort of work? It is a well trodden path but is it really fair to load the development cost on the customer? Referring to the agricultural scene, we have an almost exact parallel in harvesting machinery for fruit and peas. The market is not great and there is in fact very little in it for the manufacturer, he is lucky if he has a few machines to build. After the first one is built most farmers just go on down the road and get their local engineering firm to build them one. This is very definitely a difficult area and there is no easy answer. There is a need for recognised ways to spread the cost of some of these developments and to recognise the fact that New Zealand has got limits in what it can tackle. I think there is a whole range of smaller items which can be developed and I think that there have been plenty of examples of developments which are very successful in New Zealand and there is no reason in the small and lighter gear why there should not be a good export potential.

One area which did receive a lot of attention during the Seminar was how far to mechanise. The trend is definitely slightly away at the moment, partly because of mechanical problems, partly the cost and partly the results which have been achieved. It is all very much in the melting pot and probably one of the major factors is that capital is becoming much scarcer while labour is relatively speaking easier to get. It is probably fair to say that this situation will continue until labour problems become more severe. Then, of course, there will be a rush to try and catch up so the emphasis now should be to keep on steady development. The amount of steady development over the last 10 years is pretty encouraging. No-one in the industry has got anything to be ashamed about as there has been a lot of progress. There have been good things and some unsuccessful things. This is inevitable, but overall there has been a lot of progress and that is very reassuring.

Going quite off the research side now into extension. So we do not get it mixed up with training, extension is the researchers job of getting the information out. Within the Ministry of Agriculture and Fisheries there is an Advisory Division whose job it is to get information out, so our responsibility is to get it out just as far as that division. In forestry there is not the same infrastructure and it is very difficult for the LIRA Director to judge how much research and how much extension he should undertake. It is rather a paradox: if you do research well, afterwards the pressure comes even more strongly on extension so you end up by doing all extension work. People look back and say they did a good job up to 3 years ago but what have they done since? In fact it has taken them that period to get the information out effectively. I am quite sure that LIRA will run increasingly into this problem and everybody has got to help them strike a reasonable balance.

Labour and Training have received a great deal of attention and it has been fully merited. People have to be trained whether they are doing smallwood harvesting or not, and my only comment is to say it is very nice to see the people who are responsible for doing the training here at this Seminar keeping up with the play. It must have been pretty encouraging to all of them to see that their role is so well recognised and appreciated. It is clear from our rather stimulating talk this morning that there is plenty of scope for research into labour turnover. This may be outside the direct scope of LIRA but it will be within their responsibility to try and prod or coax somebody into doing something about it. Obviously there could be some very large benefits there.

To round off the Seminar, I would like to make three quick points. First of all I would like to say that the Seminar was very well planned. It led us step by step through all the factors and it gave everybody a chance to put their point of view and to comment on other peoples point of view, foresters, loggers, managers, scientists, everybody was here. LIRA has given you good value in this respect.

I think it would be very nice to remind people that participation in LIRA is a good thing. I was talking, quite by coincidence to somebody this morning, who did not know I was giving this summing up and I did not tell him. He said "you know, I've quite enjoyed this Seminar. My company wasn't very much in favour of LIRA but this past year we have decided to join and support them." I would like to encourage other people (although I am probably preaching to the converted) that anything you can do to support and help the interests of LIRA is also helping the interests of the industry.

The second point is a follow-on from the first. It is very nice to see that all these different people from the different parts of the industry have come together to discuss their problems. This is a sign of a very healthy industry.

The final point, is the overall objective. What is it really? Well, you can call it what you like: export, getting or saving overseas funds, diversification, there are many different names for it. When the chips are down this is what we are trying to do both in agriculture and forestry: to get overseas funds, to increase the exports. In a few years New Zealand will have more wood than can possibly be sold on the home market so the objective now is to get out, diversify, and get as many options as you can for the future. It will not be easy and it will not be vastly profitable but it will be a very worthwhile addition to the range of options which New Zealand just cannot afford to miss out on. Finally, on a very personal note, I have enjoyed the Seminar very much, and I am going back with a few ideas and I hope you all feel the same.

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