

Small Forest Management

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**HARVESTING  
A  
SMALL FOREST**

This publication has been jointly prepared by  
the Ministry of Forestry and the  
New Zealand Logging Industry Research Organisation

*Harvesting a Small Forest* is part of the *Small Forest Management* series, which is intended as a guide for owners and managers of small forests. The *Small Forest Management* series includes:

1. Special Purpose Timber Species
2. Forestry Joint Ventures
3. The Resource Management Act
4. Planning a Small Forest
5. Establishing a Small Forest
6. Managing a Small Forest for Timber
7. Harvesting a Small Forest
8. Marketing a Small Forest

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## *Introduction*

Harvesting is the point when returns from the long-term investment in a forestry project are finally achieved. It is also often part of the ongoing forestry cycle, being generally followed by planting the next crop.

Harvesting often has a high impact visually and on the land. If not done correctly, many thousands of dollars per hectare can be lost and the productive capacity of the land jeopardised.

Harvesting operations require careful and thorough planning. This publication recommends the following steps:

1. Think ahead: A well managed harvesting operation should be planned in advance, taking into account factors such as the ideal timing, the most appropriate type of log sale, the extent of owner involvement in the operation and any significant transportation requirements.
2. Obtain resource consents if required: The Resource Management Act 1991 may impose constraints on some harvesting activities. These should be established well before harvesting in order to minimise any adverse effects on the environment and maintain or enhance the sustainability of the land.
3. Draw up a formal harvesting plan: The harvesting plan will be the reference document for the harvesting operation.
4. Establish a harvesting prescription and complete necessary contracts: The harvesting prescription is formulated from the harvesting plan. It provides instructions for carrying out the work and forms the basis for any contracted work.
5. Undertake the harvesting operation, complying with the requirements of the Resource Management Act 1991 and the Health and Safety in Employment Act 1992.
6. Clean up after harvesting: It is important that the harvesting site is left in an agreed state and ready for its next purpose.
7. Re-use the land: Harvested land is often replanted for forestry, or may be used for other purposes.

In most cases professional advice should be sought. Forest owners who do not have the necessary forest harvesting skills and equipment should use consultants and contractors whose proficiency are recognised by the forest industry.

This publication is part of the Ministry of Forestry's *Small Forest Management* series. The issues of complying with the Resource Management Act 1991 are fully explained in *The Resource Management Act* and marketing requirements and methods in *Marketing a Small Forest*. *Planning a Small Forest* stresses that harvesting issues should be considered at the initial stages of any forest growing investment.

An explanation of terms particular to the harvesting industry is included in the *Glossary* on page 55.

## *Thinking Ahead*

Thinking ahead involves taking a harvesting “overview” and considering factors such as the harvesting options (thinning or clearfelling<sup>1</sup>), the timing of the operation, the type of sale, the choice of harvester and the level of forest owner participation.

### HARVESTING OPTIONS

Harvesting wood from a forest can be done by production thinning or by clearfelling. Production thinning generates income during the life of the forest; the crop is thinned and the produce sold. A non-production thinning (a “waste thinning” or “silvicultural thinning”) leaves the trees to rot where they fall, returning nutrients to the soil where they can be recycled by the remaining crop.

### PRODUCTION THINNING

About one quarter of New Zealand’s forest estate is production thinned. From the mid-1970s to the early 1980s there was strong interest in production thinning. However, ample wood supply from clearfelling later reduced this interest. With the steep increase in log prices in 1993 and an increase in pulp wood exports (as logs and as wood chips) there has been a resurgence of interest.

To ensure final crop production goals are met, production thinning must be carried out at the time specified in the management plan for the forest<sup>2</sup>, regardless of the market conditions. If a production thinning is delayed because market conditions are not ideal, subsequent tree growth can be reduced. Late thinnings can also reduce the crop’s stability, making it more susceptible to being blown over.

The total volume removed in a production thin needs to be sufficient to make the operation economically viable. In addition, thinning should remove enough trees to allow machines to move around the forest without damaging the final crop trees. However, it is important that the stand is not “over-thinned”, as leaving too few crop trees will result in lower clearfell volumes at the end of the rotation.

Thinning too early or removing too many trees can result in increased branch growth on the remaining trees, producing a lower value log at harvesting.

### KEY CONSIDERATIONS

**Proximity:** The forest’s proximity to a pulp mill or small wood user (such as a fence post manufacturer) will influence transport costs, which could affect the viability of a production thinning.

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<sup>1</sup> There are other harvesting systems applicable to New Zealand situations, in particular the low impact harvesting methods needed when harvesting indigenous species covered by a sustainable management plan or permit under the indigenous forest provisions of the Forests Act 1949. Different methods again would be needed to harvest a mixed species planted forest, such as selective harvesting of a nurse crop within a high value, special purpose timber crop. However, this publication deals with harvesting single species, even-aged, planted exotic forests.

<sup>2</sup> Management plans are described in *Planning a Small Forest*.

**Access:** Road building costs can quickly negate potential earnings from thinning.

**Terrain:** The flatter the terrain within the stand, the lower the thinning cost will be.

A full economic analysis should be carried out on the whole project (thinning and final crop), not just of the thinning operation. If production thinning economics are marginal it may be better to forgo the small income, do a waste thinning, and grow the crop trees to a harvestable size.

## THINNING OPTIONS

Production thinning of radiata pine is often done when the trees are large enough to produce log sizes of 0.25 to 0.35 cubic metres, usually at age 11 to 14 years. A single thinning should reduce the number of remaining trees to between 300 and 400 stems per hectare.

Alternatively, production thinning can be done earlier, at first thinnings stage. This method, which exploits material which has traditionally been left to rot, is feasible given favourable topography. For example, trees could be thinned from a planted 1100 trees per hectare to 600 trees, which could yield an average merchantable piece size of around 0.12 cubic metres. A second thinning could reduce stocking to 400 stems and a third at about age 20 to 250 stems per hectare. This last operation should produce sawlogs as well as pulplogs.

## TECHNIQUES

(Descriptions of the equipment mentioned in this section can be found in *Harvesting Activities* on page 35.)

New Zealand's commonly used production thinning techniques are felling and trimming by chainsaw, then extraction by rubber-tyred skidders. Mechanised systems are being introduced in larger forests; these vary from static delimber systems (where a grapple loader pulls trees through a delimber) to harvesters mounted on 20-tonne excavators which fell, delimb and cut to length at stump for forwarders to extract to the roadside.

Another popular system uses two or three fallers to cut the trees and a small crawler tractor to drag the logs out and push them into stacks on the skid for self-loading trucks. This system has the advantage of being able to work on steeper slopes than a skidder.

Small hauler systems can be used on steep country if an economic analysis shows the operation to be viable, although in New Zealand haulers are more likely to be used in thinning higher value Douglas fir.

Systems using agricultural tractors fitted with guard plates (making them suitable for forestry work) can also be used with three-point mounted logging winches or forwarder trailers.

## DO IT YOURSELF?

Thinning operations offer the most potential for those undertaking some of their own work. However, doing it yourself requires a commitment to become a well trained, professional operator.

Thinning machinery is smaller and requires less capital outlay than harvesting equipment. There is also more flexibility on the time of felling and the time between felling and delivery to mill. This may fit in with seasonal work on farms.

## **SYSTEMS & MACHINERY**

Given the range of harvesting equipment operating and its changing availability in different parts of New Zealand, it is not possible to be specific in this handbook. Forest owners are advised to use a consultant with local knowledge or seek information from local contractors or other forest owners. The Logging Industry Research Organisation (LIRO) has also produced a number of reports on production thinning.

## **CLEARFELLING**

Clearfelling is the most commonly used harvesting method in New Zealand, mainly because many forests are on steep and/or broken topography, but also because of market requirements for sawlog-size products. The remainder of this publication deals primarily with clearfelling - harvesting a total stand at maturity and removing all the merchantable material from the site. However, many of the principles which follow (such as statutory obligations and sound planning) also apply to other forms of harvesting, such as thinning.

## **TIMING THE HARVEST**

Timing the harvesting of a mature crop of trees can have a large effect on the financial return to the forest owner. Unlike most other crops, harvest timing for a forest is flexible, and may be delayed or brought forward depending on market conditions or other factors.

## **ECONOMIC CLEARFELL AGE**

A forest's volume growth does not occur in regular steps over its lifetime. For example, radiata pine intensively managed on a pruned sawlog regime experiences the greatest volume growth when it is 20 to 25 years old, with total volume potentially doubling between around age 20 and 30 years. If the forest is harvested early in this period, major volume production and consequently value can be lost.

Larger trees usually generate higher revenue and lower harvesting costs. However, there is a point when the additional value from annual tree growth does not exceed the compounded costs of growing the forest. The economic clearfell age is influenced by the regime used and the types of logs the forest can grow.

Forests grown for clearwood offer a large gain in value as the pruned logs reach (and grow beyond) a minimum size, usually 300 millimetres diameter at the small end of the log. Trees grown under unpruned sawlog regimes reach the minimum sawlog size (usually 200 to 300 millimetres small end diameter, or s.e.d) earlier; increased size does not result in a large value increase. New Zealand radiata pine's economic clearfell age is generally between 25 to 30 years, with pruned stands usually at the upper end of this range.

## **ECONOMIC LOG SIZE**

Logs sold to sawmills and other domestic processors or for export must meet minimum specifications for diameters and lengths. As trees grow they become large enough to meet

higher value log specifications. For example, export and domestic pruned log specifications commonly have a s.e.d of 300 millimetres. Once pruned butt logs reach this diameter, the value of the stand greatly increases. Cutting before this would result in considerably reduced value.

However, the value of a forest does not always increase in direct proportion to volume growth. Extending the rotation age can produce logs larger than the market requires. This reduces the logs' value because machinery will not be able to handle and process them in the normal way.

## **PRE-HARVEST INVENTORY**

One way to accurately determine the size of the logs which will be produced during harvesting is to carry out a pre-harvest inventory. This normally samples the forest on a statistical basis to provide an estimate of recoverable volume per hectare by log grade.

The pre-harvest inventory system used most often in New Zealand is the Method of Assessment by Recoverable Volume by Log Types (or MARVL), a computer-based system requiring training and experience in inventory design, measurement and log grading. Total recoverable volume can usually be estimated at a reasonable cost to within a 10 percent margin for error. However, it is more difficult to obtain the same precision in estimating individual log grades. The area of the forest (in hectares) is an important element in calculating the total volume, particularly with small forests. If the exact area is unknown, it can be measured from aerial photographs or a simple survey.

An inventory can be done by a forestry consultant, and forestry contractors may also specialise in inventory work. The Ministry of Forestry can supply contact details.

## **MARKET FLUCTUATIONS**

A decision to harvest a forest can be influenced by market returns. Timing harvesting to coincide with buoyant markets and increased prices is more possible with a forest crop than with most other crops.

Increasing volumes of logs and timber produced in New Zealand are being sold on the export market. Prices are affected by:

- the economic performance of purchasing countries
- currency fluctuations
- the seasonal demand for timber in the importing country
- the seasonal supply of wood from other exporting countries
- the availability of wood from other countries, which can vary with factors such as legislative changes and infrastructure developments.

Export markets can be volatile, resulting in log price fluctuations. Domestic market prices are influenced by the export market, as during times of high export price (and high supply to export markets) New Zealand sawmillers compete for at least some of their log supplies against this export price.

New Zealand's domestic log market is influenced by the country's economic conditions, particularly in relation to the building and construction industries. International prices for

processed timber (lumber) can also affect domestic log prices - for example, decreases in the price of export lumber mean sawmills have less money to buy logs.

## **CONTINUITY OF HARVEST**

Depending on forest size, it is possible to programme harvesting to provide ongoing income by cutting only part of the forest in any one year. This may require felling some areas at an earlier than normal age and others later, in order to sustain a steady production level.

## **OTHER TIMING CONSIDERATIONS**

Even small areas of forest can yield significant revenue. This income may well be used to complement other activities, such as offsetting losses from other business ventures, financing a new building, equipment or business venture, or providing education or retirement funding.

## **SALE TYPES**

Following the decision to harvest, the type of sale needs to be determined. The sale process is examined in more detail in the *Small Forest Management series' Marketing a Small Forest*. Once the terms of the sale have been agreed, a sale contract should be signed setting out the responsibilities of the buyer and the seller.

There are three main types of sale:

- Block sale
- Stumpage sale
- Sale by grade

### **Block Sale**

In a block sale, the forest stand or woodlot is sold for a lump sum. The buyer is responsible for harvesting the wood, and will try to get the maximum value from the block.

The main issue in a block sale is to accurately assess the wood volume in the forest so that the seller can determine whether a fair price is being offered. In most cases a valuation should be done by an independent forestry consultant before the sale. This type of sale is generally suited to small woodlots where owners do not wish to be directly involved in harvesting.

### **Stumpage Sale**

A stumpage sale involves selling the standing wood at a rate per cubic metre or tonne. The buyer is responsible for harvesting the wood.

The seller needs to ensure that the buyer removes all merchantable wood, as the buyer may leave small stems or isolated clumps of trees which are difficult and expensive to recover. Leaving this wood would reduce the return to the seller.

The stumpage rate (price) relates to the mix of different log grades in the forest as well as the costs of harvesting and transporting the wood. Forests with a high proportion of good quality sawlogs should receive a higher stumpage than those with a high proportion of pulp

wood. A pre-harvest inventory is advisable to determine the log grades in the stand. Professional advice should be sought from an independent consultant.

### **Sale by Grade**

Sale by grade involves selling individual log grades. The different log grades are sold on the basis of being loaded on truck or delivered to the mill or wharf. Sales by grade are likely to provide the best return to the grower but can require considerable work in managing the harvesting and sale process. This type of sale is commonly handled by forestry consultants working on commission for the seller.

### **HARVESTING RESPONSIBILITY**

Responsibility for the harvesting operation (that is, forming roads and tracks, felling, extracting and processing the trees and transporting the logs) depends on the type of sale. In many cases the buyer is responsible for all these operations. However, it is still in the grower's interest to ensure harvesting is carried out properly to avoid future problems with restocking and growing the next crop, adverse environmental effects, and unnecessary damage to fences, adjoining pasture or neighbouring young trees.

In a sale by grade the grower may be responsible for the entire roading, harvesting and transport process.

### **OWNER INVOLVEMENT**

Forest owners contemplating harvesting must decide on their level of involvement. Choices include:

- "Do it yourself" - being a planner, log marketer and harvester.
- Using a professional consultant, but still doing the harvesting work.
- Using professional consultants and experienced contractors, but overseeing the operation.
- Leaving the management completely to professional consultants and contractors.

If the forest owner plans to harvest only occasionally, using consultants and contractors is likely to be the best option. However, owners working towards harvesting on a regular basis (eg, two to ten hectares per annum) may take a more active part in the harvesting operation.

A number of owners in similar circumstances could form a co-operative harvesting venture, reduce costs and amalgamate their annual harvests for marketing purposes. For example, a second-hand skidder and second-hand loader in good condition would cost four owners about one hectare of trees each and would last many years with the small amount of use they would receive.

The advantages of "do it yourself" harvesting are:

- the cost may be lower than contractors' rates
- the quality of the work is under the owner's direct control
- there may be less urgency to work in wet conditions, which minimises the chances of soil damage
- there may be more flexibility to harvest when markets are most favourable.

It is possible to design harvesting systems for a wide range of small forest situations using three or four workers and one or two machines. Co-operative harvesting operations may be a viable option where an owner or several owners are working towards small annual harvests.

*It must be noted that a decision to become a tree harvester implies a commitment to become a skilled and professional harvesting operator. Legislation and the dangers of harvesting leave no room for an ill-informed, unprofessional approach.*

## **FOREST INDUSTRY RECORD OF SKILLS**

The Forest Industry Record of Skills (FIRS) system is administered by the Logging and Forest Industry Training Board (LFITB). Completed as a series of modules for specific forest tasks, the system recognises skills based on practical work. Harvesting operators qualify for a National Certificate in Forest Harvesting upon completion of 13 modules and at least four years' work experience.

The New Zealand Forest Owners' Association aims to see all the existing workforce trained and qualified to minimum industry standards. This policy sets the standard for most harvesting work in New Zealand and is the benchmark for compliance with the HSE Act.

Forest owners considering doing their own harvesting should ensure that workers they employ are trained or undergoing training for the tasks they are doing, and that this training is recognised under the FIRS system. More information on the system can be obtained from the LFITB or the Ministry of Forestry (see *Where To Go For Help*).

## *Statutory Obligations*

The Resource Management Act 1991 (RMA) and Health and Safety in Employment Act 1992 (HSE) have a major influence on any forest harvesting operation.

These Acts must be considered at all stages of the harvesting process by all parties, regardless of who is doing the physical work. This section describes a number of actions which the forest owner should carry out. While in many cases the owner may pass the task to an agent (for example, hiring a consultant who in turn may hire a contractor under a written contract), the owner should at least check that the tasks described in this section have been carried out. Forest owners cannot pass on their responsibilities (or liabilities) under the RMA or the HSE Act, so it is in their interest to keep a check on their agents.

### **RESOURCE MANAGEMENT ACT 1991 (RMA)**

Local authority planning is primarily governed by the RMA. The purpose of the Act is to promote the sustainable management of natural and physical resources. Regional and district councils are required to produce policies and plans consistent with this purpose.

Under the RMA, regional councils are responsible for controlling activities with respect to water quality, soil conservation and natural hazards and hazardous substances. They do this through policies and rules described in regional policy statements and plans. District plans, prepared by district councils, detail the controls on land use and subdivision of land. Further information on the RMA and how it relates to forestry can be found in the *Small Forest Management series' The Resource Management Act*.

District and regional plans must be adhered to when harvesting. If an activity such as "vegetation removal" (the term many regional councils use for harvesting a crop of trees) or "earthworks" (forming roads or tracks) is not permitted as of right under a regional or district plan, a resource consent will be needed. This may involve meeting extra environmental requirements or safeguards. It may also involve public notification and hearing of any objections or submissions.

Small forest growers should contact regional or district council planning staff to establish their local obligations. If a resource consent is required, the forest owner may wish to seek specialist legal advice to make sure everything is done correctly.

Planning ahead for harvesting will reduce delays and expense in obtaining any required resource consents. A good harvest plan can also be used in an application for a consent (see *Planning the Harvest* on page ??).

While harvesting is generally done by contractors, resource consents are usually held by the forest owner or the holder of the cutting rights. The consent holder should spell out any operational requirements, including consent conditions which may be part of the consent, in a written contract with the contractor. If the forest owner is employing an agent such as a consultant, they should ensure that the agent is fully briefed about resource consent conditions and any other requirements the agent should include in any contracts.

If the consent holder does not provide directions or guidelines, the forest owner *and* the contractor are liable for any environmental damage. Individual operators can be held responsible for their actions unless they can prove they were following directions.

It is important that contractors are supplied with operational guidelines which reflect what the owner or local council wants to achieve in terms of the environmental “quality” of the operation. Guidelines for good forest practices are detailed in the *New Zealand Forest Code of Practice* (see page ??) and may be supplemented by rules in regional and district plans.

The forest owner should consider very early in the planning process what aspects need monitoring to meet legislative requirements and harvesting objectives. This may influence the harvest planning process and help define the monitoring to be carried out by the owner, the contractor and the supervisor.

Some areas where environmental performance may be monitored include:

- checking that slash, debris and sediment do not get into waterways
- making sure defined stream-side vegetation is left undisturbed and stream banks are intact
- disposing of harvesting residues such as piles of logs, branches and soil at the edges of hauler landings
- checking that special areas (eg, cultural sites, historical sites and stream-side areas with high values) have been protected
- checking that sediment control procedures for roading and harvesting operations have been followed and that drainage is left in good condition (eg, culverts cleaned and drains dug)
- minimising soil erosion potential by limiting any earthworks (the resource consent may have very specific earthworks requirements)
- checking no waste has been left on site (eg, the forest owner should specify that no oil or antifreeze can be left in the forest and that rubbish is properly cleared).

Using the conditions listed in the consent, the forest owner should compile a checklist before the sale, and inspect the operation every few days and again at the end of harvesting. The contractor should be advised immediately and in writing of breaches to the consent. The written instruction may help provide evidence that the owner took all reasonable steps to prevent the breach.

### **Non-Compliance with the RMA**

The RMA includes some stringent liability provisions which hold people and companies responsible for their activities and subsequent environmental consequences. These are not restricted to the operator doing the work, but may also involve the managers of the company employing the operator, the company itself, or a person employing the company.

Conviction for an offence against land use, water or discharge provisions, among others, carries a penalty of up to two years in prison or a fine of up to \$200,000. Lesser offences, such as failing to provide information, can carry a fine of up to \$10,000. Certain offences can attract fines of up to \$10,000 per day.

The RMA also provides for issuing abatement notices by local councils or enforcement orders by the Planning Tribunal. These notices can require operations to stop if:

- the Act, or rules in plans, or resource consents are, or are likely to be, contravened, or
- there is, or is likely to be, an adverse effect on the environment.

Abatement notices will involve all those responsible for harvesting in additional costs, delays in job completion and delivery, and will attract the stigma of failing to comply with the *New Zealand Forest Code of Practice* or consent conditions.

The notices can also describe the remedial action required before work can proceed. The cost of the notice and of remedial action may rest with the forest owner or contractor. Significant delays can occur while staff and machines are diverted to correcting the fault, or harvesting may be halted while other appropriate machinery is brought to the site to remedy the adverse effect.

Forest owners need to be aware of their responsibilities under the RMA and rules in district and regional plans. They should also recognise that even after harvesting is completed, they must ensure that any resource consent conditions and local rules are not contravened.

### **HEALTH & SAFETY IN EMPLOYMENT ACT 1992 (HSE ACT)**

The main purpose of the HSE Act is to prevent harm to employees in places of work. It requires that employers take all practicable steps to provide a safe working environment. Employers must identify all hazards in the work place and eliminate, isolate or minimise hazards considered to be “significant”<sup>3</sup>. All employees or visitors must be educated and informed about the hazards to which they could be exposed.

The Act also imposes responsibilities on what it terms “Principals”- for example, people or companies who engage contractors or consultants rather than employees. A Principal must take all practicable steps to ensure that contractors, subcontractors or their employees are not harmed at work, and document these steps. Forest owners are regarded as Principals if they employ a contractor directly or if they employ a consultant (or other intermediary agent) who in turn employs a contractor.

As a Principal, the forest owner should:

- undertake contract control, which may include spot inspections, safety audits, meetings, and reporting on safety management performance and accidents. This could involve:
  - viewing the contractor’s safety plan, checking that the crew is regularly using checklists in the plan and ensuring that any poor practices shown up on those checklists are corrected
  - borrowing and using some contractors’ checklists for random checks, or obtaining local Department of Labour assistance in making up a checklist.
- provide information on safety at work sites. Forest owners should advise contractors (in writing) of hazards on the property that could affect the operation. This may include narrow culverts, unstable sections of tracks, bluffs or tomos, public roads or power lines. The contractor should also be notified in advance of any visitors to the site (including the forest owner).

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<sup>3</sup> The HSE Act interprets “significant hazard” as an actual or potential source of serious harm; or harm which is more than trivial (the severity of which depends on a person’s extent or frequency of exposure to the hazard); or harm that does not usually occur (or is detectable) until a significant time after exposure to the hazard.

- not give any directions or instructions which may increase hazards. If a contractor refuses to accept directions which may increase hazards, the owner will not be able to call in another contractor to carry out unsafe practices without incurring a high risk of liability under the HSE Act in the case of an accident.

Communication on matters relating to the HSE Act should always be in writing, signed by both parties with each keeping a copy. If an accident should occur, it may be useful as evidence that directions or instructions were actually given.

A contractor should have a safety management plan in place before being allowed to work on the forest owner's property. If forest owners are doing their own harvesting, they should have a similar safety management plan, which should include:

- a list of all hazards and whether each hazard is a significant hazard
- a list, for each significant hazard, of all the practicable steps taken to eliminate, isolate or minimise the hazard, in that order
- a safety management plan showing how to deal with hazards (safety equipment, training, procedures etc)
- a description of the use and care of protective clothing and equipment
- a description of emergency procedures
- an assessment of any new hazards specific to a particular work site
- a procedure for regularly auditing the plan using checklists
- a skills audit and training plan for each member of the crew
- the name of a supervisor, assigned in writing, for any member of the crew who is not adequately trained for the job they are doing
- procedures for introducing new employees to the crew
- procedures for visitors to the work site
- a register for all injuries and near misses
- a list of first aid supplies and emergency equipment available to the crew, and a description of their location.

*Business Management for Logging*, published by the Logging Industry Research Organisation (LIRO), includes a step-by-step plan to help harvesting contractors with safety management plans. Forest owners doing their own harvesting may also find it useful. Copies can be obtained from LIRO (see *Where To Go For Help*)

Many of the above tasks can be carried out by a consultant (or other intermediary agent), but it must be stressed that the forest owner still carries a high level of responsibility. It is in the owner's interest to use only agents who are skilled and experienced, with a proven record of good conduct in their field.

Further information on safety in the workplace is available from Occupational Safety and Health (OSH), part of the Department of Labour.

### **Non-Compliance with the Health & Safety in Employment Act 1992**

The HSE Act has harsh penalties for those who do not comply with its requirements. For this reason untrained people should not take part in harvesting operations. The Logging and Forest Industry Training Board can provide information about harvesting training options.

Failure to implement systems to fulfil employer responsibilities in the HSE Act can result in fines of up to \$25,000. Fines up to \$50,000 can be imposed where death or serious harm occurs, even if the employer was unaware of the hazard. A fine of up to \$100,000 and possibly one year in prison can be imposed where a hazard that could cause serious harm is knowingly left.

Other significant costs to consider in the event of an accident are:

- lost production
- repairs
- removing hazards
- damaged business image as a result of being prosecuted
- stress experienced by people (and their families) being prosecuted.

Anyone involved with an accident may be liable under the HSE Act unless they can show and prove they took all practicable steps to avoid the accident happening. This includes employees, employers, Principals and others lawfully in the place of work. “Shared” responsibility is not “diminished” responsibility.

## *Planning the Harvest*

A harvest plan is an essential component of the harvesting operation, although the amount of detail in the plan will depend on the size of the area being harvested and the potential for adverse effects. For example, a 100-hectare stand on erosion-prone soils requires a very detailed plan, but a one-hectare woodlot on stable soils may only need a simple diagram showing the location of the landing site and truck access.

The harvest plan is the reference document for the entire harvesting project, and may cover many months of operation. It is the basis for formulating the harvesting prescription (which provides detailed instructions for physically carrying out the work), which in turn will be used as the basis for formal contracts.

### **THE PLANNING PROCESS**

Below are some important aspects of harvest planning. As a rough guide, these would apply to stands of more than five hectares, on moderately steep hill country adjacent to a small stream, where average environmental effects are likely.

#### **Pre-Harvest Inventory**

Some form of pre-harvest inventory (see page ??) of the standing wood is important to enable effective harvest planning.

The inventory provides:

- an estimate of total wood volume, which will influence the cost-effective design of roading and landings.
- the log types likely to be produced. This is important in designing landings of sufficient size for sorting and stacking the logs. It may also dictate the likely markets, influencing the timing of the harvesting in order to maximise returns.
- the size of the trees and logs, which will determine the size and type of machinery needed for harvesting.

#### **Identify Constraints**

The site should be examined and any constraints on harvesting operations identified. These may include:

- historic and cultural sites
- adverse ground conditions (erosion-prone, unstable or wet soils)
- stream- or lake-side management areas
- adjacent residential areas
- land topography and steepness (and its suitability for different harvesting options - broken topography with slopes of 20 degrees or more will require hauler logging)
- down-stream uses such as water supply from streams or springs
- area of public access such as roads or walking tracks
- structures such as power lines and fences
- hazards to harvest workers such as cliffs, tomos, rock falls, old fences and standing dead trees.

The harvest plan should take these constraints into account by using, for example, lower impact hauler systems on erodible soils or by avoiding damage to indigenous forest and scrub in stream or lake-side areas.

District and regional plan requirements relevant to the particular site must also be examined. Rules which apply to vegetation clearance and earthworks are particularly important for harvesting operations. For example, a forest may be able to be hauler logged as a permitted activity but ground-based extraction may be a controlled activity needing a consent. In such a situation, the forest owner may use a hauler system even where topography would allow a cheaper, ground-based system.

### **New Zealand Forest Code of Practice**

LIRO produced the *New Zealand Forest Code of Practice* in 1990 and revised it in 1993. It is used by the forest industry as a guide to forestry planning and practice (including harvesting). The *Code* suggests the following operational planning and control process:

1. Identify the values which may be affected by the proposed operation and follow the steps described in the *Code's* environmental section.
2. With the help of the *Code*, identify operations which may potentially affect the values. The operation technique with the lowest impact (within reasonable costs) can then be chosen.
3. Check the compliance of the selected operation technique under relevant district or regional plans and obtain resource consents if necessary.
4. Monitor the performance of the operation to ensure that it complies with requirements.

LIRO has prepared an example of this process for a farm woodlot, which may be useful for forest owners considering harvesting their trees. Copies can be obtained from LIRO.

### **Appropriate Equipment**

A harvest plan should have the above information on site constraints and forest characteristics and a suitable map of the area. This information will identify the appropriate type of harvesting equipment (eg, skidder, tractor or hauler) and the basic outline of roads and landings to cater for equipment, site and management constraints.

Having identified the appropriate *type* of equipment, the final harvesting plan will consider which is the most *likely* equipment. This will be determined by matters such as the availability of contractors and the cost-effectiveness of the systems. For example, the different makes and sizes of haulers have varying capacities of rope length, which in turn influence the siting of landings and roads. Given the range of harvesting equipment and its changing availability in different parts of New Zealand, it is not possible to be specific in this handbook. Forest owners are advised to use a consultant with local knowledge or seek information from local contractors or other forest owners.

### **Road & Landing Design & Construction**

The location and design of the roads in a forest will be influenced by topography and the planned harvesting method (which determines where the landings will be and therefore where the roads need to go). The forest size and environmental requirements will determine roading standards. For example, if the block is small, summer harvesting of short duration can be planned and road construction can be minimal. However, a larger forest located on

an environmentally sensitive soil type and requiring access all year will need a higher standard of all-weather access.

Road and landing location, design and drainage are major aspects of harvest planning because:

- soil erosion from roads and landings can be a major source of sediment moving into waterways
- layout and construction have a major impact on the productivity and efficiency of the harvesting operation and consequently its costs
- good design provides better and safer working conditions
- in the subsequent forest rotation, tree growth is reduced on roads and landings owing to topsoil removal and soil compaction. It is important keep the size of roads and landings to a minimum.

Roads and landings should be designed and constructed to a standard sufficient to allow an effective harvesting operation while providing minimal adverse environmental effects and loss of productive land.

A well designed roading network can meet all these needs. “Budget” roading can often be more expensive in the long run, as it is prone to rain damage, can cause sedimentation of waterways, can mean that wood spoils on landings which trucks cannot reach, and often requires substantial (and costly) maintenance.

The *New Zealand Forest Code of Practice* contains information on designing and constructing roads and landings.

### **Access to Public Highways**

Access to a public highway from private land must meet the requirements of Transit New Zealand and the relevant local authority in terms of safety for logging trucks and other road users. Road design criteria is covered more fully in the *Small Forest Management series’ Planning a Small Forest*. The considerations for obtaining a land use consent for road or track construction are described in *The Resource Management Act*.

### **Resource Consents**

Having prepared the harvest plan, it is now possible to proceed if the operation is “permitted” (can be undertaken without consent) under district or regional plans. Aspects of the operation which are not permitted will require a resource consent.

The harvest plan is likely to be used when seeking consents for operations such as road construction and harvesting of forest blocks. The *Small Forest Management series’ The Resource Management Act* includes examples of progressing a consent application.

### **WRITING THE PLAN**

Using the information gathered during the planning process, the harvesting plan can be written. It should be in a written format so that it can be referred to. The length and complexity of the plan will depend on the size of the harvesting job. For most small jobs (of two to ten hectares) a typical harvesting plan may be one or two pages of text and a couple

of maps. Larger harvesting operations with a number of complex issues could involve many pages of text and maps.

A typical small forest harvesting plan should include:

- details of the stand such as area (in hectares) and species
- details of the products which can be harvested from the stand, categorised by log types, log sizes and volumes (both volume per hectare and total volume)
- the markets for which each product is destined
- a map (or maps) showing
  - \* the stand's location in relation to the nearest road
  - \* the access route to be used by trucks removing the products
  - \* topography
  - \* existing and new internal roads, tracks and landings
  - \* streams and stream protection areas
  - \* stream crossings
  - \* areas to be harvested by particular methods (eg, those areas to be harvested by hauler and those by skidder)
  - \* the order in which the stand is to be harvested, by "settings" (a setting identifies which part of the stand will be extracted to a specific landing)
  - \* any areas which need protection from damage during the harvesting operation
  - \* any hazards such as cliffs or tomos (holes in the ground caused by water erosion).

## THE HARVESTING PRESCRIPTION

The harvesting prescription is based on the harvesting plan and should include any resource consent conditions. It clearly defines the work requirements for the operation, and should be produced as a written instruction for the harvesting operator and supervisor.

The harvesting work should be done according to the prescription and with supervision to check that the defined requirements are achieved.

The prescription should:

- identify the area to be harvested by description and map. This may include information about the stand, such as volume (total and average tree), tree diameter (average and range) and expected log grade volumes
- include a map showing the location of roads, landings and which areas will use which harvesting methods
- identify any areas where environmental values require special care
- include any conditions which may be specified in a resource consent
- detail any special conditions defined by the forest owner
- identify supervision checklists for monitoring the operation
- include a copy of the log specifications for the harvest
- detail site clean-up requirements at completion of the harvest.

## TENDERING

Competitive tendering is often a good way of getting the best price for a job. This is particularly the case when a small forest owner has not had previous experience with forestry contracts. Forest owners can advertise in the local press and/or contact a number of

contractors and invite them to tender for the work. The Ministry of Forestry can supply contact details for local harvesting contractors.

Contractors interested in tendering should be provided with a copy of the prescription and details of the area to be harvested. They should inspect the block before giving the owner a tender.

While unreasonably high tenders should not be accepted, it is equally important to avoid accepting very low tenders which may result in the contractor losing money or the job not being done properly in an attempt to make a profit. Low tenderers may also disrupt the operation by pulling out before it is completed if they start to lose money.

## CONTRACTS

Any work carried out for a small forest grower by someone else, such as a forestry contractor, should be done under a written contract to provide clarity and protect the interests of the parties concerned.

Once a tender has been accepted, a contract should be signed between the forest owner (or the owner's agent) and the successful contractor. The contract should contain the harvesting prescription and set out the period for completing the work and details of payment.

Harvesting contracts typically consist of two parts:

- The actual contract, signed by the contractor and the forest owner (or representatives).
- A description of the work and a list of conditions, usually attached to the contract and called the First Schedule. The harvesting prescription is often used as the First Schedule.

An example of a contract for harvesting is contained in *Forestry Law and Precedents* (available from the Ministry of Forestry). The example can be modified to meet specific requirements.

A small forest grower with several similar harvesting jobs with different prices and possibly an extended timeframe, may use the contract to include this extra work. This is done by exchanging letters of variation along with new First Schedule.

When dealing with issues relating to contracts, it is highly recommended that law professionals with experience in forestry matters be consulted by both parties at an early stage.

## *The Harvesting Operation*

The harvesting operation itself involves converting trees to logs and delivering the logs to buyers. It includes felling, delimiting, extraction, log making, fleeting, loading and transportation.

### HARVESTING MANAGEMENT

Good harvest planning is of little use if harvesting management is poor. Requirements in a sale contract are also of little use if they are not enforced. Harvesting needs to be supervised to ensure that contract conditions are met and the forest owner receives the best value for the trees.

Harvest management is generally done by on-site supervision, using checklists and recording results on a regular basis (preferably weekly). Checklists can be created using the harvesting prescription, forest owner requirements, legal requirements (including consents), and the log buyer's specifications.

### PRE-HARVESTING CHECKS

The following questions should be satisfactorily answered before harvesting starts:

Will the value of the forest be maximised through recovering high value logs?

Will the contractor/buyer remain in business for the duration of the contract?

Does the contractor have a harvest prescription to follow, written by the owner, the owner's agent, the buyer, or the contractor?

Does the contractor have a safety management plan in place? Has it been sighted? Has the contractor been advised in writing of any unique features of the property that could put him or his employees at risk?

Have all parties agreed on who pays for roading and tracking, and how the land will be left after harvest?

Are contractor and transport operations co-ordinated so that logs do not deteriorate before reaching the buyer?

Have the necessary contracts been signed and financial guarantees put in place?

Have any necessary resource consents been obtained?

Is there a clear, written statement of how and when payment is calculated and received?

### MAXIMISING VALUE RECOVERY

The amount of supervision needed to ensure maximum return to the forest owner depends on the type of sale. Supervision is not as critical for a block sale, as the price is fixed for the whole block. However, a stumpage sale needs supervision to ensure that all the merchantable wood is recovered from the site.

In a sale by log grade, supervision is very important to ensure that all merchantable material is recovered and that the highest value mix of log grades is produced. A standard sample of logs should be regularly inspected and the number of faults counted and tallied to see if an acceptable standard is being achieved. Contracts should include the action to be taken to rectify any shortfall in standards. The tally can also be compared on a weekly basis to monitor changes in log quality - this may indicate a change in the forest growth as logs are drawn from different parts of the stand.

## MONITORING WOOD REMOVAL & PAYMENT

In stumpage and log grade sales, payment is based on the amount of wood removed. The harvesting operation should include a way of monitoring this amount to ensure it is all paid for.

The usual system is a uniquely numbered load docket for every load of logs which leaves the forest. The forest owner receives a copy of each docket and can reconcile volumes removed over time against payments from the buyer.

The *Small Forest Management series' Marketing a Small Forest* details the processes of wood sale, monitoring supply and measurement.

## HARVESTING ACTIVITIES

### Felling

Felling trees in New Zealand is usually done by people using chainsaws (called a motor manual method, see *figure 1*) or by a variety of mechanical harvesters in larger scale operations. Felling should normally ensure the trees fall across the slope to minimise stem breakage when they hit the ground. The HSE Act requires that tree fallers have some formal training.



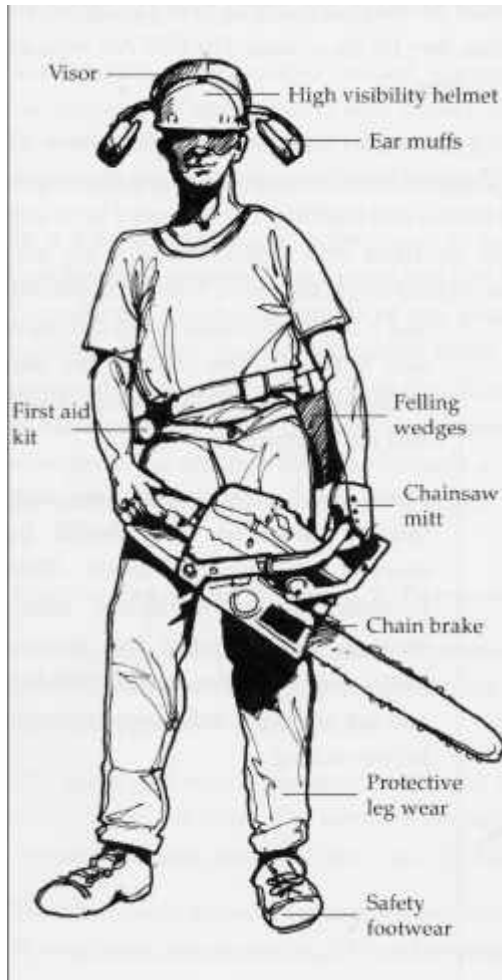
1 Faller felling tree

Anybody using a chainsaw in forest operations must wear safety footwear (a minimum of a steel toe-cap), New Zealand Standards-approved leg protection, ear muffs and high visibility safety helmet and clothing. The saw must be in safe working order with a chainbreak or hand mitt fitted. Workers are also encouraged to wear eye protection, spiked boots and have both a chainbreak and a hand mitt fitted to the chainsaw (see *figure 2*). Tree fallers are also required to carry felling wedges and first aid equipment.

These legal requirements are continually reviewed and should be checked at time of harvest. OSH promotes forest workplace safety through administering the various bush codes and enforcing the HSE Act, and can advise on safety requirements for tree falling.

## Delimiting

Delimiting is removing branches from the felled tree. It can be done at the stump or at a landing by chainsaw or special delimiting machines. Log buyers will specify a delimiting standard (eg, all branches must be cut off flush with the stem).



2 An equipped chainsaw operator

## EXTRACTION

Extraction is recovering or moving logs from the stump to the landing or skid for further processing. Extraction methods vary, depending on terrain. The main vehicles for extraction are:

**Skidders:** On easier country up to around 15 degrees slope, skidders can drag trees to the landing. A skidder is a purpose-built, rubber-tyred, pivot steering, four wheel drive harvesting vehicle (see figure 3). It has a winch and fairlead and/or a grapple to secure the logs and lift some weight off the ground to aid the machine's traction.

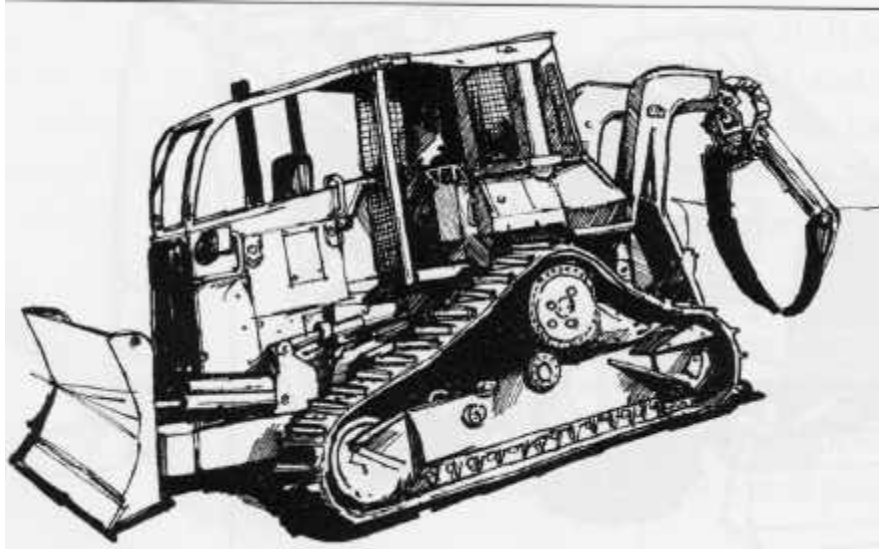
Skidders are capable of working on flat to easy terrain but with formed tracks can work steeper slopes, especially with downhill pulling.

**Crawler Tractors:** Crawler tractors can be used on more difficult country (up to about 20 degrees slope), can work in poorer ground conditions and can form their own tracks. However they are slower than skidders. Some crawler tractors are purpose-built for



3 Rubber tyred skidder

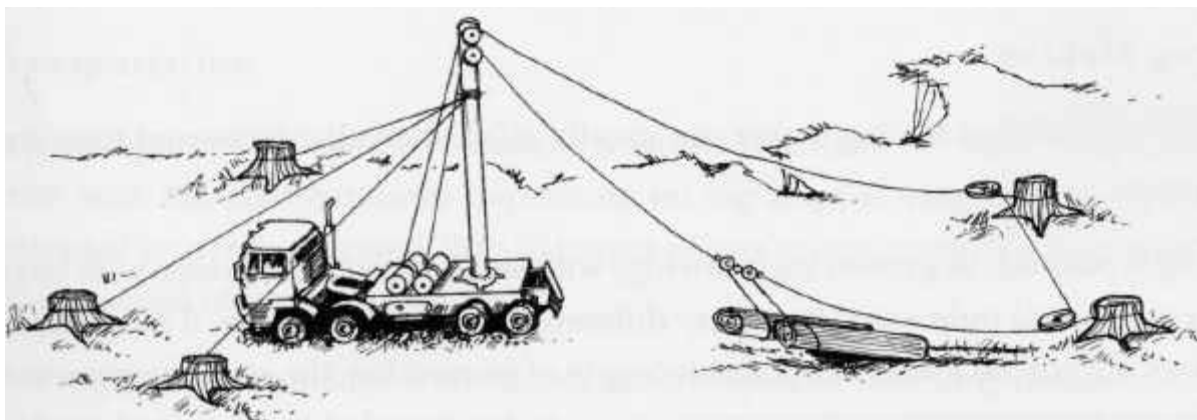
harvesting with integral winch and fairlead and/or a grapple, and weight distribution to maximise traction when loaded (see *figure 4*). Non-purpose-built tractors should use a towed arch to increase their efficiency for log extraction.



4 Crawler tractor fitted with a log grapple

Ground-based extraction is sometimes extended onto steeper country by creating a network of tracks from which machinery can work. However, this should be avoided where possible as it creates greater erosion potential, has adverse visual effects and can be hazardous.

**Haulers:** Aerial cable or hauler systems are used on steep hill country over about 20 degrees slope. A hauler consists of a tower supported by guy ropes, and has several winches (or “drums”) with wire rope (or cable) which is able to partially or fully suspend logs and haul them to the landing (see *figure 5*). The hauler is fixed in position on one landing and recovers all the wood its cables can reach from that point. It is then moved to the next landing and so on until the harvest is complete.



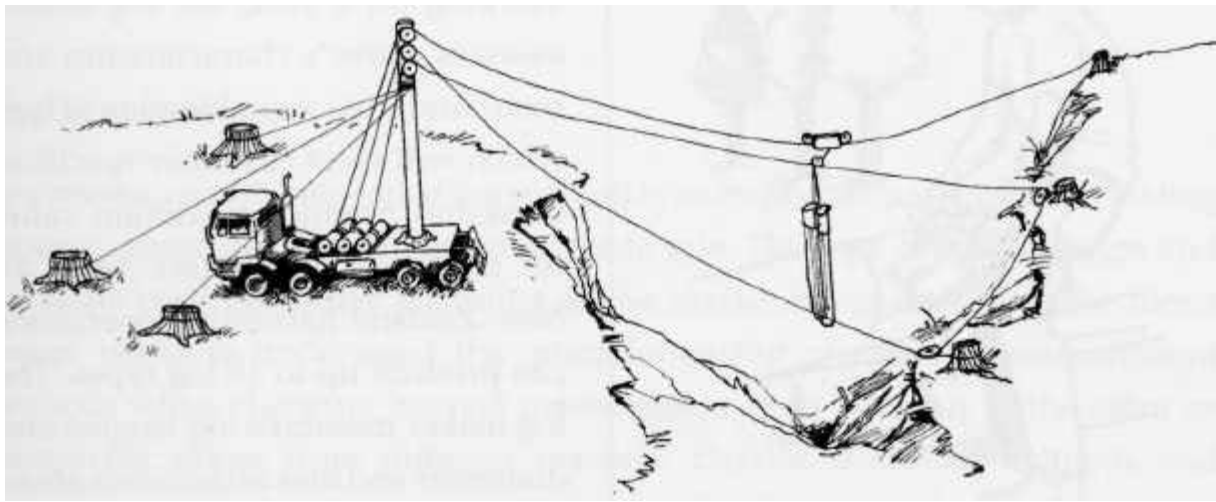
5 Hauler extracting tree stems using high-lead with a log grapple

Because they do not involve machinery passing backwards and forwards over the site, haulers cause less soil disturbance and generally have less environmental impact than

skidders and tractors. However, they are usually more expensive to run as they have a high capital cost.

Haulers have a wide range of sizes and configurations. The simplest is a two cable machine which allows only for pulling logs along the ground using a high-lead system (see *figure 5*).

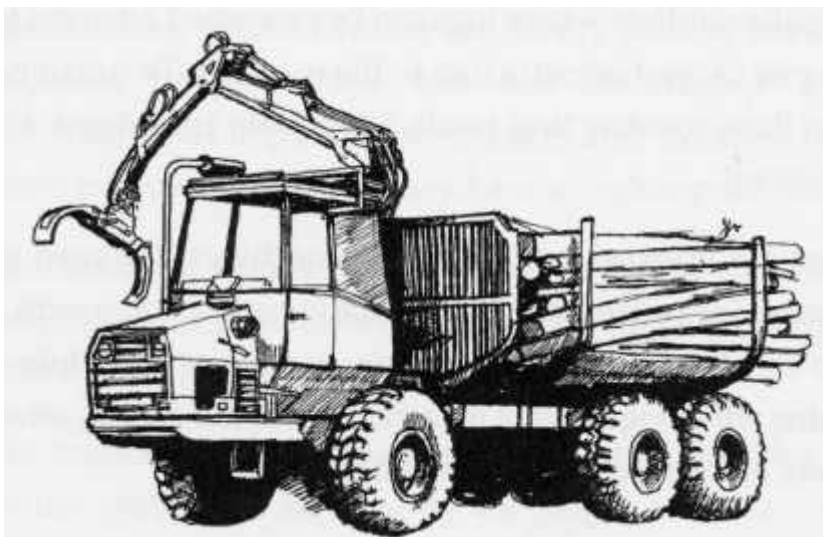
The more sophisticated haulers have up to five cables, allowing the full range of hauler systems to be used by the single machine, ranging from high-lead to motorised remote control carriages. The most complex systems allow trees to be extracted fully suspended above the ground (see *figure 6*), important in areas with erodible soils and for protecting riparian reserves.



6 Hauler using skyline and suspended tree

**Two Staging:** Two staging uses two methods to get trees from the stump to a final processing landing. For example, trees can be extracted to an initial landing using a hauler and then moved by a skidder to another area for log making and loading.

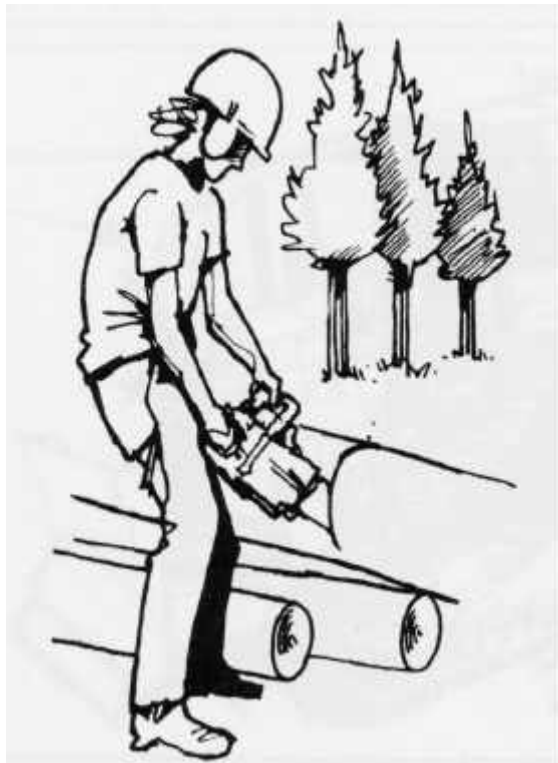
Two staging can reduce landing and road construction and can be used to offset the effects of difficult terrain, soil types and landing size restrictions. The method is particularly useful for small woodlots where logs can be processed adjacent to existing roads without the cost of road construction to the woodlot. Two staging can be more cost-effective than constructing roads where site conditions are difficult or forest areas are small.



**Forwarders:** Forwarders are off-road, self propelled machines designed to carry logs from stump to roadside or landing. They usually have a crane with a log grapple which allows self loading and unloading (see *figure 7*). While a forwarder is the best machine when log making is carried out at the stump, other extraction

7 A forwarder

methods are more efficient with full tree lengths.



Logmaker preparing logs for sale

### **Log Making**

The decisions of the log maker can greatly affect the value recovered from the forest.

Log types such as pruned logs, sawlogs with small branches, sawlogs with large branches and pulp wood have very different values. For example, if a log maker does not cut the maximum possible length of pruned log, the remaining portion is downgraded to unpruned sawlog with a consequent loss in value.

Working on a skid, the log maker assesses a tree's characteristics and then cuts it into a combination of logs which will meet customer specifications and produce maximum value for the forest owner. New Zealand harvesting operations can produce up to 15 log types. The log maker measures log lengths and diameters and makes decisions about where to cut the

### **Fleeting**

Fleeting is sorting logs into stacks of the same grade and length, ready for loading. Wheeled front-end loaders or excavator-type grapple loaders are generally used for fleeting and loading trucks. Where there is only a limited number of different log types or on small jobs, self-loading trucks could do this task.

### **Loading**

Loading is usually done with the same machine which fleets, although in some operations self-loading trucks are used.

### **Transportation**

Log transportation from New Zealand's forests is usually by truck and trailer units with the configurations depending on log lengths. Logging trucks are restricted to carrying around 25 to 30 tonnes of logs to give a total legal, on-road, all-up weight of less than 44 tonnes.

Rail transport is economical when logs are transported over long distances. In areas without good road access, logs are sometimes transported by cableway and barge. A combination of transport methods may be necessary to get logs from forest to buyer.

### **Log Measurement**

Log measurement (also called log scaling) is an important part of the harvesting process, especially in a stumpage or grade sale. The type of measurement and the units used can differ according to the market being supplied. The forest owner needs to understand the interrelationship of different measurement methods when changing harvest measurement from one unit to the other or comparing prices from different markets. Details of scaling methods and measurement units are contained in the *Small Forest Management series' Marketing a Small Forest*.

## HARVESTING SYSTEMS

Harvesting systems vary according to the form in which the wood is extracted. Some common examples are:

Felling and extracting the whole tree to a landing. This leaves a clean site for replanting but removes unmerchantable debris from the site, concentrating it at the landing and reducing the nutrient recycling over the harvested area. This method is unavoidable on some hauler operations where chainsaw delimiting on steep slopes is too dangerous.

Felling, delimiting and topping the tree at stump and extracting the tree length to a landing. This is common practice in New Zealand but the site may need some preparation work before planting the next crop to reduce, remove or crush unmerchantable debris.

Felling, delimiting and cutting the tree into logs at the stump. This leaves a large number of pieces to extract so is more likely to be used with forwarder operations (which carry loads of logs from the stump to the landing).

## LOOKING AFTER THE SITE DURING HARVESTING

It is important to ensure the harvesting site is left in a state which will minimise costs and maximise growth in subsequent rotations. The following issues can affect the site and should be part of any checklist monitoring procedure.

**Slash:** Slash is the unmerchantable branches and tops which are left on the site. It has advantages and disadvantages for future tree crops. As an advantage, the foliage and branches can contain significant quantities of nutrients for lower fertility sites such as sand dune forests. Leaving the slash and allowing it to rot, returning nutrients for the next crop, can be highly beneficial. Burning slash or pushing it into piles or windrows should be avoided wherever possible; burning loses nutrients to the atmosphere, and windrowing can concentrate nutrients in the piled slash.

As a disadvantage, large amounts of slash on a site can hinder subsequent tree planting and tending operations, increasing their cost. The best way to avoid this is to ensure that all merchantable material is recovered by selling the low quality, pulpwood material. If this is not possible, the bulk of the slash may be reduced through methods such as crushing it with a large roller (eg, one towed behind a crawler tractor).

Slash must not be deposited into or near waterways as it could alter the water flow. If slash does get into a waterway and is likely to cause a problem, it should be immediately removed, taking care not to damage the stream banks in the process.

**Machine Movement:** Moving machines over soil can cause compaction, particularly on wet soils or soils with poor structure, such as clay. Compaction can inhibit drainage and root penetration, which can reduce subsequent tree growth.

Keeping machinery on specified tracks will help reduce compaction. Landings and tracks where machinery is continually operating should take up minimal space while still allowing effective harvesting. Hauler systems may be necessary on sites with compaction-prone soils; although more costly, they greatly reduce machine movement. Harvesting on these sensitive soils may also need to be confined to summer months, as winter rain may worsen compaction.

Machines should be kept clear of environmentally sensitive areas. If harvesting is adjacent to waterways, machines should not enter any defined waterway protection zone and must cross only at designated points. These zones and crossings should be physically marked (eg, with red plastic tape) by the owner's agent before work starts. Temporary culverts may also be necessary to reduce damage at stream crossing sites.

**Rubbish Disposal:** Rubbish such as unwanted wire rope, oil and oil filters and other debris should be collected by the harvesting crew and disposed of in an appropriate manner.

#### COMPLETION INSPECTION

Shortly before harvesting operations are complete, a thorough inspection of the site should be undertaken to ensure all the conditions of the contract have been met. It is easier to correct any problems while contractors and machinery are still on the site.

When the job is completed, and all consent and other contract conditions have been met and documented, the contract should be signed off by the forest owner and the harvesting contractor or purchaser. Final payment for the harvesting work should not be made until this final inspection and any remedial work are completed.

## *Post-Harvesting Maintenance*

When the trees have been harvested and the site cleaned up to the owner's satisfaction, the site can be used for its next purpose. It may be replanted in another crop of trees, turned into pasture by oversowing with grass or left to revert to scrub. Even in the latter case, the site should not be "abandoned", especially if there are soil and water values to be considered.

### **SOIL & WATER VALUE MAINTENANCE**

There may be a risk of erosion for a number of years after harvesting while the site "settles down". The time will vary depending on topography and site, but as the next crop grows and areas of exposed soil are covered, the risk diminishes. Regular checks should be carried out and arrangements made for ongoing road and track maintenance to ensure that culverts and drainage systems are kept functional.

If the owner wants the original contractor to undertake this work, the responsibility for these inspections (and any remedial work) should be defined in the harvesting operation contract. The work may be subject to a separate price or some other arrangement for paying the contractor.

The *New Zealand Forest Code of Practice* describes techniques for ongoing site maintenance.

### **SITE CLEAN-UP**

After harvesting, the site should be cleaned up to a pre-agreed level (which should be stated in the contract). There may also be a need to prepare the site for restocking, such as raking up some of the slash which often piles up around landings using a suitably equipped excavator, or ripping up old tracks using a tractor equipped with a ripper.

It may also be necessary to repair fences and fix broken gates.

As with soil and water maintenance, the responsibilities for this work and the payments involved should be specified in the contract.

## *Financial Considerations*

The net return from a harvesting operation is influenced by:

- harvesting costs
- costs of complying with RMA requirements
- costs of meeting legal requirements
- taxation considerations.

### HARVESTING COSTS

**Piece Size:** The volumes of individual trees (“piece size”) affect production rates for harvesting operations. More handling will be needed for a lot of small trees, so production rates (and unit costs) will be lower than for the same volume in fewer trees of a larger size. Typical piece sizes in radiata pine clearfell harvesting range between one and three cubic metres. These are generally regarded as efficient sizes.

**Extraction Distance:** If trees have to be extracted a long way to the landing, extraction times will be longer, slowing production rates and increasing unit costs. Average haul distances for ground-based skidder operations are generally between 150 and 175 metres, while haulers can function efficiently over distances of 500 to 700 metres.

**Terrain:** Harvesting operations on slopes over about 15 to 20 degrees will require more expensive hauler systems than ground-based machines such as skidders or tractors. Steep, broken country with many small ridges will require frequent shifting of hauler machinery, again increasing costs. Roothing in steep terrain will also be more expensive, as more earthworks are needed to build roads and landings.

**Soils:** Harvesting costs are likely to increase on soils which are waterlogged, erodible or prone to compaction, as they require systems which cause the least damage to the soil. Examples include high lead systems or equipment fitted with special tyres or tracks. Planning the road and landing layout on these difficult soils will take more time, and their construction and maintenance costs are likely to be higher.

**Access:** The cost of access roading to a forest which is a long way from established roads will be high compared to a forest adjacent to a public road.

If low quality public roads require upgrading, the forest owner should advise the local authority of their intention to harvest (and therefore of the increasing road use) at least one year in advance. The local authority may seek a cost sharing arrangement with the forest owner. As large sums of income and expenditure could be involved, the forest owner should employ the services of a consultant with roading experience to negotiate with the local authority.

The quality of road access can affect transport cost. Trucks travelling on poor quality roads at low speed will carry less volume per hour than on good roads, increasing transport costs.

**Size of Harvested Area:** The fixed costs of harvesting a small forest area mean higher costs per cubic metre than for a larger area. Fixed costs include planning and consent application, roading costs and transporting harvesting equipment to the site. Fixed costs are generally disproportionately high on blocks of less than five hectares; economies of scale tend to level

out on blocks larger than 10 hectares. However, a forest owner with a small (less than 10 hectares) block can compensate for this to some degree by growing a high value product.

**Local Contractors:** The number and skill of local harvesting contractors can affect harvesting costs. Prices are likely to be lower in areas with a large forest resource and many contractors, owing to a better selection of equipment, higher skill levels and more competition between contractors.

**RMA Compliance:** The location (regional and/or district council area) of the forest and the land use constraints applied by local authorities may affect harvesting costs. Harvesting costs may increase if the site is difficult and requires considerable management input to meet regional and district plan requirements.

**Boundary Interference:** The cost of harvesting is likely to increase when the forest area is adjacent to fences, neighbours and utilities (such as water, power and telephone lines). These factors will require additional management input and extra effort by the harvesters.

## FACTORS AFFECTING HARVEST RETURNS

Unless a forest is sold as a block sale, the following factors can affect the grower's income.

**Felling:** Recoverable volumes (and hence returns) are reduced when the fallers leave high stumps and/or the trees break when they hit the ground. Good fallers will cut the trees to leave low stumps, and use directional felling to reduce tree breakage, improving ease of extraction. Directional felling should also assist the direction of extraction.

**Delimiting:** If the buyer's delimiting standards are not achieved, logs are likely to be downgraded in value.

**Extraction:** Skilled extraction results in the maximum volume being removed from the forest through minimising breakage and recovering all merchantable pieces.

**Log making:** Factors which ensure good log making include:

- The log maker is given, and understands, the log specifications for the sale and knows the relative values of different log types
- The log maker is trained to forest industry standards and holds the Forest Industry Record of Skills module for log making
- The log maker has the correctly calibrated measurement tools; these should include a logger's tape for length measurement and callipers to measure diameter limits
- Good and consistent log making techniques are used to optimise the value of each tree
- The logs are well marked with spray paint so they can be cross cut and sorted correctly.

Logs must meet the minimum diameter specifications and be cut to the correct length without splitting the ends. Logs which do not meet buyer's specifications are likely to be downgraded.

**Fleeting:** High quality logs sorted into lower value stockpiles will reduce returns. Including lower value logs in higher quality grades leads to customer dissatisfaction and extra management input to correct the errors.

**Loading:** Damage to logs during loading may lead to customer dissatisfaction. Loading is usually the starting point for production documentation, so it is important to record the details of the load correctly.

**Transportation:** The person carrying out the log delivery should check that the log documentation is correct and that the load measurement is carried out correctly.

**Log Degrade:** Freshly cut trees and logs can be prone to fungal and insect attack. Radiata pine's most important degrading agent is fungal attack which causes sapstain. The sapstain fungi produce a blue discolouration which makes the timber unacceptable for high value visual grades. However, the fungi does not affect the timber's strength properties.

In hot, humid conditions, sapstain can occur within three days of felling, and in cooler and drier weather about 10 days. It is very important that felled trees are extracted promptly and logs are delivered to the customer before degrade occurs. At worst, high quality pruned logs affected by extensive sapstain may only be fit for pulpwood.

**Weight Loss:** Once trees are felled they start to lose weight through natural drying. If a log type is sold on weight measurement, or by volume measurement through a weight/volume conversion factor, the weight loss can reduce harvest returns.

## HARVESTING RISKS

The *Small Forest Management series' Planning a Small Forest* details the risks of forest management; many of which apply to harvesting. The small forest owner should also be aware of some special risks that apply to harvesting, as these can have significant financial impacts.

### Contractor Availability

Well established contractors often have longer term, more secure harvesting contracts with large forest owners and therefore may not wish to harvest small blocks. For the small forest owner, this may mean that the contractors who work small blocks are less well established or sometimes just entering the industry. They may:

- have older plant and equipment, possibly meaning more down-time
- have inadequate planning support and be less experienced
- lack job security, working from one small block to another
- have frequent shifts between work sites, incurring extra costs. Owing to these frequent shifts, contractors involved in small forest harvesting can face cost increases of 50 to 100 percent over those working in larger forests.

Contractors can overcome these problems and get continuity of work through good organisation or links with woodlot purchasers. However, harvesting costs will usually be higher for small woodlots than for large forest operations.

### Market Changes

A major risk to the small forest grower is a downward change in market conditions during harvesting. If the sale is other than a block or stumpage sale, the forest owner will need to decide to either stop harvesting or accept a lower return. Similarly, the buyer may stop or

slow down harvesting, which could affect other aspects of forest management such as restocking.

### **Taxation Considerations**

Small forest owners should assess the taxation implications of their harvest revenue. Under present law, income from the sale of trees (including trees planted for shelter, erosion or other agricultural and pastoral purposes, and including any disposition by way of licence/easement, or sale of any right to future profits from harvesting) may be spread over the year in which it was received and the preceding three years.

Forest owners anticipating fluctuating revenue levels as a result of harvesting operations can use an Income Equalisation Account, which is held by the Inland Revenue Department. Some interest is payable on these accounts.

## *Where To Go For Help*

Professional advice may be invaluable when harvesting a small forest. Often the cost of this advice will be small compared to the money that could be lost through poor decisions or mistakes.

### **FORESTRY CONSULTANTS & MANAGERS**

Private forestry consultants and managers operate throughout New Zealand. The New Zealand Institute of Forestry (NZIF) operates a recognition scheme for forestry consultants. Services applicable to harvesting which consultants offer include:

- cost and revenue information, including computer growth modelling and information on log prices to estimate revenues from forestry projects
- management of harvesting operations
- advice on the sale of timber from mature forests
- assistance with the sale process
- forest mapping (some consultants have Global Positioning System (GPS) equipment and computer software which can produce accurate maps at reasonable cost)
- forest inventory, including pre-harvest inventory
- valuation of immature and mature forests for sale
- resource consent requirements
- roading design and construction
- harvesting planning, including equipment availability and capability.

### **LEGAL & FINANCIAL ADVICE**

Legal advice may be required to action contracts for harvesting operations and management. It is preferable to obtain the services of a lawyer who is experienced in dealing with forestry and RMA matters. Expert advice on forestry taxation is recommended.

## *Glossary of Terms*

**At mill door:** A pricing point for logs (or roundwood) delivered to the mill. A combination of stumpage, harvesting, loading and transport costs.

**At stump:** The point where further work may be carried out after felling but before extraction.

**At wharf gate:** A pricing point for logs (or roundwood) delivered to the wharf for export.

**Butt log:** The bottom (first) log of a standing tree.

**Cable logging:** Any harvesting system employing a stationary, powered machine with drums, spars, blocks and wire rope to haul logs from the felling site to an assembly point or skid.

**Chipwood/pulpwood:** Low grade logs not suitable as sawlogs, which can be converted into wood chips or pulp after debarking.

**Clearfelling:** The total felling of a stand and the removal of all merchantable material. Also called harvesting.

**Clearwood:** Wood free of branch knots or any other defects, particularly as a result of pruning.

**Delimiting:** The removal of branches and stem cones from tree stems in the preparation of logs.

**Extraction:** The process of moving the tree or logs from the felling position to the landing.

**Forwarder:** A purpose-built machine which loads and unloads itself and carries (rather than drags) logs from the stump to the landing.

**Hauler:** General term for a cable logging machine which is equipped with winches and which operates from a set position to haul logs from stump to landing.

**Landing:** A prepared area to which trees or logs are extracted and where logs may be prepared, sorted, sized, stockpiled and loaded onto trucks (also called skid, dump or yard).

**Log making:** The process of assessing the tree's quality characteristics and dimensions and then cutting logs to maximise value and meet the log grade requirement.

**Peeler or veneer log:** Generally large and well-shaped logs suitable for manufacturing rotary-cut or sliced veneer. Peeler logs of lesser quality can be rotary-cut for industrial plywood.

**Production thinning:** An operation where selected trees are removed for sale before clearfelling. Production thinning can produce small sawlogs, posts, poles and pulplogs.

**Sawlog:** A log suitable in size and quality for manufacturing sawn products, ie, boards, beams or framing timber.

**Skid:** See Landing above.

**Skidder:** A self-propelled log extraction machine specifically designed to haul logs from felling areas to skid sites.

**Slash:** Branches, bark, tree tops, unmerchantable logs, uprooted stumps and broken trees left on the ground after harvesting. Also pruning and thinning debris.

**Stumpage:** Price paid for standing trees (on the stump). Values may be expressed as dollars per cubic metre, dollars per tonne or dollars per stand.

**Windrows:** Slash and vegetation debris pushed aside into rows, with a cleared row between.

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