Best Practice Guidelines for Mechanised Harvesting and Processing

First edition December 2002
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This Best Practice Guideline is to be used as a guide to mechanical harvesting and processing. It does not supersede legislation in any jurisdiction or the recommendations of equipment manufacturers. FITEC believes that the information in the guideline is accurate and reliable; however, FITEC notes that conditions vary greatly from one geographical area to another; that a greater variety of equipment and techniques are currently in use; and other (or additional) measures may be appropriate in a given situation.

ISBN 0-

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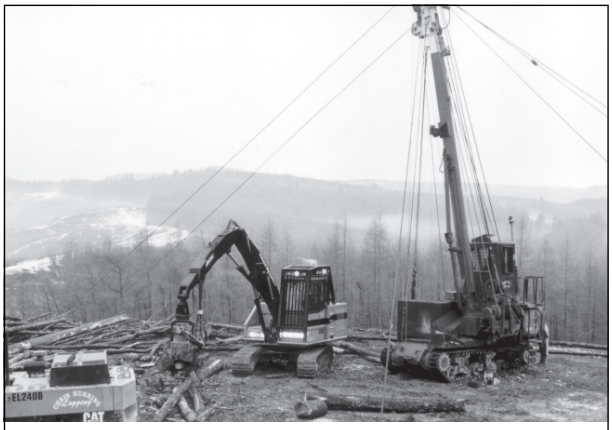
Mechanised harvesting and processing basics

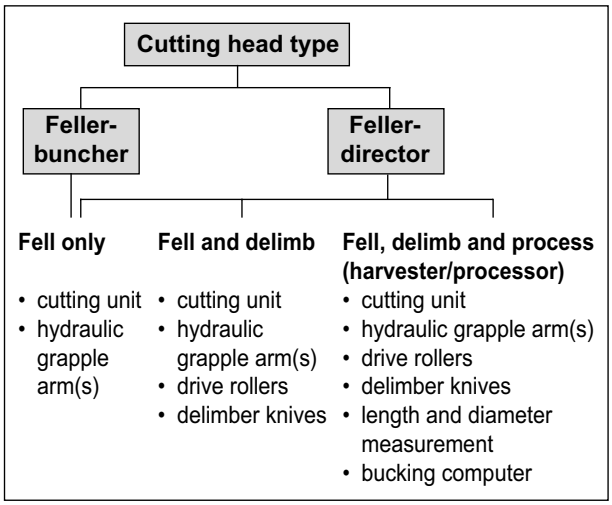
What is mechanised harvesting and processing?

Mechanised harvesting and processing involves the use of machines to complete the felling, delimbing, and/or processing of plantation trees. Mechanisation may be applied to one or more of these functions. For example, trees may be mechanically felled, extracted, and then delimbed and processed motor-manually. In other operations, all phases may be completed mechanically, or just the processing is mechanised.

Mechanised thinning



Mechanised processing on a yarder landing



Mechanised harvesting machines provide an alternative to motor-manual felling, delimbing, and processing. Mechanised systems are commonly confined to flat to rolling terrain (slopes less than 22°). To a lesser extent, mechanised delimbing and processing have become an integral part of cable logging and superskid operations.

A range of machine types can complete mechanised harvesting and processing operations. Furthermore, the delimbing and processing phases can be completed either at the stump, on the cutover, at the roadside, or at a landing or skid site.

The configuration of an operation (partially or fully mechanised) will be influenced by a range of factors, including:

- Type of operation (thinning or clearfelling, cable or ground-based)
- Terrain (slope and soil conditions)
- Stand characteristics (tree size, form, spacing, hindrance, etc.)
- Weather conditions (particularly cold)
- Contractor preference (machine types, crew skills)
- Volume to be harvested
- Forest owner requirements (quality, safety, cost, log value recovery, etc).

Machine types and their capabilities

The four types of mechanised harvesting and processing machines are:

- Mechanised fallers - can do either felling, or felling and delimbing
- Mechanised harvesters - can fell, delimb, and process
- Mechanised processors - can delimb and process only
- Static delimbers - can delimb only, dependent on another machine.
- Feller buncher - able to control the tree by holding it in the vertical position and placing it where required
- Feller director - guides the tree by pushing with the boom or moving the butt around

Mechanised fallers

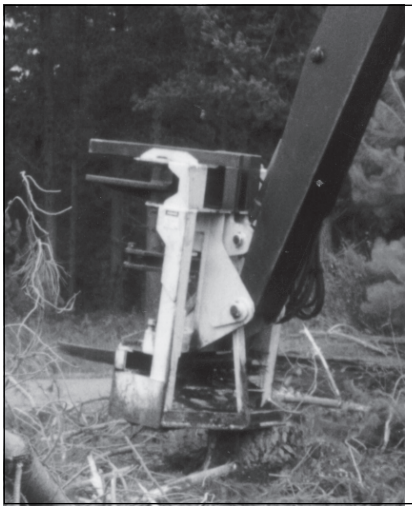
These machines comprise two main components: the cutting head and the carrier machine.

Cutting heads

Mechanised fallers can have a range of cutting heads with different functions, used in different ways. Broadly, cutting heads are described according to their functions, as shown at on the previous page.

The term feller-buncher relates to a cutting head capable of directly controlling the fall and placement of the tree using the hydraulic capability of the head and carrier. Feller-buncher heads are usually attached via two pivot points to the end of the outer boom (e.g., Timbco).

In contrast, the feller-director head is only capable of controlling the fall of the severed tree by swinging the butt or pushing with the boom. These heads are dangle heads connected to the end of the outer boom either by a yoke (e.g., Waratah HTH230) or by a single pivot (e.g., Hultdins F850). Some have the capacity to delimb as well, others are simply felling heads.



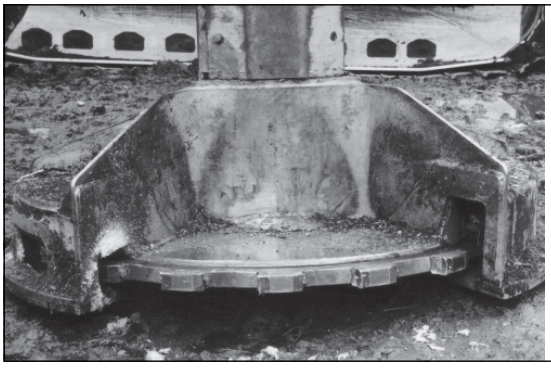
**Timbco feller-buncher head (left)
Waratah HTH230 (above)
and Hultdins F850 (right)**

The cutting unit on a head may comprise a retracting chainsaw, circular disk, or shears. In New Zealand, the chainsaw-cutting unit dominates the market because it results in clean and narrow cuts, and is usually cheaper than a disk saw. It does, however, need higher levels of maintenance than other cutting unit types.

There are two types of disk saw, the continuous and the intermittent. The continuous disk saw operates all the time, with the tree only being gripped once it is severed. This head is therefore most suited to dense stands of small-diameter trees. The disc saw relies on the inertia of the heavy spinning disc to do the cutting. Common discs sizes are 1 - 1.2 m in diameter.

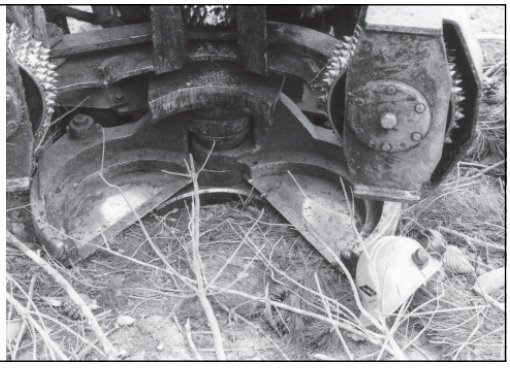
The intermittent disk saw is more suited to larger trees where more felling control is required. Unlike the process with the continuous disk saw head, the tree is gripped throughout the cutting action. The saw head is powered during the cutting process and thrust into the stem by hydraulic rams (e.g., rotosaw).

The shear-cutting unit comprises either one or two blades that slice through the tree with a scissors-like action. They require considerable power to provide the necessary cutting force. Some degree of butt damage may be expected from the crushing of the fibres. For this reason, shear-cutting heads are most often used in pulpwood harvesting.



**Disk saw
cutting unit
(left)**

**and shears
(right)**

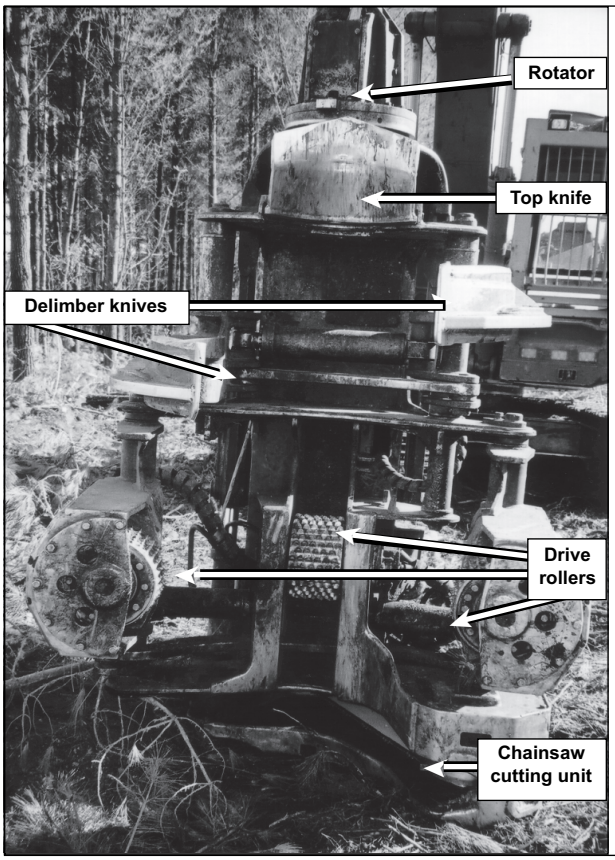


A stem being processed through a Waratah harvester/processor head

Mechanised harvesters

The harvester/processor head is a type of feller-director. It is capable of felling, delimbing, and processing. It is fitted with drive rollers, delimbing knives, stem measurement equipment (diameter and length), and one or two cross-cutting chainsaws.

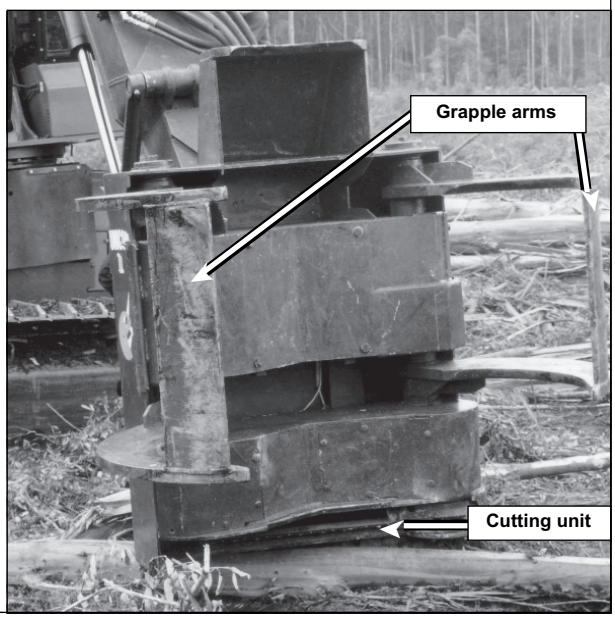
Felled stems are grabbed in the delimbing arms, and fed through the knives using the drive rollers. To propel the stem through the head, the drive rollers have gripping devices such as spikes, tyres, chains, bars, or thumbnails. Length is measured using one or more mechanical wheels in contact with the stem surface as it passes through the head.



Cutting head components

Major components of a Waratah feller-director head (left)

Major components of a Unicon feller-buncher head (below)



Carrier machines

There are two main types of carrier machine used in combination with a cutting head. These are:

- Swing boom
- Fixed, where the base moves from tree to tree.

The swing-boom carrier is used almost exclusively in New Zealand (with the one exception being the fixed carrier Bell TF120). These carriers can be divided into four main groups, as listed on page 5.

Modified excavators are commonly used carriers in New Zealand, working in felling and in landing-based processing operations. They share many of the features of the purpose-built non-levelling carriers (e.g., increased clearance (high and wide), logger boom, under-slung rams, zero tail swing, safety glass cabs, and so on).

Carrier type	Common examples
Swing Boom	
• Tracked excavator (modified earthworks machine)	Hitachi EX400 Komatsu PC300LC-7 Volvo EC 330B LC Caterpillar 320, 330
• Tracked purpose-built forestry (non-levelling)	Tigercat 845B Timbco T415C
• Tracked purpose-built forestry (self-levelling)	Tigercat L830 Timbco T445C Prentice 730FB Timberjack 2618, 2628, 608
• Wheeled purpose-built	Ponsse Ergo harvester Valmet 921
Fixed	
• Tracked	Bell TF120

The self-levelling carrier allows up to 30° tilt on the main body relative to the tracks. This can provide increased safety and performance for working on steep and/or broken terrain (*see* Machine Capability for more detail).

Wheeled carriers (of European origin) are not common in radiata pine clearfell operations because they are suited to smaller average piece size.

On flat to rolling and/or wet terrain, the six- or eight-wheel drive carrier can offer benefits where ground pressure and disturbance, or portability between sites, are critical issues. Common in Europe where damage to the tree roots is unacceptable (in thinning operations).

Mechanised processors

The term processor relates to machines capable of delimbing and/or cutting tree lengths into log lengths.

Examples of processors include:

- Stroke-boom processor (such as the Timberline and Tigercat)
- Excavator grapple with cut-off saw
- Bed processor (such as the Hahn Harvester, twin-grip harvester)

The stroke-boom processor is a dedicated delimber-processor machine usually mounted on an excavator or forwarder type base. An overhead sliding boom is fitted with delimber knives and a cross-cut saw on the front end of the boom. A rear set of knives, and a 2nd crosscut saw is mounted in the lifting frame. The knives hold the tree length parallel with the boom. Delimbing is achieved by gripping the tree length in the rear knives and extending the boom with the front

Hitachi excavator harvester

Timberjack self-levelling harvester

A six-wheel Timberjack harvester

A Timberline stroke-boom processor

A Waratah cut-off saw attached to the front of the grapple

A Hahn Tree Harvester. The remote loading grapple is on the left. The operator sits in the cab in the middle.

A twin-grip harvester

Static delimber

knives encircling the stem. Log lengths are electronically measured from the boom position, and the front or rear saw is used for cross-cutting.

The base machine is able to slew to sort logs of different grades. The stroke-boom processor can be used in the cutover, but is more commonly used to delimb and process on a landing.

The excavator grapple with cut-off saw is able to cut tree lengths at pre-marked log lengths. It has a powered chainsaw that can be moved in and out from the grapple to obtain accurate measurements. This movement is controlled by hydraulic rams.

The bed processor manoeuvres the tree length through a fixed processor. One example, the Hahn Tree Harvester, is a landing-based machine that delimbs and cuts tree lengths into logs. A slewing remote grapple at one end of the machine places the tree length into delimbing knives. These knives are fitted to a chain-driven carriage that runs back and forth on a bed or bunk. The butt of the stem is held by another set of knives at the front of the bed while the carriage knives delimb down the tree length. The cutting unit is a retracting chainbar, capable of sideways movement for accurate saw placement. Cut logs accumulate at the out-feed end of the machine, requiring fleeting and sorting by a loader.

An alternative bed processor is the twin-grip harvester. This wheeled machine is usually mounted on a purpose-built four-wheel-drive carrier or a six-wheeled forwarder base. It is fitted with a slide-boom extension with either a felling head or a grapple attached. Tree lengths are fed through the delimber knives with inverted rubber-tyre feed rollers attached to the fixed bed. The feed rollers also position the stem to be cross-cut using a chainsaw cut off saw. The twin-grip harvester is able to sort cut logs using the grapple. Stems are fed through the delimbing knives at right angles to the direction of travel of the machines.

Static delimbers

The static delimber is a stand-alone axle or skid-mounted device capable of delimbing only - it is not fitted with drive rollers or a cross-cutting saw. Stems to be delimbed are pulled through a set of powered delimber knives that close around the stem. Often remotely controlled, the static delimber works in combination with a Bell loader, skidder, or excavator loader. As the stem diameter decreases towards the top of the stem, the knives close further around the stem to ensure that branches are neatly delimbed. Delimbed branches accumulate around the base of the delimber, requiring periodic cleaning by the pulling machine.

The delimber hydraulic system is powered either by a small diesel or petrol motor (e.g., as in the case of the Super Trim and George delimbers) or by an accumulator system off the drive rollers (e.g., Harvestech delimber). Depending on the model, the delimbing knives may be at right angles to the stem being delimbed, or they may be angled to promote a slicing action.

Advantages of mechanised harvesting

Mechanisation can provide the following advantages compared with motor-manual harvesting and processing.

Improved safety

Mechanisation of felling, delimbing, and processing tasks can improve safety by eliminating, isolating, or minimising a range of hazards normally faced by motor-manual workers. Examples for each task are shown below.

Task	Hazards eliminated	Hazards isolated	Hazards minimised
Mechanised felling	• Objects falling on the faller • Chainsaw cuts to feet • Chainsaw hazards (e.g., kickback) • Wedges	• Falling objects • Falling or hung-up trees and debris • Unexpected tree movement • Ground hindrance	• Excessive noise for operator • Adverse weather • Physical fatigue • Loss of control of falling tree
Mechanised delimbing	• Chainsaw cuts to feet and legs • Unstable footing • Chainsaw hazards (e.g., kickback)	• Ground hindrance • Flying debris • Unexpected tree movement • Other machines and workers • Branches under tension	• Excessive noise for operator • Adverse weather • Fatigue and boredom
Mechanised processing	• Chainsaw cuts to feet • Chainsaw hazards (e.g., kickback)	• Flying debris • Unexpected tree movement • Other machines and workers	• Excessive noise for operator • Adverse weather

High production

Mechanisation can allow high production (tonnes or cubic metres per day) relative to the worker input. High production for the operation (as opposed to an individual task) requires that the mechanised tasks be matched with the other phases of the operation.

For example, a mechanised harvester may be capable of felling 60 trees per productive hour. In contrast, an individual motor-manual faller may fell 15 trees per productive hour under similar conditions. Over an 8-hour day, the mechanised harvester fells the equivalent of three to four motor-manual fallers' daily production.

High production levels are also possible as machine operators are capable of more-sustained productive work (resulting in a longer productive day), and the ability to double-shift the machine by using more than one operator in a work day. These production benefits are possible because machine operators are not exposed to high physical workloads, and they are largely unaffected by adverse weather and lighting conditions.

Felling quality

When performed correctly, mechanised felling can provide improved felling quality over motor-manual felling by:

- Reducing breakage
- Presenting tree lengths for more efficient hook-on or drag accumulation
- Shortening the extraction distance by moving tree lengths to flatter ground and/or towards the landing.

Mechanised felling provides more control over felling direction and reduces the impact when the tree hits the ground. As a result, mechanically felled trees tend to break at 3/4 tree height as opposed to 2/3 tree height for motor-manually felled trees. This leads to fewer small merchantable pieces required to be extracted, thereby increasing extraction productivity.

High-quality mechanical delimbing - here the nodal swelling has been partially removed

Delimbing quality

Mechanised delimbing can increase delimbing quality by ensuring that all branches and stubs are removed from around the entire surface of the stem. This does require that the tree lengths are matched to the delimbing machine/head, and that the delimbing knives are well maintained.

Where tree lengths are mechanically felled and subsequently machine handled, many of the branches are broken off. This incidental delimbing can reduce the workload for skid workers (who often have to delimb/trim in successive passes), allowing a better overall delimbing quality to be attained.

The machine cab provides protection and comfort for the operator

Environmental issues

Mechanised felling makes it easier to directionally fell trees away from streams and other protected sites.

Mechanised delimbing and processing at the stump or on the cutover allows slash to be left on the cutover. This allows nutrients in the slash to return to the soil instead of being accumulated in heaps around the landing. Leaving slash on the cutover can also reduce soil erosion by providing protection from the impact of rain splash and run-off.

Also, mechanised felling and harvesting machines can walk over slash dropped in front of the machine during delimbing. This reduces the ground pressure exerted by the machine and reduces soil disturbance.

Improved working conditions

Mechanisation improves the working conditions by offering a more comfortable and protected environment (the cab). The improved working conditions and safety afforded by mechanisation may be significant when attracting and retaining skilled workers within a harvesting crew.

Harvesting costs

High production and/or a reduction in crew member turnover can reduce the harvesting costs for the contractor and forest owner.

Disadvantages:

- High capital and operating costs - need for high volume
- Sensitivity to tree form/branch size
- Damage to the butt during felling
- Slope limitations (inflexibility if a contractor has to deal with a steep area)
- High stumps
- Matching productivity (output from other phases of the operation)
- Stem damage from feed rollers
- Branches torn out of the stem rather than sliced off.

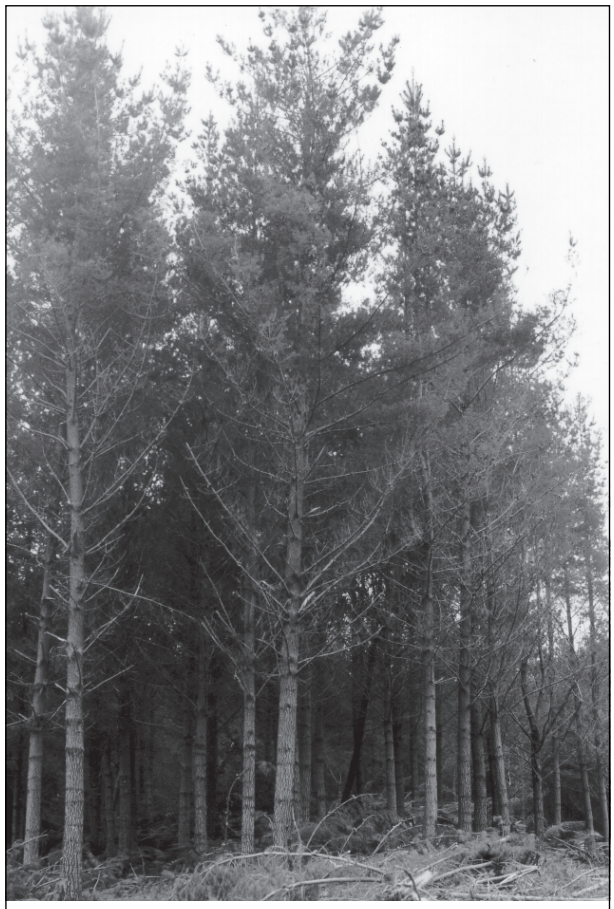
Factors affecting the use of mechanised harvesting systems

Stand/tree characteristics

The characteristics of the stand to be thinned or clear-felled will determine if mechanised harvesting is possible or profitable. Most important is the tree or piece size (weight and diameter). These two factors will influence the type and size of machine and head required. The greater the tree size, the fewer trees that need to be handled to attain high production figures. However, as the tree size approaches or exceeds the design specifications for the harvesting machine, the machine will struggle, possibly compromising the safety of the machine and/or operator. As tree or piece size increases, so does the tree height. This will affect the ability of the machine to handle the tree during felling and positioning, and the delimbing and processing work content per tree.

As the tree or piece size increases, the tree form and crown weight distribution (branching and lean) may also become significant factors affecting productivity and safety. These two factors will affect the ability to control the tree's fall. Tree form also influences the efficiency of the delimbing and processing phases.

Branch size influences delimbing quality. The bigger the branches, the greater the required capability of the delimbing equipment. There is a tendency to cause greater stem and equipment damage when branches are beyond the machine's capability. Such trees are usually delimbed motor-manually, requiring extra time and/or workers. The number and spacing between branches will also have an influence on the amount of effort required to delimb the stem.



Tree size, branching, form, and lean affect mechanised harvesting operations

Terrain and ground conditions

The terrain on which it is working affects the performance and safety of a mechanised harvester. Terrain features that have the most effect are ground slope and roughness, slope length, and soil type and conditions (including moisture content, previous mounding). As the slope increases, the ability to climb and machine stability decreases. Harvesting machines operate best when working up the slope, thereby keeping the weight over the tracks or wheels. As the slope increases, the machine becomes less stable when working (out to the side of the machine).

As a result, the width of the felled strip needs to be reduced to minimise the chance of the machine tipping over sideways and to retain the ability to handle the felled tree once cut. Also, as the slope increases the ability to travel up the slope is restricted by track or wheel slippage.

The Code specifies that machines should not be operated on slopes that exceed the maximum slope specified by the manufacturer. Manufacturer-specified slope limits provide the upper slope limit from a technical basis. For example, a manufacturer may specify a maximum slope limit of 22° for a tracked machine as determined through static stability testing.

However, this may overestimate slope that the machine can work safely and productively on. For example, adverse weather (rain, snow, or wind) and/or light conditions, tree size, and operator skill may significantly reduce the slope limit for a particular machine.

Harvesters do not typically work downhill unless they are able to access a lower slope from which to work up again. Safe slope limits when working downhill are always less than when working uphill (e.g., 12° downhill versus 21° uphill).

Machine capability

The machine capability will affect what tasks the machine can do (fell, delimb, and/or process) and how the machine handles the stand/tree characteristics and terrain. For most harvesting machines, the overall machine capability is a function of the base capability and head capability.

The following factors are important when assessing the capabilities of a machine base:

- Base type (track, wheels with/without band tracks, non- or self-levelling) and size (e.g., 25 tonnes)
- Boom type and configuration
- Hydraulic system performance
- Tail swing, particularly if used in production thinnings
- Gradability (affected by track motor power, machine weight, weight distribution, track width/profile)
- Slew power
- Ground clearance
- Lifting power (boom/ram configuration)

Every make of excavator or harvester has its own unique features that make it impossible to give precise slope limits for each machine.

Harvesting machines with a self-levelling base are designed to operate more efficiently when travelling on slopes, and cutting and handling trees. With the slewing main body (near) horizontal, power is not wasted trying to counter gravity. The machine weight is also more evenly distributed over the tracks.

The type and amount of slash present affect the climbing ability of tracked (or wheeled) machines, as does stump size and density. The addition of aggressive growser bars to the tracks (not exceeding 50 mm on all or alternate shoes) can increase climbing ability. However, too much grip and the machine can climb dangerously steep slopes. Too little grip may result in uncontrolled descent, particularly on wet slash. It should be noted that aggressive growser bars could severely affect the manoeuvrability of base machines with less powerful drive motors and damage roads when being moved.

Operator skill and teamwork

The operator is the key component in any mechanised operation. The capability of a machine is defined by its mechanical characteristics and these characteristics are easily identified and/or measured for a particular machine. However, it is the skill, motivation, and care shown by the operator that give the ultimate outcomes (i.e., wood processed in a timely, safe manner that does not adversely affect the machine or the environment).

The overall performance of an operation is not based on individual capabilities and performance. Rather, it is how the different operators and machines integrate and work with each other that defines the overall outcome.

System woodflows and work patterns

System woodflow and work patterns relate to the amount of wood flowing through the system and the path that the wood travels.

In any harvesting system, individual phases aim for production balance with preceding or following phases. In this way, the wood flows evenly over the course of the day with no major bottlenecks.

Where one or more phases of the operation are not balanced, that phase limits the production for the operation and may cause disruption through interference. Machine or worker utilisation levels may drop, resulting in an increase in logging costs in real terms.

The introduction of mechanised phases to a manual operation needs particular consideration for woodflow. Often machines produce at high levels, requiring the other phases to be equally as productive. For example, replacing two manual fallers felling 180 trees per day with a machine capable of felling 400 trees per day will require changing the whole logging system.

The work patterns are important as they usually dictate the haul distances and the angle of approach to the landing(s). These in turn affect how even the woodflow is to the landing and the layout of the landing activities.

Job prescription requirements

The job prescription may list conditions imposed on the operation to ensure that regulatory and company policy needs are met. Regulatory constraints may include consent conditions imposed through the Health and Safety in Employment Act 1992, Resource Management Act 1991, and the Historic Places Act 1980.

The forest company may also impose requirements to ensure that it receives a desired level of value and quality. Operational issues that may constrain the harvesting operation include:

- Minimal damage to crop trees in production thinning operations
- Low stump heights
- Damage to roadways
- Log quality requirements
- Damage to drainage systems
- Traffic flows through access roads.

Safety requirements for harvesting machines

Mechanised harvesting machines require safety features as specified in the Approved Code of Practice in Forest Operations, and the Approved Code of Practice for Operator Protective Structures, as follows:

Situation	Code Requirement
Machines working in standing trees	• Comply with Falling Object Protective Structure (FOPS)
Machines working where there is a risk of objects entering the cab	• Comply with Operator Protective objects Structure (OPS)
Machines (excluding hydraulic excavators) not working on flat ground	• Comply with Roll Over Protective Structure (ROPS) • Approved seatbelt or other safety restraint
Hydraulic excavators working on slopes where stability cannot be assured	• Comply with Cabin Operator Protective Structure (COPS) or Tip Over Protective Structure (TOPS) • Approved seatbelt or other safety restraint
Machines working at night	• Lights capable of illuminating the immediate work area
Machines with structures that may come into contact with overhead power lines	• Appropriate warning displayed in the machine cab

Note: In some cases, the falling object protective structure (FOPS), roll over protective structure (ROPS), cabin operator protective structure (COPS) or tip over protective structure (TOPS) could be the same structure.

Mechanised felling cuts and their use

Felling of individual trees is usually accomplished with one of three felling cuts, as described below.

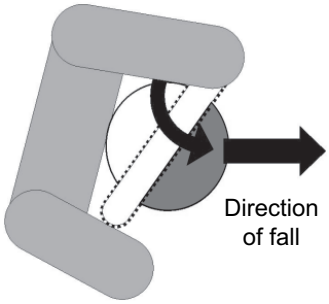
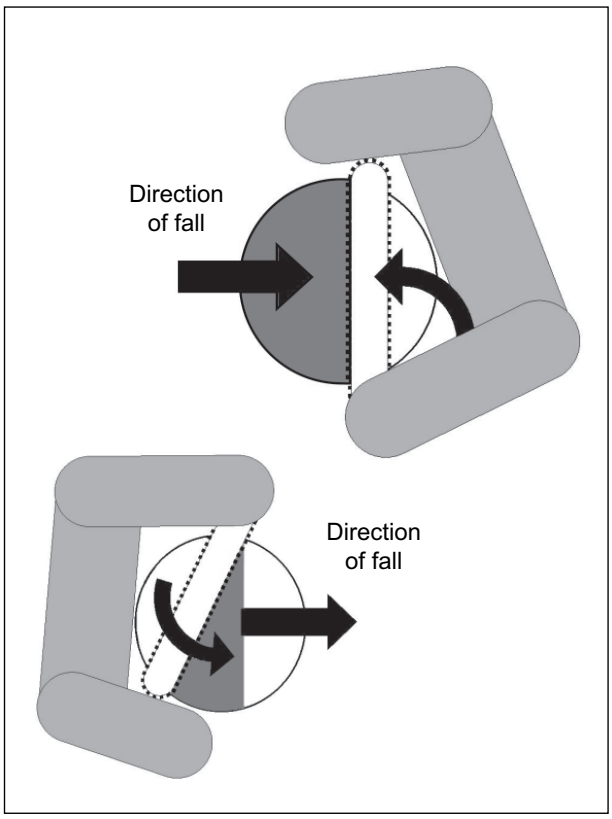


Illustration of the single back (release) cut using a chainsaw felling head (viewed from above)

Single cut

- On small to medium/large trees (relative to the felling head capacity) a single back (release) cut can be made as the tree is levered forward.
- The felling head should be positioned behind the intended direction of fall. This will ensure that the cut is completed at right angles to the intended direction of fall, and will allow the direction of fall to be controlled.
- The single cut should be made as close to the base of the tree as possible to maximise the volume recovery.



Double cut

On larger trees, an additional front (compression) cut may be required to completely sever the tree, and avoid butt damage and slabbing. This is often termed double cutting.

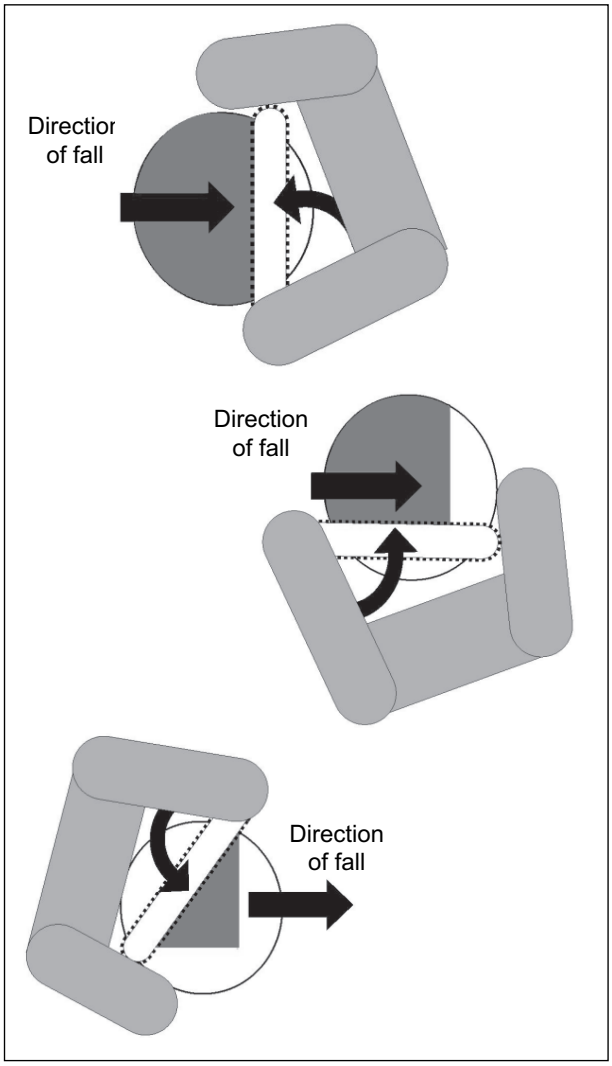
The two-step double cutting technique requires a front cut, followed a slightly raised backcut. The double cut will require repositioning of the felling head (feller-director), or head and machine (feller-buncher).

To complete a double cut:

1. A front cut at 90° to the intended direction of fall is made first. Make this cut as low to the ground as practicable.
2. After repositioning the head/machine, the back cut is made, slightly higher than the front cut.

   The front and back cuts need to be aligned to ensure there is no holding wood on either side of the tree.

In addition to a single front cut, multiple front cuts may be used on heavy forward-leaning trees to provide a greater area for the absorption of compression as the back cut is made.



Triple cut

On very large trees where the back cut cannot be completed in a single cut, a triple cut may be required to completely cut the tree.

To complete a triple cut:

1. A front cut at 90° to the intended direction of fall is made first.
2. After repositioning the head/machine, a cut is made into the holding wood from the side (if the chain bar pivots from the left side of the felling head, this cut is made on the right side of the tree relative to the intended direction of fall (as shown at left). This cut is slightly higher than the front cut and should only be deep enough to allow the final back cut to sever the holding wood.
3. The final back cut is completed from behind the intended direction of fall. This cut is made at the same height as the side cut (slightly stepped up from the front cut). The completion of the cut is made when the saw severs the hingewood. Therefore, it is important that the bar completes the cut when the bar is parallel to the front cut.

Factors affecting mechanised log-making decisions

Three major issues affect mechanised log-making decisions. These are:

- The characteristics or attributes of the stems
- Log grade specifications
- Log cutting instructions.

Stem and log attributes

A number of stem or log attributes are recognised and/or measured during log-making. Some are considered defects.

Note: The following definitions and guides to measurement are not intended to replace similar guides supplied by forest owners or managers, who have often developed their own systems for their own specific purposes and markets. Guides supplied by employing organisations must be followed for all operational log-making decisions.

Geometric centre (or middle)

The geometric centre of a circular area is the centre of a circle which has an end-area based on the average of two diameters.

Pith centre

The pith centre is where the pith lies in relation to the centre of the log. The pith is not necessarily the centre of the log.

Out of round/Ovality

Out of round, or ovality, of a log is the difference between the smallest and the largest diameter at one end.

Large-end diameter (LED)

The diameter of the larger (or lower) end of the log, usually expressed under bark (machines measure over bark).

Length

The length of the log is the distance measured along the shortest straight distance between the cut ends.

Tolerances

Lengths may often be cut to a defined tolerance, and tolerances vary according to organisational requirements. Typical tolerances might be ±5 cm, or alternatively –0 and +5 cm.

Small-end diameter (SED)

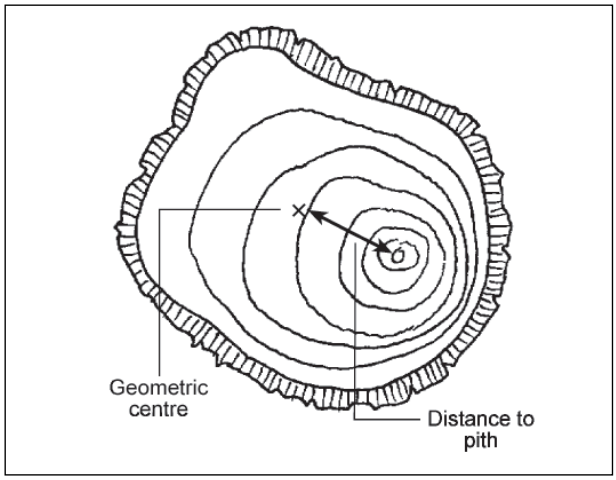
The diameter of the smaller (or upper) end of the log, usually expressed under bark (machines measure over bark).

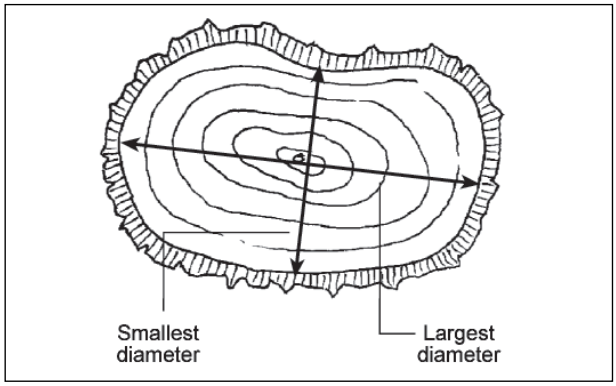
Cut face

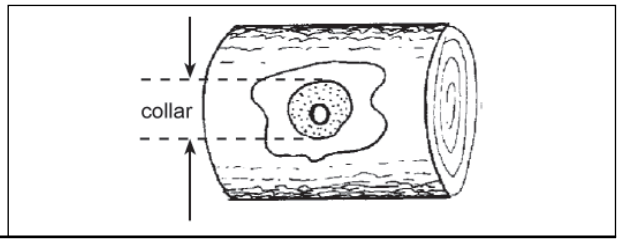
The cut face is a result of removal of nodal swelling around a knot or knots. This leaves a cut surface on the log, larger than the diameter of the branch(es).

Collar

The collar is a single, sometimes irregularly shaped, ring of wood surrounding the knot. It is not usually included in knot measurement.







Knots

A knot is defined as where a branch has been cut off flush with the stem.

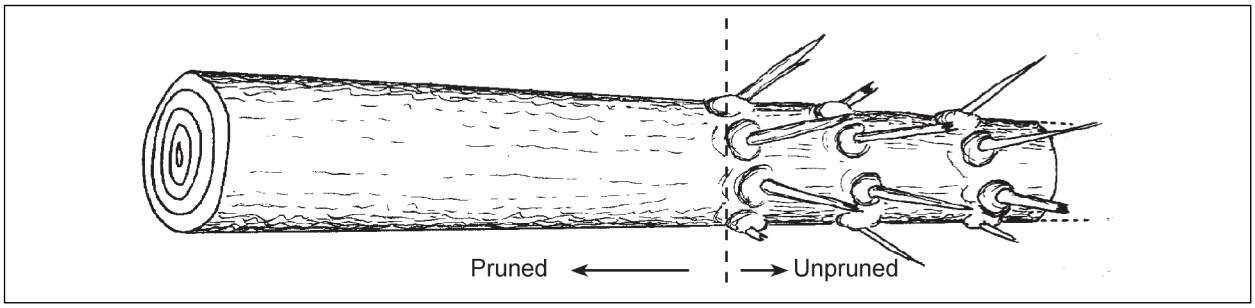
Spike knot

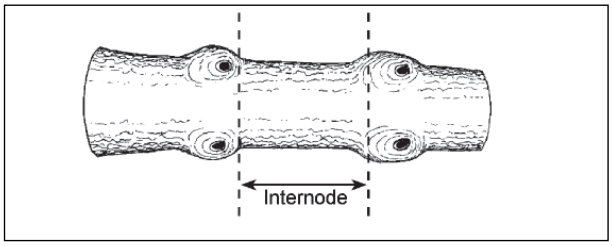
Spike knots are the result of acutely angled branches. These knots are often measured by comparing the length of the knot parallel to the log axis (A), with the knot's width (B). A high ratio of A:B (e.g., where length is more than four times the diameter) will indicate a more serious defect.

Pruned/Unpruned

The pruned zone is where the branches were pruned off when the tree was young. Consequently, there is no evidence of branches or epicormic shoots.

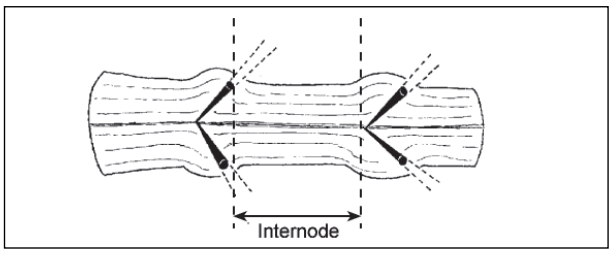
An unpruned log is one that has evidence of branches or epicormic shoots on the outside of the log.





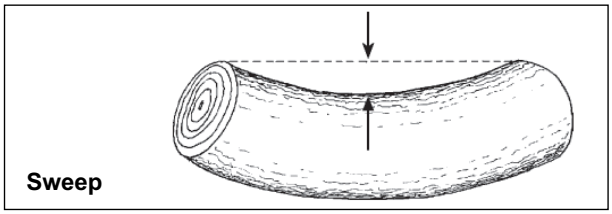
Internode

An internode is a knot-free section of the log. Measurement is of the shortest length parallel to the log axis. Usually, an internode is described as such when the whole circumference is knot-free.



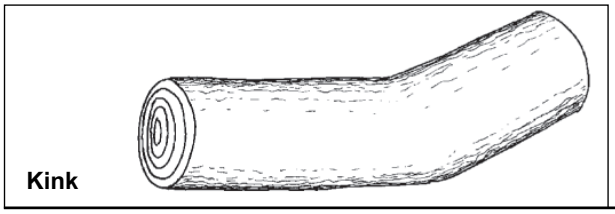
Taper

Taper is the diameter change per unit of length, expressed as a ratio.



Sweep

Sweep is defined as a predominant curve or bend in a single direction or plane. Wobble may also be present within the predominant curve and must be measured independently.

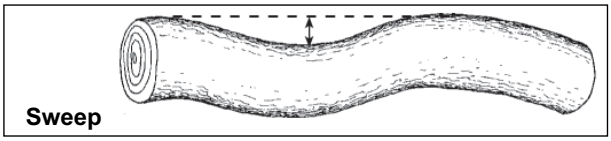


Kink

A kink is a short deflection within part of a stem. In logs it appears as a sharp change in the direction of the axis of the log.

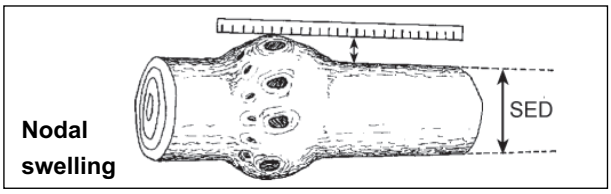
Wobble

Wobble defect is more than one bend over the length of the log. It can also be described as sweep in more than one plane.



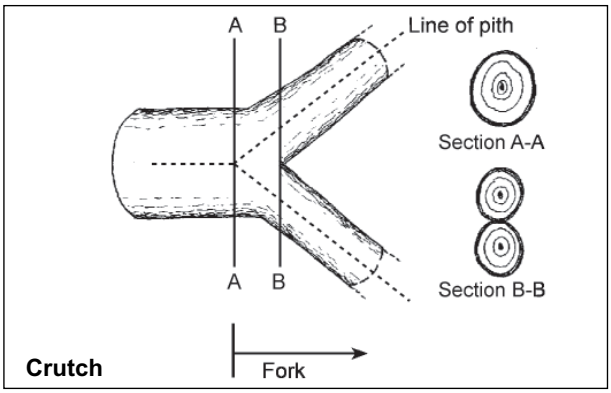
Nodal swelling

Nodal swelling occurs around a branch node (includes nodal swelling in pruned logs).



Crutch

The crutch zone is the part of the stem from where the pith diverges, to where the two stems diverge. A fork is where two diverging stems remain attached to the crutch zone.



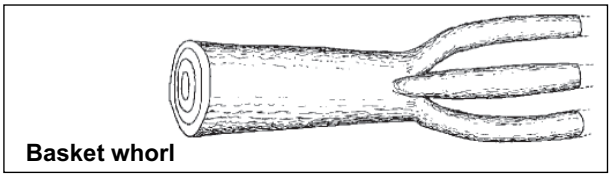
Malform

Some common types of malformation include:

- Forks
- Basket whorls
- Ramicorn branches.

Forks are usually caused by the loss of a leader by disease, or animal or snow damage. The lost leader is then replaced by two other leaders. Basket whorls are multiple forks coming from the same whorl. They are also usually a response to leader damage.

Ramicorn branches are large, steep-angled branches. A smaller, trimmed, ramicorn branch is termed a spike knot.

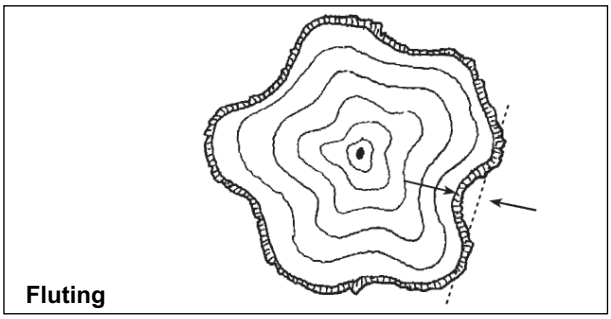


Malformations may also include kink, wobble, and sweep.

Malformation has the effect of limiting the potential value of a stem. Most areas affected are cut to waste. This is because resulting logs are difficult to handle, transport, or process by the end-user.

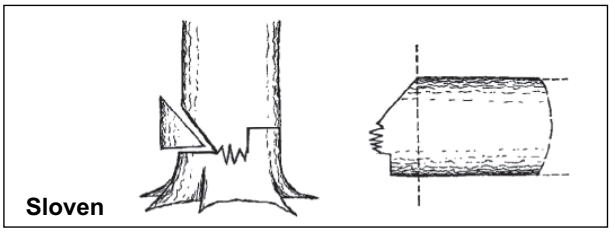
Fluting

Fluting is a depression in the circumference of the butt of a stem. It is often due to creasing of the bark or the growing together of buttresses.



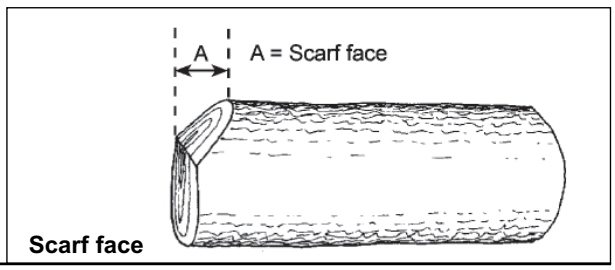
Sloven

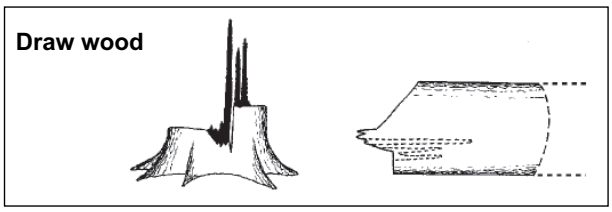
The sloven is the unwanted portion of the stem butt that retains the shape of the felling cut/s. It is usually removed in order to obtain a flat end-face, and to remove felling-related draw wood defect. Sometimes a limited amount of scarf face is allowed on the end of the log, depending on the log grade.



Scarf face

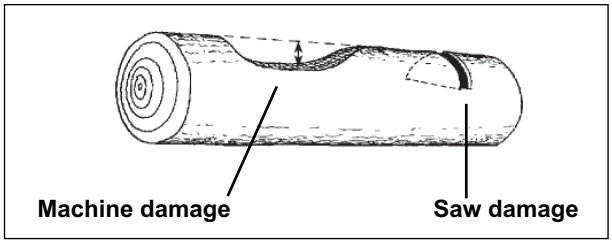
The part of the scarf top cut that is retained on the log.





Draw wood

Draw wood occurs when wood fibre is pulled out of the butt of the log during felling or cross-cutting. It is a hole or holes at the end of the stem. Draw wood holes may remain despite the cutting of the sloven.



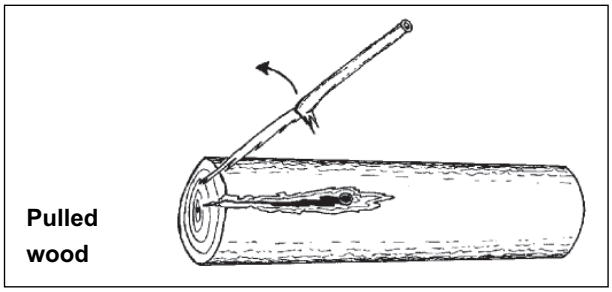
Machine or saw damage

Machine damage is log damage caused by:

- Harvester drive rollers losing traction or applied with excessive pressure
- Delimber knives blunt or incorrectly sharperned
- Extraction machine blades or grapples
- Loader forks, tines, or grapples.

Damage may differ in terms of depth, width, and length. Other kinds of damage that have a similar effect include:

- Partial chainsaw cuts
- Holes
- Pulled branches when the branch is torn off rather than sliced off.



Pulled wood

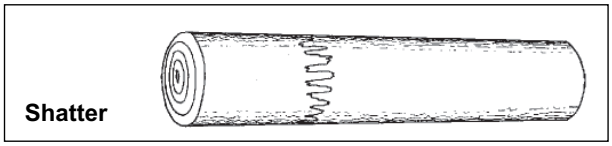
Pulled wood refers to where the branch is pulled free of the tree. This is usually against its natural growth angle and often after it has been partially cut. The effect is to tear a slab of wood from the stem. This usually includes the knot.

Pulled wood damage can occur when:

- Stems are extracted by the head
- Stems are delimbed head-first
- The delimbing knife is driven back from the head towards the butt.

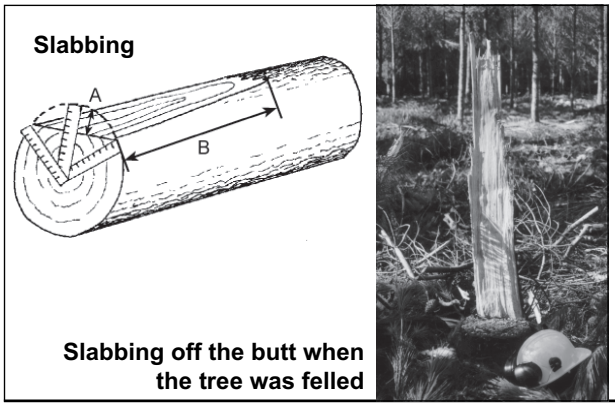
Pulled wood damage can include wood pulled or drawn from part of the knot area (i.e., not a clean cut) by delimbing knives.

Pulled wood is measured as for machine or stem damage.



Shatter

Shatter is a breakage of fibre within the stem. It is often caused during felling, or during extraction.

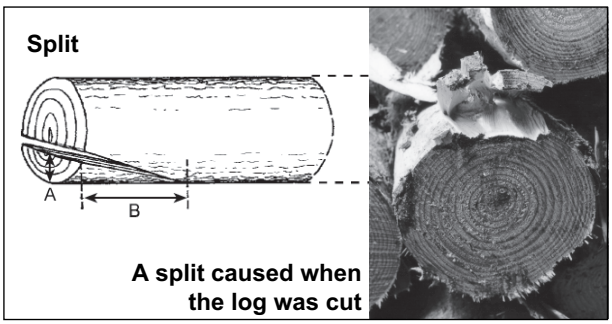


Slabbing

Slabbing of logs is the loss of wood from the side of the log, often towards the ends. It is caused by incorrect cutting, usually of the part of the log under compression.

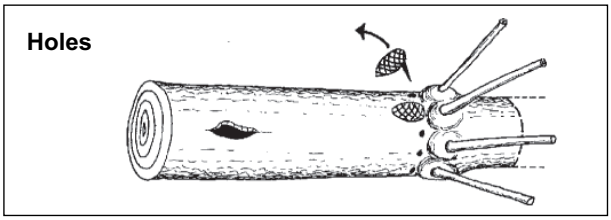
Split

A split is a crack or fracture of the log visible from the log end.



Holes

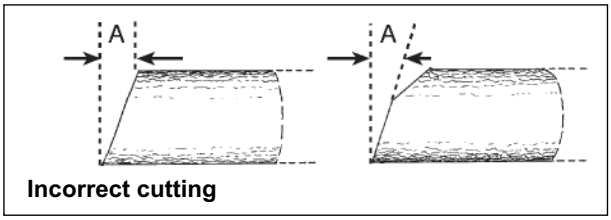
Holes in the stem or log include cone-holes, or holes caused by other means. Cone holes can be considered small bark-encased knots.



Incorrect cutting

End-cuts should be at right angles to the centreline of the log. Incorrect cutting may occur as a result of either faulty equipment or incorrect work method, including:

- Unevenly sharpened cutters
- Loose chain
- Worn or damaged chainsaw bar
- Stem not held correctly in the knives
- Careless cutting
- Not accounting for butt flare or malformation



Insect infestation

Insect infestation is attack of stems by wood-boring or bark-chewing insects. Evidence of infestation is normally the presence of the insects, larvae, or frass and holes. On the stem the clearest indication of insect attack is holes in branch ends, or a yellowing of the log or stem end.

Rot

Rot is wood decayed as a result of action by bacteria or fungi. The affected wood can be soft and spongy to the touch.

Sapstain

Sapstain occurs as a result of infestation of logs by fungi. A common form of sapstain is bluestain. Exposed sapwood is colonised first. Sapstain fungi favour warm, humid conditions.

The use of spiked rollers can expose a stem to rapid infestation of sapstain in warm, humid conditions.

Log grade specifications

The Log Specification Manual contains information that defines each log grade.

It may contain information such as:

- Company name
- A listing of log grades or types
- Species
- Log age restrictions
- Associated allowable defects or characteristics, and measurement criteria (e.g., knots < 10 cm)
- A revision date or copy number
- Specific log types
- Diameter and length information
- Branding or marking requirements
- General comments

25/05/2004	
Grade	H 30
Lengths	4.89 m (4.87 – 4.92) 5.49 m (5.47 – 5.52) 6.09 m (6.07 – 6.12)
Diameters	Minimum SED = 30 cm Maximum LED = 50 cm
Knots	Maximum 15 cm including collar and not to exceed 1/3 SED Spike knot maximum 8 cm, not to exceed 1/4 SED
Sweep	Maximum sweep of SED/4 over log length
Wobble	Maximum 5 cm permitted
Kink	Not permitted
Ovality	No restriction
Pith	No restriction
Fluting	No restriction
Nodal Swelling	5 cm
Bark Damage	Bark damage resulting in decay not permitted
General	No draw wood, rot, stain, dry wood, or splits. Ends cut square. Trim flush with log.
Marking (large end)	Crew number stencilled in blue. Blue stencilled “H” on every 5th log. Felling date on every 1 in 10 logs.
Docket Information	
Log Type	Sawlog
Grade	H 30
Length	Fixed
Customer	Woods Timber
Unloading Point	Rotorua

Example log grade specifications

Log cutting instructions

Cutting instructions are developed to meet market requirements. They must be current and valid before being applied in an operational log-making situation. The cutting instruction developed by the forest owner may include information such as:

- Company name
- Compartment or stand identifier
- Priorities for cutting
- Length and diameter information
- Volume of a particular product required.
- Crew name
- Date
- Log types
- Sweep and other defect allowances

In mechanised log-making, the cutting instruction is usually entered into the harvester’s computer to allow automated location of the cut zones. An example of the information entered is shown on following table.

Species No.	1
Species	Radiata pine
Bark offset	0
Scale factor variance	0

Log No.	Grade (mm)	Min. length (mm)	Max. length (mm)	Target length SED (mm)	Min. SED (mm)	Max. (mm)	Max. LED (%)	Max. speed
1	PL	5600	5650	5625	360	900	900	100
2	PM	4950	5000	4975	360	900	900	100
3	PS	4350	4400	4375	360	900	900	100
4	S1	6100	6150	6125	300	900	500	100
5	S1	5500	5550	5525	300	900	500	100
6	S1	4900	4950	4925	300	900	500	100
7	S2	6100	6150	6125	220	900	500	100
8	S2	4900	4950	4925	220	900	500	100
9	A	5200	5250	5225	300	900	900	100
10	K1	4400	4450	4425	220	900	900	100
11	AG	4875	4925	4900	100	900	400	100

Example of cutting instructions entered into a harvester-processor computer

The attribute characteristics of the log grades are not entered into the computer, as the computerised system is unable to recognise log attributes. The machine operator, who enters a log number into the computer, must assess the stem attributes before selecting the log grade.

Changes to cutting instructions

Cutting instructions can be changed at any time. Usually a new version is issued via fax or e-mail, or hand-delivered by the supervisor. The current version may also be changed verbally by the supervisor, harvesting manager, or other authorised person. In this case, a written verification of the change should be issued within 24 hours of the change.

The machine operator, the foreman or contractor, quality control staff, and the loader operator should hold a current version of the cutting instructions.

When cutting instructions are changed:

- check the new details to ensure that they relate to the operation
- re-programme the log grades, lengths, or priorities as necessary
- inform the other workers of the changes (either issue new copies or amend existing ones)
- re-arrange the layout of the stacks to accommodate any new grades or lengths.

Verbal instructions are open to interpretation - changes should be initiated by the person in authority.

If there is a slow response to cutting instruction changes, the effects will include:

- A shortage of some log grades produced
- Less-value logs may be cut from each tree length.
- A surplus of other grades

Surplus logs may be downgraded as they age. The result is a significant loss to the forest owner.

Planning considerations

The system approach

Operational planning focuses on the placement and timing of the individual phases of the operation.

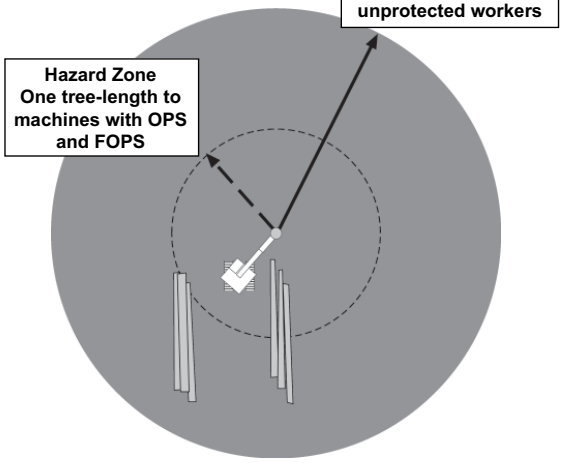
Specifically, this means deciding:

- Where to start felling, and how it should be progressed through the block
- How to open the block up
- The location of major extraction routes and how they should be used
- Which landings to use

- Timing of felling to suit weather, extraction capability, market demands etc.
- How to handle slash and waste build-up on the landing
- Daily production targets (trees, stems, or loads) for different parts of the operation
- Entry point(s) and directions to the landing
- The layout of the landing activities to allow separation of workers and machines, adequate log storage areas, and safe locations for loading trucks and vehicle parking
- Environmental considerations.

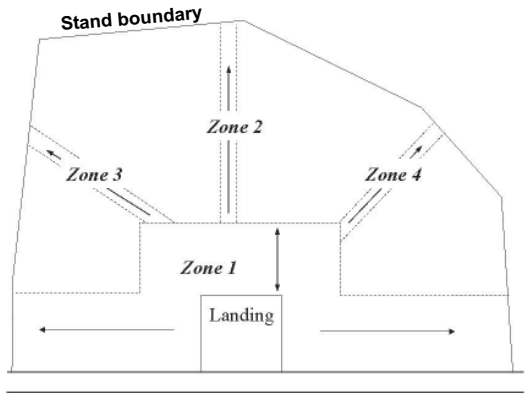
Operational planning needs to address wood flows and work patterns to ensure that safety, production, and quality targets are met. This requires the planning of the felling, extraction, and processing phases to promote balance and increased production, as well as detailed planning for each individual phase. For example, felling should provide a range of extraction haul distances to even out woodflow on to the landing and allow available landings to be fully utilised. Often extraction is the limiting phase, meaning that daily felling and processing production figures are restricted by the extraction capacity.

For more information on workflow patterns for ground-based operations, refer to the **Best Practice Guidelines for Ground-based logging**.



The hazard zones about a tree being mechanically felled (viewed from above)

Note: Broken links of chain can cause serious injury to any person in the vicinity of the harvesting machines. "Chain shot" as it is known can penetrate through safety glass and has been known to injure machine operators inside the cab.



An example of the felling pattern in a clearfell operation

Felling with a mechanised harvester

Hazard zones

Before planning any mechanised felling operation there needs to be consideration of the hazard zone about the machine. The Code states that unprotected workers should not enter within two tree-lengths of a working felling machine. This is designed to isolate hazards associated with sailors or breakage from the felled or adjoining trees. In addition, the hazard zone should take into account the risk associated with the chain breaking or flying off the bar during operation. In this case, the manufacturers usually suggest a hazard zone of 70 m in the cutting direction of the saw chain. The hazard zone should also account for likely stem movement after felling - for instance, if felling and delimbing on to bunches downslope of the machine.

The Code also states that other machines (fitted with approved OPS and FOPS structures) may approach to one tree-length of the tree being felled, but no closer, and providing the operator does not leave the cab.

Clearfell work patterns

The terrain and ground conditions, layout of the block (landing and boundary locations), wind direction, and tree lean will influence the felling pattern.

Mechanised felling typically progresses out from the landing, felling into standing trees. This pattern ensures that the trees are presented butt-first for extraction, and contrasts with motor-manual felling which usually progresses from the back to the front of the block.

Most mechanised felling involves felling into standing trees. As well as orientating the trees for extraction, this has the effect of:

- Slowing the fall of the tree reducing breakage
- Dislodging any overhead hazards in the trees ahead

- Creating new overhead hazards with trees and tops breaking off and remaining in the standing trees.

Often it is best to first fell the zone within two tree-lengths of the landing and adjoining road (Zone 1). This ensures a ready supply of wood as the operation commences. It also reduces any interruptions or hazards associated with felling too close to the landing and road throughout the rest of the harvesting operation.

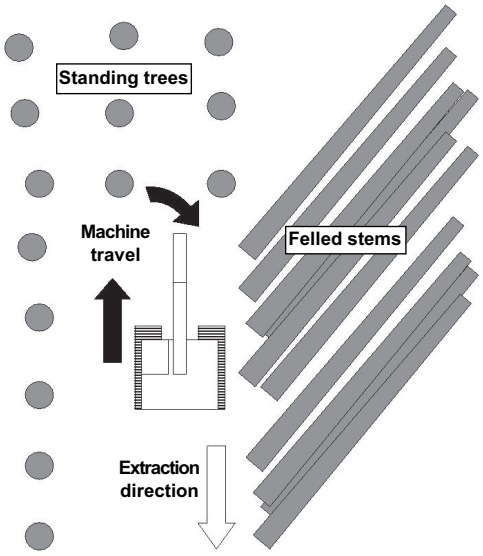
Having isolated the future felling hazards from landing workers and road users, the next step is to fell several strips to create a range of possible felling faces. These strips (Zones 2, 3 and 4, see diagram) are felled progressively out from the landing. On flat terrain, these strips can be located to provide an even spread across the block. It may be easier to work along the planting rows, particularly if the stand was mounded before planting. In more rolling terrain, these strips will concentrate up gully bottoms. This allows subsequent felling to work uphill from the gully bottom.

Once the outer boundary is reached, trees may need to be felled parallel with the boundary (to reduce damage to the adjoining stand). To aid the efficiency of breaking out, it is advisable to try to turn these edge trees towards the landing for butt extraction.

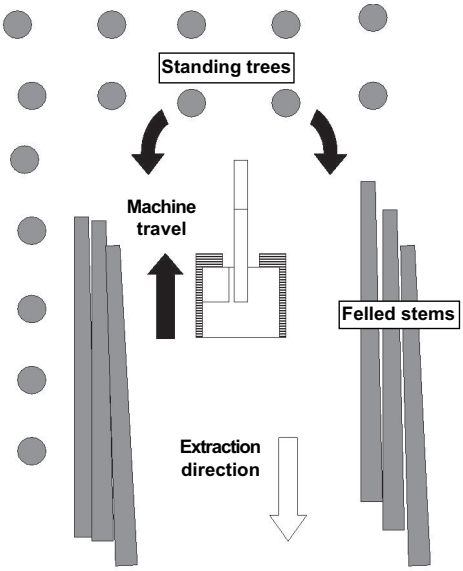
At the end of each strip, the machine is walked back towards the landing before commencing the next strip (or run). Alternatively, the machine may fell back along the strip when felling at right angles to the direction of travel. When felling it is important to plan the stem layout to ensure that the felling machine does not get boxed in. When this occurs, it may be necessary to get the extraction machine to shift the stems.

Once several felling faces have been established, the felling machine is able to alternate between different felling faces to balance woodflow to the landing and allow entry of wood from both sides of the landing. This also allows the felling machine to work away from the skidder or other extraction machine.

The width of each strip (or run) will be dictated by the type of felling head (feller-buncher *vs* feller-director), tree spacing and size, wind, slope, and operator performance.



Using a feller-buncher, a strip of felled trees is laid out to the open side of the machine, butts pointed towards the landing

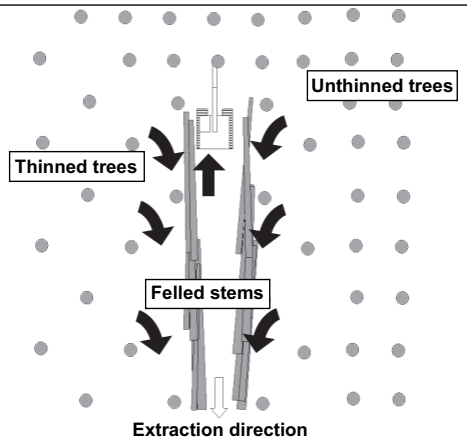


Using a feller-director, one or two strips can be laid out to the side and behind the machine. When felling a strip 4–5 trees wide, it may be more difficult to slew all stems down the open side of the machine (i.e., to form one strip). This also means that the machine has to walk further (around the butts of the felled trees) to start the next strip.

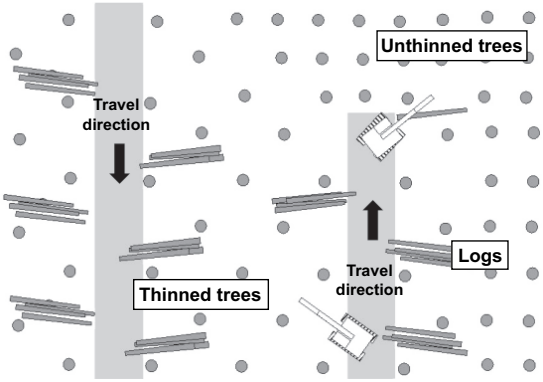
Production thinning work patterns

Felling patterns in production thinning operations are often more varied because of the residual stand and the harvesting system used.

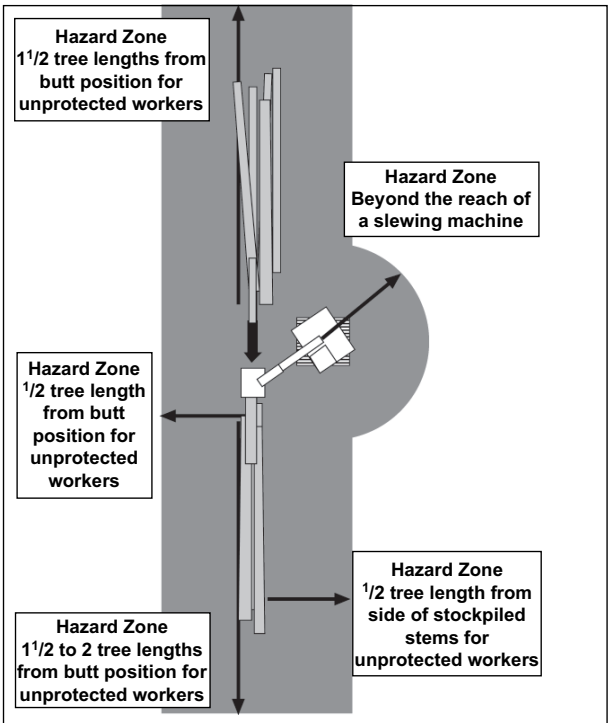
For tree length extraction, many of the same principles for clearfelling apply. Felling normally progresses away from the landing or road. The presentation of the felled stems will depend on the extraction direction. Where the residual stocking is low, the extraction machine may employ a branch-like extraction pattern, which can cross over the planting rows. As the residual stocking increases, extraction is constrained by the planting rows and the residual crop trees.



Stem presentation for tree length extraction



Log presentation in a cut-to-length system



Example of hazard zones about a mechanised harvester delimbing operation

Note: Chainshot can also occur during processing or cutting the sloven off

Felling normally progresses by removing a complete row to form the access track. Trees on either side of this track are carefully felled and turned to be orientated parallel with the track. This aids drag accumulation for extraction and reduces the chance of damaging the residual trees.

In this situation, the felling machine must walk back towards the landing or road edge before commencing the next strip. Small hydraulic excavators fitted with grapples are commonly used to bunch stems for extraction in production thinning operations.

In cut-to-length (CTL) operations (forwarder extraction) the felling strips may progress away from and then back towards the landing or road edge. The trees are felled at right angles to the travel direction and processed into bunches on either side of the track. This allows the forwarder to load the stacks from either direction.

Delimbing with a mechanised harvester

Hazard zone

If felling and delimbing are being carried out simultaneously, the hazard zone around the delimbing machine will reflect that discussed previously for felling.

Stems for delimbing may also have been previously felled (motor-manually or by a machine with felling head), or they may be delimbed out of a chute in front of a yarder.

In either case, the hazard zone needs to account for movement of the stems for delimbing, and the delimbed stems, and the machine itself.

Stems may slide easily when there is a suitable bed of other delimbed stems and/or when the bed is sloping downhill. In this case, the hazard zone may need to be extended to ensure that unexpected stem movement does not pose a hazard to workers.

Delimbing location

Mechanised delimbing may occur in different parts of the operation according to system requirements. Options include:

- Delimbing at the stump directly after felling
- In the cutover, where the stems have been previously felled
- At the road edge or landing to which the stems have been extracted.

On yarder landings, the delimbing machine may also be used to clear the chute and process the stems into logs.

The system configuration will define where the delimbing machine needs to be located. A dedicated ground-based delimbing machine can delimb in the

cutover or at the road edge or landing. Delimbing in the cutover provides the benefits of increased extraction efficiency (through no branches, presentation, and bunching) and the retention of slash on the cutover. The trade-off in this case is that the machine spends more time walking than if delimbing at the road edge or landing. Delimbing at the road edge or landing does not allow the benefits for extraction or slash management to be realised.

Work area requirements

A dedicated delimbing area should be planned to ensure that it has the following features:

- A defined hazard zone that is clear of any other workers or machines
- Room to manoeuvre both machine and stems
- Sufficient room to align (or swing) the stems prior to delimbing, and room to stockpile delimbed stems
- An area to dispose of accumulations of slash (in accordance with resource management policies)
- Coverage by appropriate warning signs.
- A relatively flat and stable working area, to minimise unexpected machine and stem movement
- Room to stockpile stems for delimbing. Alternatively, in a "hot" operation, room will be needed for the extraction machine to drop and push the stems. In either case, planning should aim to reduce unnecessary walking of the machine

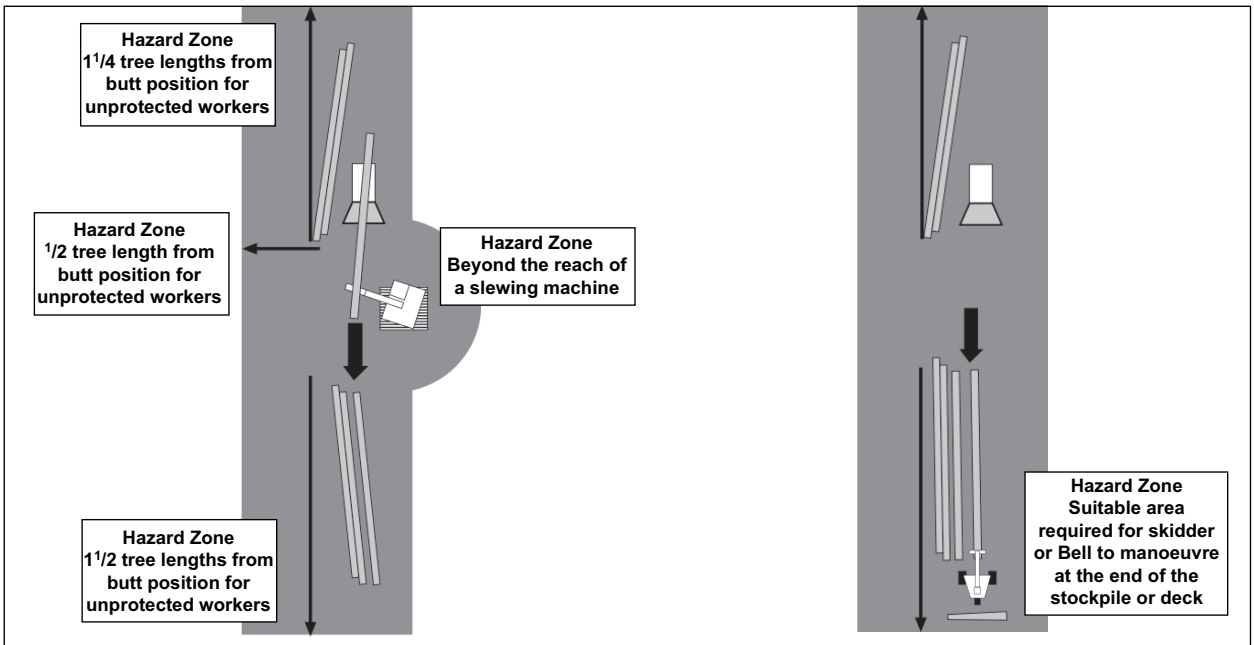
Delimbing with a static delimber

Hazard zones

The hazards associated with the use of a static delimber include:

- Stem movement on either side of the delimber. This happens particularly when aligning the stem with the delimber, and when the delimbed stems are stockpiled or laid out for further processing
- Flying debris
- Restricted visibility for the machine operator (excavator - back left and to the right; Bell loader - behind).
- Unexpected movement of the delimber as a stem is being pulled through it
- Movement of the pull-through machine as it pulls the stem through either by slewing or reversing the machine or a combination of both
- Instability of the pull-through machine as the delimbing motion is completed

The hazard zone around the delimbed stems needs to account for stems sliding further than expected, or other stems being pushed out of the stockpile. The hazard zone beyond the end of the delimbed stockpile also needs to account for the maximum stem length, and area for machine manoeuvring.



Example of hazard zones for a static delimbing operation using an excavator (left), or a skidder or Bell loader (right) as the pull-through machines

Delimbing location

A static delimber may be used in the cutover (where stems have been previously bunched), at the road or landing edge, or on the landing.

An excavator loader (usually a 20-tonne machine or larger) or Bell is required when delimbing in the cutover to transport the delimber (carry or push/pull) from bunch to bunch. When delimbing on a landing, either pull-through machine can be used.

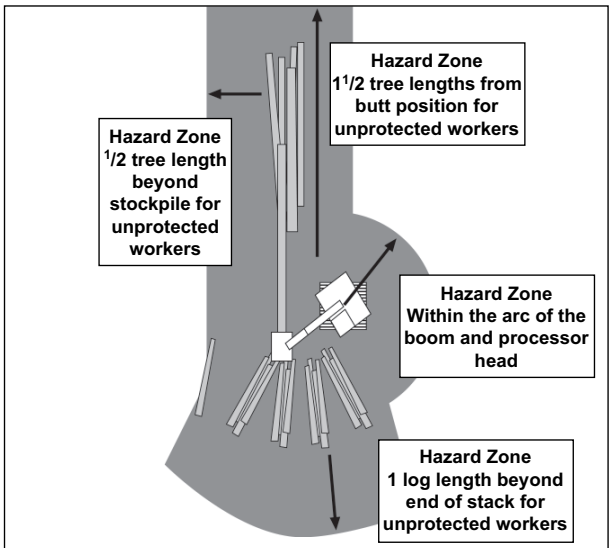
Delimbing on the landing does increase the necessity to deal with accumulations of slash.

Work area requirements

A dedicated delimbing area should be planned to ensure that it has the following features:

- A defined hazard zone that is clear of any other workers or machines
- Room to manoeuvre both the machine and stems
- Room to stockpile stems for delimbing. Alternatively, in a "hot" operation, room will be needed for the extraction machine to drop and push the stems
- An area to dispose of accumulated slash (in accordance with resource management policies)
- A uniform working area, to minimise unexpected machine and stem movement. The delimber may be used effectively on a slope providing it is located parallel with the slope and stems are pulled directly downhill through it
- Sufficient room to align (or swing) the stems prior to delimbing, and room to stockpile delimbed stems
- Coverage by appropriate warning signs.

Log-making with a mechanised processor. Stems are fed right to left to give the operator a better view of log characteristics.



Example of hazard zones for a mechanised processing operation (harvester-processor)

Log-making with a mechanised processor

Hazard zones

The hazards associated with mechanised processing include:

- Stem movement
- Log movement after cutting and when putting into stockpiles
- Flying debris
- Movement of the machine and components
- Restricted visibility for the machine operator
- Thrown or broken chainsaw chain.

If felling, delimbing, and processing are being done at the same time (e.g., CTL), the hazard zone around the harvesting machine will reflect that discussed previously for felling.

The processing machine may delimb the stems prior to log-making, or the stems may have already been delimbed. For mechanised harvester machines, the stems are usually fed from right to left through the head. This means that the operator can see the measuring wheel before cross-cutting and can view the chainsaw bar as the cut is completed. On occasions, the stem may be slewed down the left side of the machine when cutting lower-value pulp log(s) off the top of the stem.

Processor placement

The placement of the processor will depend on the type of processor. Machines fitted with dangle head

processors are usually positioned so that the stems pass from right (stem stack) to left (log stack). This provides a good view of the log protruding from the head prior to cutting.

Work area requirements

A mechanised processing area should be planned to ensure that it has the following features:

- A defined hazard zone that is clear of any other workers or machines
- Room to manoeuvre both the machine and stems
- Sufficient room to align (or swing) the stems prior to processing, and feed through the delimbing knives if delimbing and processing
- An area to dispose of or store slovens, stem waste, and tops (in accordance with resource management policies)
- Coverage by appropriate warning signs.
- A flat and stable working area, to minimise unexpected machine and stem movement
- Room to stockpile stems for delimbing. In a "hot" operation, room will be needed for the extraction machine to drop (and push) the stems.
- Sufficient room to stockpile processed logs
- Access to the processed logs for a fleeting/sorting machine. Logs may be fleeted to sets of bearers where the marking and quality control are completed

Work area safety

Warning signs

Rules

- *Signs warning of work in progress shall be displayed when work is on or near public or private roads or adjacent to boundaries.*
- *Planning of appropriate warning methods shall be prepared as part of hazard management.*
- *Permanent signs shall comply with the Manual of Traffic Signs and Marking, published by Transit New Zealand/LTSA.*
- *Temporary traffic control signs shall comply with the Code of Practice for Temporary Traffic Management, Transit, September 1st, 2000.*
- *Where there is a road control authority, formal authorisation shall be obtained and compliance made with any conditions set by the authority before any signs warning of operations are placed and work commences.*

Note that Transit jurisdiction covers all private forest roads that can be physically accessed by the public. If not, the forest owner is considered the road control authority, and their policies apply.

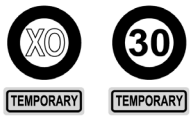
Acceptable signs

According to the Transit code, the following signs may be used:

- Advance warning signs

- Direction and protection signs


Keep Left



Speed Limit

- End of works/operation signs


Derestriction

Placement of signs

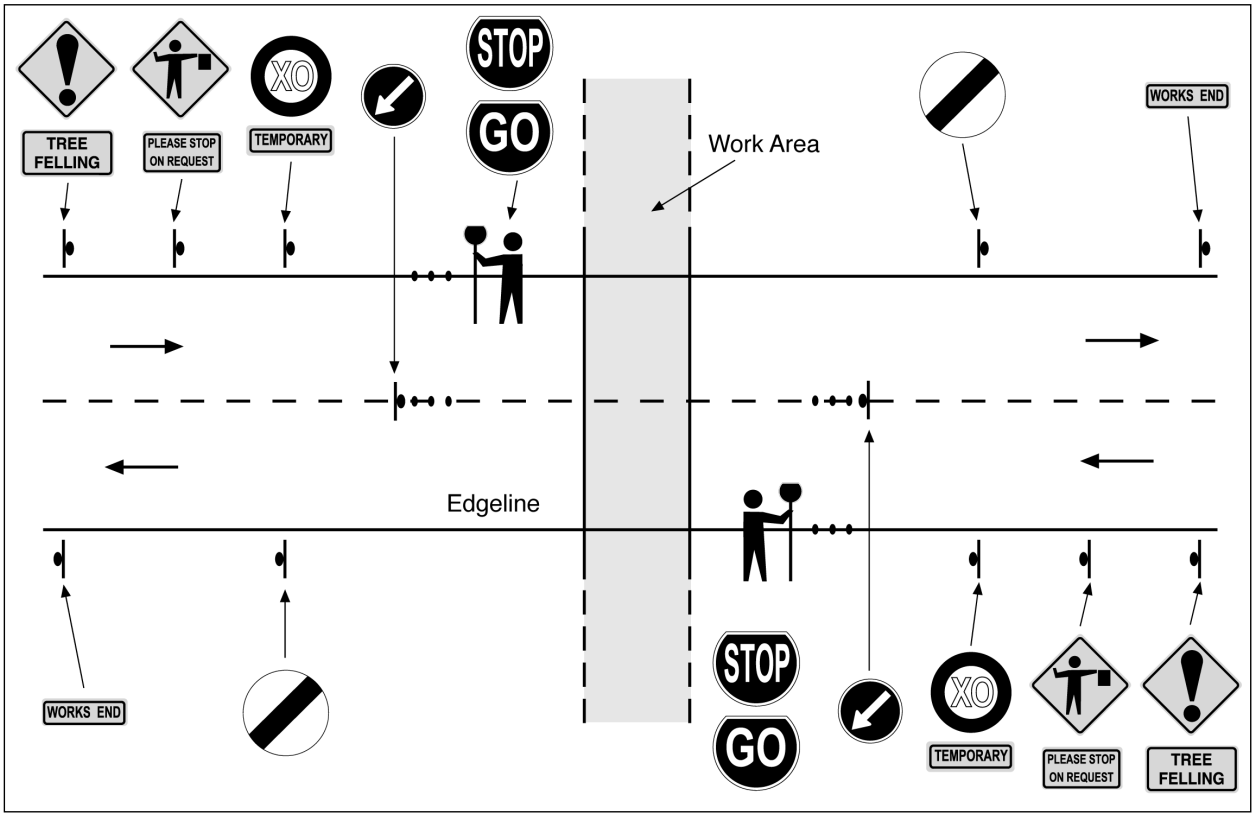
Tree felling operations within two tree lengths of a road are required to have warning signs.

Transit requirements for sign placement relate to average annual vehicle usage. The following guidelines relate to traffic control on Level 1 roads; these are roads that carry less than 10 000 vehicles per day.

Traffic speed	Distance from advance sign to hazard
50 km/hr	75 m
70 km/hr	105 m
100 km/hr	150 m

from Transit code, Sept. 2000

- The distances between the advance warning sign and the edge of the operational area vary with traffic speed (*see left*).
- The diagram below gives an example of the required signs and placement. Road closure is less than 5 minutes at any one time. For full details refer to the Transit Code.



Communication

Hand signals

Hand signals may be used to direct the movement of a machine or catch the attention of a machine operator.

Any person can give the stop signal in an emergency.

Predict machine movement and allow time for the operator to react.

Entering an operational area

Crew members need to understand and adhere to designated work and hazard zones. This is particularly important when approaching a working machine.

It is important to stay outside the hazard zone while the chainsaw operator or machine is working. If approaching a chainsaw operator or machine, first get their attention and indicate that you want to approach. If possible, alert the machine operator of your intentions by first making a radio call to him or her.

Remember to stay back until the operator has ceased the task they are doing. Machine operators should lower any raised implements and lock the hydraulic activation control lever (if present) to ensure that the machine is safe for them to get out of the cab, or for someone to approach.

Stay beyond the hazard zone until instructed by the operator to approach.

When approaching a machine, it is safer to attract the operator's attention and approach from the cab-side of the machine.

All visitors to an operation should have received prior permission from the contractor or foreman and be wearing the appropriate personal protective equipment.

Training and supervision

Mechanised harvesting and processing operators need to be skilled or under training in the particular tasks they are doing.

In addition, the Approved Code of Practice for Safety and Health in Forest Operations requires that a competent person supervise workers who are new to the operation or task. Regardless of their training status, new workers should not be allowed to work unsupervised until they have demonstrated that they are unlikely to harm themselves or others.

All inexperienced workers should be under a documented training programme. They should be aiming to pass the relevant NZQA Unit Standards that apply to the mechanised harvesting and processing tasks being undertaken.

Harvester simulator training

Computer-based simulators (e.g., Simlog, Timberjack T10) provide both employers and trainees with the opportunity to reduce the learning-curve associated with training. They also allow the task sequences to be learnt and performance measured in an environment that is both safe and devoid of mechanical damage.

Knowledge of hazards

As part of the supervision and training programme, operators need to be shown the hazards they will face on the job and the control measures to manage those hazards. These hazards include those that directly affect the machine operator and those that affect other people at the work site.

Before starting any new block or operation, all crew members must be involved in identifying significant hazards at the work site and appropriate control measures. There must be documented evidence on the site listing the hazards and controls, and showing that all have been explained to the crew members.

The two main hazard categories are Operator Health Hazards and Operational Hazards. All operators should be familiar with both categories of hazards.

Operator health hazards

Machine operators working in forestry operations need to be physically and mentally capable of doing their tasks without endangering themselves or others around them.

To maintain performance levels and prevent accidents, ensure that you:

- Take adequate rest breaks
- Keep physically fit
- Do not let drugs or alcohol impair your judgement.
- Maintain an adequate level of hydration and diet
- Get adequate sleep

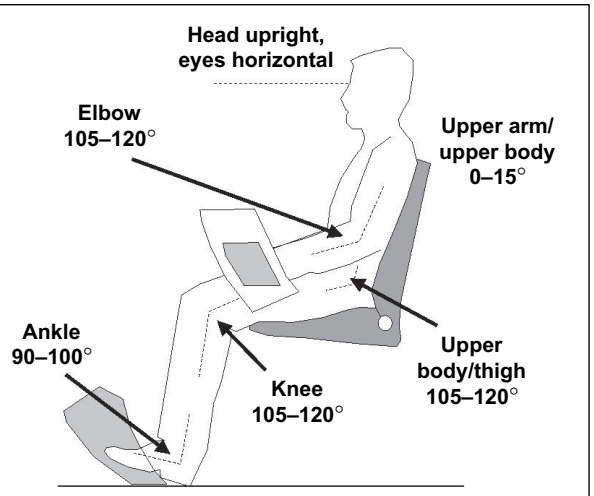
The machine cab environment provides protection for the operator from many task-related hazards and the effects of weather extremes. Despite these benefits, there are hazards commonly faced by operators that will impact on their long-term performance and health.

Occupational overuse syndrome (OOS)

OOS refers to a range of disorders characterised by pain and/or other sensations in muscles, tendons, nerves, soft tissues, and joints. When working, your muscles may become fatigued. Often this fatigue is

associated with pain, stiffness, and weakness felt at the end of the day. With complete recovery, these discomforts tend to disappear over night. However, when recovery is not complete fatigue levels can accumulate, requiring an even greater recovery period. Over time fatigue levels can result in the development of an overuse injury.

In machine operators, the most common OOS injuries occur to the wrists, hands, shoulder, neck, and back. Machine manufacturers, aware of the OOS risks, have designed the cab layout and fittings to help minimise the risk of injury. They have used ergonomically-designed joystick controls and seats to improve operator positioning and physical tasks. However, if the cab is not correctly set-up and adjusted to suit the operator, OOS can still be a significant hazard.



General guidelines for seated body positioning

The most important consideration for the operator is to sit in a relaxed and comfortable position. Although sitting still, a range of muscles are used to counter the movement of the controls and machine. Often these are not the same muscles that are used when performing dynamic tasks. To achieve the desired seating comfort requires the correct positioning of the controls and the seat (for the individual) and correct body posture. Even a good posture is harmful if held for too long. Rest muscles frequently with micro-pauses and move joints and muscles regularly.

Dehydration

Dehydration is caused by either not drinking enough or by drinking the wrong types of fluids. The daily effects of not drinking enough include premature fatigue and difficulty in concentrating. In the longer-term, dehydration can cause kidney disorders and toxin build-up.

Machine operators need to drink during the day. The need to concentrate on the machine operation may mean that operators forget to drink. The inconvenience of getting out of the cab to urinate may also contribute to inadequate water intake. As a guide, drink enough so that your urine is clear.

Health hazards

Hazard	Control
Occupational Overuse Syndrome (OOS)	• Use the correct techniques when operating machine or other equipment. • If operating a machine, adjust the seat (and controls) to suit you. • Ensure all equipment is well maintained and working effectively. • Use pre-work warm up and stretching techniques throughout the day. • Use micro-pauses (short-breaks) every 5 minutes throughout the day. • Perform other tasks (off the machine) that will exercise different muscle groups. • Have regular medical examinations if you suspect a problem.
Fatigue (mental and physical)	• Build short frequent rest breaks into your day. • Take at least two evenly spaced 30-minute rest breaks during the working day.
Dehydration/heat exhaustion	• Regularly drink fluids so that you do not feel thirsty and you urinate throughout the day. • Do not drink fluids, such as soft drinks and cordials, which have more than 8% carbohydrate content. • Drink high carbohydrate drinks after work to replace energy levels. • Drink plenty of water at night to recharge the body. • Ensure that the air conditioning unit works effectively if fitted.
Lack of sleep, tiredness	• Ensure that you have at least 5 hours' continuous sleep every day. • Use power-naps (short sleeps of 20–30 minutes duration).
Early starts	• Learn to go to bed earlier to replace the sleep you lose in the morning. • Your body needs time to adjust to changes in sleep patterns. When first beginning early starts in spring/summer or after the Christmas holidays, recognise that you may remain tired until your body adjusts. • Also, allow time for your body to adjust once you go back to late starts.
Poor hygiene/infection	• Clean and dress any cuts or scratches received on the job as soon as possible, and keep them covered. • Make sure the first-aid kit is kept fully stocked. • Carry water and soap on the job to wash your hands before smokos. • Bath or shower every night. • Eat a balanced diet to keep your body healthy. • Wear clean clothes against the skin every day.

Health hazards (cont...)

Hazard	Control
Alcohol abuse	• Avoid drinking alcohol at least 24 hours before carrying out any hard physical work.
Vibration from machine	• Avoid sudden impacts or jarring while operating a machine. • Reduce the time your back is exposed to vibration by getting off the machine at least once every hour. • Make sure the seat is adjusted properly. • Ensure that the seat dampening springs are maintained - do not continue to work with a broken seat. • Do exercises while seated to even-out pressure on your spinal discs. • Control breathing and relax muscles. • Keep a good posture. • Keep fit - strengthen abdominal muscles.
Poor nutrition	• Start each day with a high carbohydrate breakfast, such as porridge, cereal, toast, bananas, pasta, or potatoes. • Eat high protein foods like lean meat, chicken, eggs, milk, and cheese at night. • Eat at the start of a break and then rest to allow digestion. • Always eat a high carbohydrate snack straight after work.
Drugs	• Avoid all non-prescription drugs as they seriously affect both your mental and physical ability to work. • Inform the boss if you are on any medication that may affect your work. Stay home if necessary. • If you are on long-term medication for a serious health complaint inform the boss or crew of your condition in case you are involved in an emergency at work.
Noise	• Use hearing protection if noise level is above 85dB. • Reduce noise exposure while in a machine by keeping doors and windows shut while working.
Hypothermia/chills	• Ensure that the cab heating system is operable in cold weather. • Have wet weather clothing handy for when working outside the cab.

Operational hazards

Operational hazards will be specific to the type of operation being undertaken. The operational hazards listed here have been divided into:

- Mechanised felling hazards
- Harvester delimbing hazards
- Static delimbing hazards
- Mechanised processing hazards.

Operational hazards

Mechanical felling hazard	Control
Unexpected tree movement	• Assess each tree for lean, crown weight, and likely direction of fall. • Use the appropriate felling cuts to safely fell each tree. • Ensure the machine is fitted with appropriate protective structures. • Keep the cab door closed (this is a requirement of the OPS protection). • Put the machine in a stable position, preferably opposite the intended direction of fall. • Fell trees uphill of the machine. Ensure the swath width is matched to the slope being worked. • Leave trees that are beyond the capability of the machine/ operator for motor-manual felling.
Proximity to other workers	• Ensure that there are no exposed workers within two tree-lengths of the felling machine. If so, stop felling until the person is in a safe position. • Ensure that there are no other machines within one tree-length of the felling machine. If so, stop felling until the machine is in a safe position.
Unplanned machine or component movement	• Ensure that there are no other machines (with FOPS and OPS) within one tree-length of the felling machine. If so, stop felling until the machine is in a safe position. • Put the machine in a stable position, preferably opposite the intended direction of fall. • Do not travel up or down slopes beyond the capabilities of the machine. • Control slew speed to suit load size.
Other machines	• Ensure that there are no other machines (with FOPS and OPS) within one tree-length of the felling machine. If there are, stop felling until the machine is in a safe position. • All other machines must be beyond two tree-lengths. • Plan the felling task to avoid having machines working too close to each other. • Machine operators should communicate with each other to avoid unsafe practices.
Machine instability	• Do not operate the machine beyond its slope capability. Note that this will vary with ground conditions (e.g., soil type, and when it's wet). • Keep the weight of the machine and boom over the front of the machine when working on slopes. Reduce the felling swath width appropriately. • Do not attempt to fell trees beyond the capability of the machine/operator. • Select a travel path that avoids side slopes, stumps, and soft ground.

Operational hazards (cont...)

Mechanical felling hazard	Control
Machine instability (cont...)	• Ensure that you wear your seat belt while operating the machine. • Exercise caution when slewing downhill with a load.
Broken saw chain	• The chain may break or fly off the bar - ensure there are no unprotected workers within 70 m of the machine when it is working. • Always operate the machine with the door and (front and side) windows shut.
Terrain (particularly the risk of rollover)	• Identify areas where the terrain may be hazardous before starting the operation. • Do not operate the machine on slopes beyond the machine capability. If necessary, leave trees for motor-manual felling. • Select a travel path that avoids side slopes, stumps, and soft ground. • Aim to fell while going up the slope, not across it. • When travelling back down a steep slope, reverse down, with the boom low and slewed slightly to the cab side to improve the rear view. • Wear your seatbelt at all times when operating the machine.
Overhead hazards (power lines, trees, sailors, broken heads)	• Check the harvest plan and/or job prescription for known hazards. • Operations around power lines must comply with the OSH Approved Code of Practice for Safety and Health in (Part 2) Maintenance of Trees Around Power Lines. • Check for overhead hazards before getting out of the protected cab. • Wear your helmet, boots and hi-vis when outside the machine cab. • Check for ropes and guylines in cable logging operations.
Exiting the machine cab	• Check for overhead hazards and other machines/operations before exiting. • Climb off the machine - do not jump. • Ensure that the correct PPE is worn when outside the protected cab. • Face the machine and always maintain 3 points of contact when descending steps.
Ineffective safety equipment and structures	• Protective structures must be built to specific standards and be maintained in good condition. Refer to the Approved Code of Practice for Safety and Health in Forest Operations and the Approved Code of Practice for Operator Protective Structures. • Machines with defective protective equipment or structures should not be operated until the problem has been fixed. • Damaged structures must be assessed by the original designer or other suitably qualified registered engineer.

Operational hazards (cont...)

Mechanical felling hazard	Control
Hydraulic equipment	• Never work under raised hydraulic equipment. Ensure equipment is lowered to the ground or chocked and stable before entering danger zones. • Work on live or pressurised systems only when you are wearing full protective equipment (gloves, protective clothing, approved eye protection). • Turn the machine off and reduce hydraulic pressures to zero when working on the hydraulic system.
Maintenance of the felling head	• Lower all equipment to the ground so the machine is resting on level blocking. • Do not move, modify or remove any safety devices fitted to the head. • Ensure that the head is secured from tilting using the locking pin. • Use proper lifting procedures when removing any heavy components. • If necessary, wrap all sharp items in a protective blanket or similar. • Immobilise the machine by activating the hydraulic lock-out device. • Isolate the head by turning the computer off.

Operational hazards (cont...)

Harvester delimbing hazard	Control
Log movement and travel distances	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the delimbing machine. In particular, consider any workers or machines down slope of where the delimbed stems are stockpiled (delimbed stems can slide easily over each other). • If there are workers or machines in the hazard zone, stop delimbing immediately until they leave. • Ensure other workers and operators at the site are aware of the hazard zone around the delimbing machine.
Flying debris	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the delimbing machine. In particular, consider any workers or machines down slope of the delimbing operation. If there are any, stop delimbing immediately until they are out of the hazard zone. • Ensure the cab door and (side and front) windows are closed when delimbing.
Proximity to other workers or machines	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the delimbing machine. In particular, consider any workers or machines down slope of the delimbing operation. If there are any, stop delimbing immediately until they are out of the hazard zone. • Plan the delimbing task to avoid having machines working too close to each other. • Machine operators should communicate with each other to avoid unsafe practices. • All workers must wear clearly visible hi-vis protective equipment.
Machine and component movement	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the delimbing machine. • Position the machine in a stable position, preferably in front or to the side of the butts. • Do not travel up or down slopes beyond the capabilities of the machine.
Machine instability	• Do not operate the machine beyond its slope capability. Note that this will vary with ground conditions (e.g., soil type, and when it's wet). • Keep the weight of the machine and boom over the front of the machine when working on slopes. Reduce the arc that the machine slews through as appropriate. Be aware of the changing centre of gravity as the stem passes through the head. • Do not delimb trees beyond the capability of the machine/ operator. • Select a travel path that avoids side slopes, stumps, and soft ground. • Ensure that you wear your seat belt while operating the machine.

Operational hazards (cont...)

Harvester delimbing hazard	Control
Ineffective safety equipment and structures	• Protective structures must be built to specific standards and be maintained in good condition. Refer to the Approved Code of Practice for Safety and Health in Forest Operations, and the Approved Code of Practice for Operator Protective Structures. • Machines with defective protective equipment or structures should not be operated until the problem has been fixed. • Damaged structures must be assessed by the original designer or other suitably qualified registered engineer.
Terrain (particularly the risk of rollover)	• Identify areas where the terrain may be hazardous before starting the operation. • Do not operate the machine on slopes beyond its capability. • Select a travel path that avoids side slopes, stumps, and soft ground. • Position the machine in a stable and level position when slewing and handling stems. • Move stems down slope (where possible) when delimbing them through the head - avoid trying to turn the stems while on a slope. Be aware of the changing centre of gravity as the stem passes through the head. • When travelling back down a steep slope, reverse down with the boom low and slewed slightly to the cab side to improve the rear view. • Wear your seatbelt at all times when operating the machine.
Hydraulic equipment	• Never work under raised hydraulic equipment. Ensure equipment is lowered or chocked and stable before entering danger zones • Work on live or pressurised systems only when you are wearing full protective equipment (gloves, protective clothing, approved eye protection). • Turn the machine off and reduce hydraulic pressures to zero when working on the hydraulic system.
Exiting the machine cab	• Check for overhead hazards and other machines/operations before exiting. • Climb off the machine - do not jump. • Ensure that the correct PPE is worn when outside the protected cab.
Maintenance of the delimbing knives	• Follow the manufacturers' instructions when sharpening the delimber knives. • Never work in the pinch area or saw area of the head while the hydraulic system is live - turn off the computer and isolate the carrier, preferably turn the engine off. • Install the locking pin in the hanging bracket to stop the head from tipping forward. • Wear protective gloves and protective eyewear (if using a powered grinding device). • Ensure you have a stable stance when working on the knives. • Cover other sharp components (e.g., rollers, other knives) with a blanket or similar to protect yourself from cuts or abrasions.

Operational hazards (cont . . .)

Static delimbing hazard	Control
Unsafe zone	• Designate the hazard zone around the delimbing operation. • Ensure that other workers on the site are aware of the hazard zone around the delimber. • Stop the operation if anyone enters the hazard zone (this includes other machines). • Ensure all workers nearby on the site are wearing effective hi-vis garments.
Unexpected tree movement	• Ensure that the hazard zone is clear of other people before commencing the operation. • Orientate the stockpiles with the direction of movement through the delimber.
Moving machine	• Clearly define the hazard zone, taking into account the travel required by the pull-through machine. • Ensure that other workers or machines are not in the hazard zone. If they are, cease operation until they have left the hazard zone. • When pulling a tree length through the delimber, check the exit area is clear of people and machines. • Do not pull tree lengths through the delimber if the exit area is not clear of people and machines. • Avoid hitting the delimber knives with the grapple.
Flying debris	• Ensure that other workers or machines are not in the hazard zone. If there are, cease operation until they have left the hazard zone. • When pulling a tree length through the delimber, check the exit area is clear of people and machines.
Overloading	• Pull the tree lengths through the delimber with a continuous action. • Place tree lengths that are too large or with excessive malform and/or large branches to one side for manual trimming.
Machine instability	• Ensure that the delimber is securely anchored before commencing. Re-anchor it if it becomes unstable during operation. • Ensure the stockpiles on either side of the delimber are aligned with the delimber. • Do not delimb on side slopes. • Pull the tree length straight through the delimber. • Place tree lengths that are too large or with excessive malform and/or large branches to one side for manual trimming. • Watch for large whorls of branches catching in the knives of the delimber. • Keep grapple position low to ensure a smooth passage through the delimber.

Operational hazards (cont . . .)

Static delimbing hazard	Control
Terrain	• Ensure that the delimber is anchored horizontally and that the entry and exit areas are aligned with the delimber. • Do not use the delimber on steep or broken terrain (which causes problems with machine stability and tree length movement).
Ineffective safety equipment and structures on the pulling machine	• Protective structures must be built to specific standards and be maintained in good condition. Refer to the Approved Code of Practice for Safety and Health in Forest Operations, and the Approved Code of Practice for Operator Protective Structures. • Machines with defective protective equipment or structures should not be operated until the problem has been fixed. • Damaged structures must be assessed by the original designer or other suitably qualified registered engineer.
Hydraulic equipment	• Do not work on live or pressurised systems without full protective equipment
Exiting the machine cab	• Check for overhead hazards and other machines/operations before exiting. • Climb off the machine - do not jump. • Ensure that the correct PPE is worn when outside the protected cab.
Maintenance of the delimbing knives	• Follow the manufacturers' instructions when sharpening the delimber knives. • Avoid cuts when sharpening the delimber knives by using well-maintained sharpening equipment and wearing protective gloves. • Keep clear of the knives/arms when adjusting the pressures on the delimber arms. • Never work in the pinch while the hydraulic system is live. • Wear protective eyewear if using a powered grinding device. • Ensure you have a stable stance when working on the knives. Never stand on the delimber. Always stand on the ground or a stable platform to complete maintenance or repairs. • Cover other sharp components (e.g., rollers, other knives) with a blanket or similar to protect yourself from cuts or abrasions.

Operational hazards (cont . . .)

Mechanised processing hazard	Control
Log movement and travel distances	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the processing machine. In particular, consider any workers or machines down slope or beyond where the logs or stems are stockpiled. • If there are workers or machines in the hazard zone, stop delimbing immediately until they leave. • Ensure other workers and operators at the site are aware of the hazard zone around the processing machine.
Machine and component movement	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the delimbing machine. • Place the machine in a stable position, preferably in front or to the side of the butts. • Do not travel on slopes beyond the capabilities of the machine.
Proximity to other workers or machines	• Ensure that there are no workers or machines (without OPS) within the hazard zone around the processing machine. If there are, stop processing immediately until they are out of the hazard zone. • Plan the processing operation to avoid having workers or machines working too close. • Machine operators and workers should communicate with each other to avoid unsafe practices. • All workers must wear clearly visible hi-vis protective equipment. • Ensure windows are clean and clear for viewing.
Machine instability	• Do not operate the machine beyond its slope capability. Note that this will vary with ground conditions (e.g., soil type, and when it's wet). • Do not delimb trees beyond the capability of the machine/ operator. • Select a processing area that is as flat and as stable as possible. • Ensure that you wear your seat belt while operating the machine.
Terrain	• Identify areas where the terrain may be hazardous before starting the operation. • Do not operate the machine on slopes beyond the machine capability. • Select a travel path that avoids side slopes, stumps and soft ground. • Place the machine in a stable and flat (as possible) position when slewing and handling stems. • Move stems down slope (where possible) when processing them through the head - avoid trying to turn the stems while on a slope. • Wear your seatbelt when operating the machine.

Operational hazards (cont . . .)

Mechanised processing hazard	Control
Ineffective safety equipment and structures	• Protective structures must be built to specific standards and be maintained in good condition. Refer to the Approved Code of Practice for Safety and Health in Forest Operations. • Machines with defective protective equipment or structures should not be operated until the problem has been fixed. • Damaged structures must be assessed by the original designer or other suitably qualified registered engineer.
Hydraulic equipment	• Never work under raised hydraulic equipment. Ensure equipment is lowered or chocked and stable before entering danger zones. • Work on live or pressurised systems only when you are wearing full protective equipment (gloves, protective clothing, approved eye protection). • Turn the machine off and reduce hydraulic pressures to zero when working on the hydraulic system. • Ensure the locking pin is in before working on a dangle-type head
Exiting the machine cab	• Check for overhead hazards and other machines/operations before exiting. • Climb off the machine — do not jump. • Ensure that the correct PPE is worn when outside the protected cab.
Maintaining the log-making equipment	• Lower all equipment to the ground. • Do not move, modify, or remove any safety devices fitted to the head. • Ensure that the head is secured from tilting. • Use proper lifting procedures when removing any heavy components. • If necessary, wrap all sharp items in a protective blanket or similar. • Never stand on the head. Always stand on the ground or a stable platform to complete maintenance or repairs.

Personal protective equipment (PPE)

The Approved Code of Practice for Safety and Health in Forest Operations requires that people working in or visiting harvesting operations wear the following personal protective equipment:

- Hi-vis helmet (when working outside a protected cab)
- Hi-vis shirt, vest, or jacket
- Hearing protection
- Safety footwear.

Other useful equipment:

- Gloves (leather or thick cotton)
- Small first-aid kit.
- Protective eyewear, unless it creates a greater hazard

Further information on PPE standards and care is provided in the **Best Practice Guidelines for Personal Protective Equipment**.

Mechanised felling procedures

Step 1 – Assessing the stand

Before starting to fell it is important to walk and assess the block for stand and ground characteristics. Often a contractor or foreman will complete a general assessment as part of the operational planning and hazard identification. Any issues specific to the felling operation should be pointed out to the machine operator, who may then choose to walk a particular part of the block.

In assessing the stand, the following issues should be considered:

- Tree quality and lean
- Road and landing locations
- Preferred extraction directions (very important in production thinning operations)
- Ground conditions, including wetness, rocks, and holes
- Terrain conditions, including steep slopes, waterways, and depressions or ridges that do not appear on any maps
- Any protected areas within the stand (e.g., riparian zones, historic sites)
- Access for the felling machine
- The location of stand boundaries (felling into adjacent trees may create hazards for other operations)
- Any hazards to machine operator and/or workers
- Areas that need to be left for motor-manual felling because of slope, tree size or form, or restricted access
- Weather patterns, particularly wind and fog patterns.

As a result of the stand assessment, the operational plan should be formulated. It should address where the block will be opened up and how the felling and extraction operations will progress through the block to ensure safety and consistency of woodflow.

Step 2 – Assessing the tree

Before starting to cut each tree, it should be assessed to determine:

- If there are any ground or overhead hazards
- Its natural direction of fall (based on wind direction, its lean, and crown weight distribution)
- How easy it will be to direct it where you want it to fall
- Any malformation or sweep that may influence the felling process
- The best machine position
- What cuts to use to fell the tree (single, double, or triple cuts).

Note that operators generally have only a restricted view of the top of the next tree to be felled. This can make the identification difficult when opening up a felling face. Where possible, the operator can look for overhead hazards when walking the machine back to the start of the next strip.

Before completing the assessment, you may need to clear around the base of the tree to see if there is any butt sweep or damage that may affect the felling.

Dealing with trees beyond the machine's capability

Trees that are too big for the machine to handle and/or trees located on slopes that are beyond the safe working limit for the machine should be left for motor-manual felling.

Step 3 – Clearing the base of the tree

Before felling the tree, clear any slash, understorey, or lower branches from around the base of the tree.

This will allow you to:

- Identify butt malformation and hazards that may obstruct or damage the cutting unit
- Position the head as low as possible, thereby reducing stump height
- Judge the placement of the cuts to ensure they are correct and complete.

Clear understorey and slash by either crushing it with the felling head or using the grapple/delimbing arms to grab material and throw it clear of the base of the tree.

Clearing slash and understorey from the base of the tree

Step 4 – Positioning the machine and felling head

Preparing for basic felling cuts

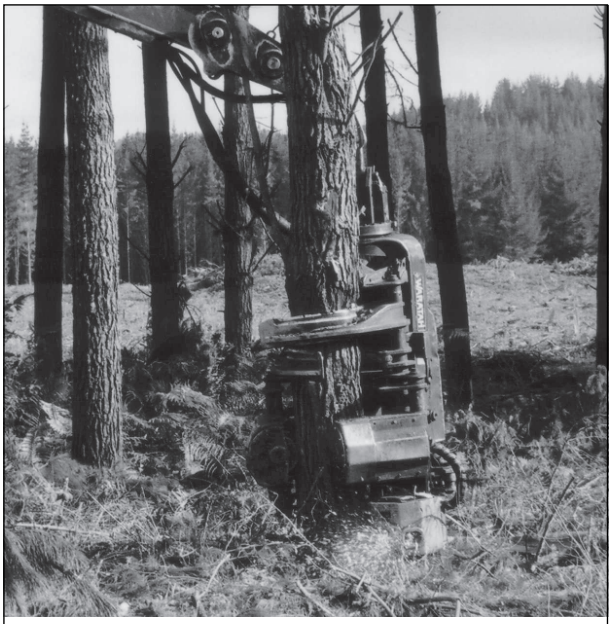
Feller-director

If using a machine fitted with a feller-director head, position the machine:

- Behind or to the side of the intended direction of fall
- In a stable position, with the tracks or wheels firmly supported
- So that the main boom and stick are not extended or crowded beyond the safe felling distances. Over-extending reduces the lifting force that can be applied to the tree when it is falling. Over-crowding can mean that the main boom is at full lift, thereby reducing the potential control of the tree.

Then:

- Position the felling head on the tree. If there are lower branches present, remove them by loosely sliding the head down the tree
- Rotate the felling head into position to complete either the front cut or back cut, as appropriate
- Lower the head as far as possible to reduce stump height



Felling head positioned to complete a front cut

- Ensure that the grapple, delimber, and/or drive arms are fully closed about the tree.

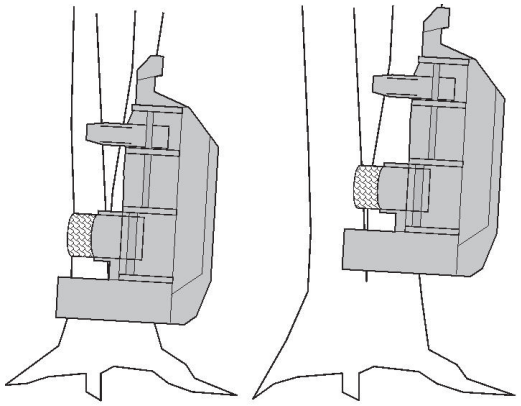
Feller-buncher

If the machine is fitted with a feller-buncher head, position the machine:

- According to the cut being made. If completing a front cut, position the machine in line with the intended direction of fall. If completing a back cut, position the machine directly behind the intended direction of fall.
- In a stable position, with the tracks or wheels firmly supported
- So that the main boom and stick are not extended or crowded beyond the safe felling distances. Over-extending reduces the lifting force that can be applied to the tree when it is falling. Over-crowding can mean that the boom is at full lift, thereby reducing the potential control of the tree.

Then:

- Position the felling head against the tree. If there are lower branches present, break them off using the head.
- Place the head against the tree behind the cutting direction. Lower the head as far as possible to reduce stump height.
- Cut the tree using the approved technique as recommended by the manufacturer.



Fell multiple leaders as one tree (left) or separately (right)

Dealing with difficult trees

Double or multiple leaders

Where a tree has two or more leaders, it is possible to either:

- Fell both leaders as if they were a single tree. This may require a single or double cut.
- Reach up the tree and fell the leaders separately.

Note that felling double leaders as one stem can result in bar damage if the head cannot grip both stems completely (firmly).

Trees with overhead hazards

Where a tree has an overhead hazard (e.g., hung-up tree or sailor lodged in upper branches), it is possible to:

- Fell an adjacent tree into the tree with the hazard, thereby bringing down the hazard.
- Carefully fell the tree with the overhead hazard, being aware of the potential direction of fall of the hazard.
- Reach up the tree with the felling head and dislodge the hazard.

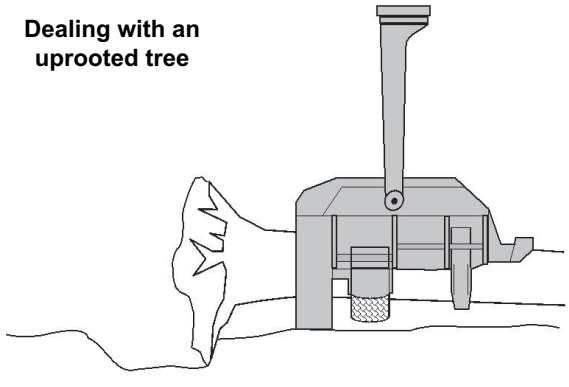
Ensure that any overhead hazards created during felling are brought down. In particular, the leaving of sailors or broken tops as overhead hazards in adjoining stands or where motor-manual felling will be used in the future.

Trees with inter-locked branches

Where a tree has interlocked branches with a neighbouring tree, it may be felled by:

- Moving the butt around. If moving the butt away from the interlocked tree, be aware that the top may break out and fall towards your machine.
- Pushing the hung-up tree with the outer boom of the machine.
- Releasing the tree and letting it roll out of the other tree.
- Tilting the felling head forward using the harvester down function.

Dealing with an uprooted tree



Uprooted trees

Trees that have been toppled in the wind or uprooted instead of being felled need to be cut from the root plate. Ensure that the tree is fully upturned and supported on the ground to reduce the tension on the top of the stem before making the cut.

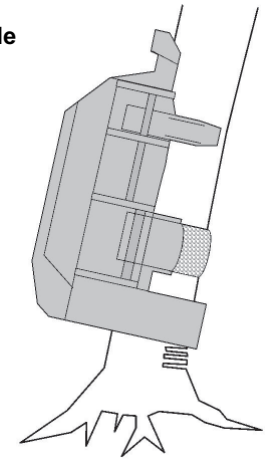
Heavy leaning trees

There are a range of options for felling heavy forward-leaning trees, according to their size and degree of lean.

The options are:

- Push the tree over using the outer boom and then cut the stem from the root plate (as above).
- Pull the tree out of the ground and allow it to fall before cutting the stem off the root plate (as above).
- Fell the tree with its lean. Place multiple front cuts in the tree to create a larger area of compression as the tree falls forward.

The use of multiple front cuts on a forward-leaning tree



Butt-swept trees

Trees with excessive butt sweep can be safely felled by either:

- Pushing the tree over and treating it as an uprooted tree (*see above*).
- Completing the felling cuts higher up the stem to avoid the sweep zone.
- Approaching the tree from a different angle so that the grapple arms can close around the tree.

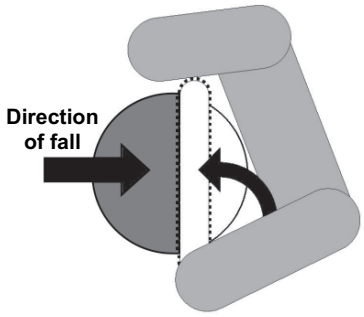
Step 5 – Completing the felling cuts

Before completing the cuts, ensure that the hazard zone around the machine is clear of other workers or machines.

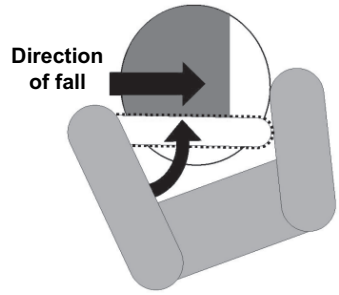
Feller-director

With the felling head positioned against the tree, the felling cut can be started. Aim to fell the tree into standing trees, open ground, or away from boundaries or sensitive areas as appropriate.

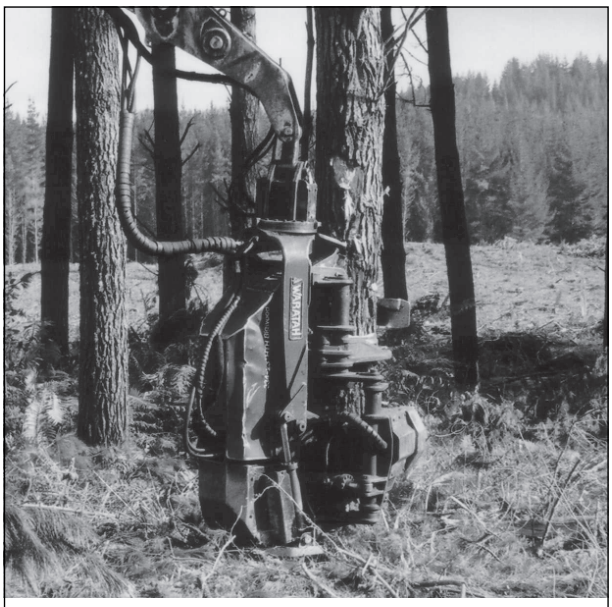
1. For felling with a single (release) cut, position the head behind the intended direction of fall so that the cut is completed at right angles to the direction of fall. (Then proceed to point 5 on next page).
2. If inserting a front cut (for double or triple cut), position the head so that a cut can be made to the front of the tree, as low as practicable. Activate the saw to cut to the required depth. Stop the front cut when the cutting unit is at 90° to the intended direction of fall.
3. If completing a triple cut, position the head so that a cut is made into the side of the tree. Ensure that this cut is slightly higher than the front cut. This cut only needs to be deep enough to ensure that the final back cut completely severs the holding wood.
4. To complete the back cut (for double or triple cuts), position the head behind the intended direction of fall so that when the back cut is completed it is parallel to the front cut. This will allow the tree to fall freely and avoid splitting.



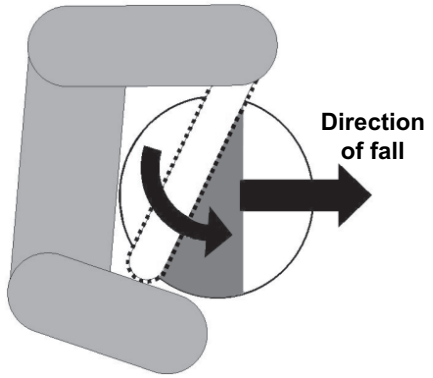
Completing the front cut with a chainsaw felling head (viewed from above)



Make a cut to the side of the tree deep enough to ensure that the final back cut severs the tree (viewed from above)



Position the head for the back cut. If you have made a front cut, position the head so the back cut is above it.



Complete the back cut so that when completed the bar is at right angles to the intended direction of fall (viewed from above)

5. Activate the saw to commence the cut. Apply a slight forward and upward force as the cut progresses, according to tree lean. Watch the saw chip pattern to gauge the position of the saw in the tree.
6. As the back cut is completed, stop the saw when it has either completely severed the tree (single back cut) or has cut the hingewood (double or triple cut). Over-cutting can pinch the bar and stop it from retracting when the tree begins to fall forward.

   On small trees, the forward rotation of the head may need to be overridden to stop the tree prematurely splitting off the front of the stump.
7. Once the tree has been cut and the saw has retracted, lift and slew the butt away from the intended direction of fall to direct the fall and position the tree for delimbing (if appropriate).
8. If the tree hangs up, the machine can be slewed away from the hazard (and the tree propelled through the head with the drive rollers if fitted) to bring it down.
9. If the tree is large or there is a risk of the butt rearing-up (e.g., when falling over a small rise) or twisting (if the tree rolls), release the tree as it completes its fall. Once it has hit the ground, you can grab it again if necessary.

As the tree begins to fall, lift the butt and slew the tree away from the intended direction of fall

Feller-buncher

The procedure for felling with the feller-buncher is influenced by whether the head has a continuous or intermittent disk saw:

- With a continuous disk saw, the tree is not gripped until the saw has severed the stem from the stump.
- With an intermittent disk saw, the tree is gripped throughout the cutting process (similar to a feller-director).

In either case, the direct attachment of the head to the outer boom allows the machine to apply more force to the tree during felling. Consequently, the machine can lift the stem off the stump once the cut has been completed. The stem can then be slewed and felled by tilting the head forward (if necessary). During the fall of larger trees, the grapple arm(s) are released to allow the tree to free fall to the ground. This reduces shock loading and the possibility of damaging the head.

Be aware that with either type of felling head, the cutting unit may be damaged or prematurely worn by contact with soil or duff when cutting trees from their downhill side. This is usually the case when felling uphill.

Step 6 – Positioning the felled tree

Once the tree has been felled, it can be repositioned to clear it from in front of the machine and provide better access for the extraction machine.

Feller-director machines capable of delimbing can complete the final felling, delimbing, and positioning movements as single flowing motions, one after the other.

Trees are usually slewed down the side of the machine and laid in bunches with the butts pointing in the extraction direction (if motor-manual delimbing is to be carried out in the cutover, the felled trees should be spread out rather than bunched). Depending on the width of the strip being felled, the machine may slew the felled trees to bunches on one or both sides of the machine.

When sliding stems into bunches, a bed of stems should be laid down to allow the remaining stems to slide easily and not become jammed or stuck (requiring extra handling time).

In feller-buncher operations, the felled trees are either laid out to the side or slewed and dropped into bunches.

For information on bunching stems with an excavator, refer to the **Best Practice Guidelines for Ground-based Logging**.

A feller-director machine slewing the felled trees on to bunches down either side of the machine. In this case the trees are being delimbed on to the bunch.

Felled trees laid out from the felling face by a feller-buncher

Maintanance procedures

Maintenance procedures are specific to the type and make of harvester. Always follow the maintenance or service requirements and procedures specified by the manufacturer.

Before maintenance of any kind is undertaken, the operator must ensure the following:

- The machine is in a safe area and on flat, clear ground.
- The machine's hydraulic lock-out lever is engaged (if fitted) and the engine shut down.
- The head is either grounded or chocked up to prevent it from falling.
- The computer control is turned to the "off" position (or to "manual" if an authorised serviceman requires pressure to the head for diagnosis).

The following sections are guidelines only, and should not replace manufacturer guidelines.

Daily maintenance

Complete the following each day:

- Lubricate grease points. Operators may choose to lubricate the machine in the middle or at the end of the day because:
  - The machine is hot and grease flows more readily
  - It is easier to see in daylight
  - It is usually warmer
  - They need a break.
- Check the cutting unit and fittings for damage or wear
- Maintain chainsaw chain (sharpening)
- Check for worn or damaged cutting surfaces and fittings on the knives (if fitted)
- Remove branches caught in between hydraulic hoses
- Check all hoses and associated fittings for damage or oil leaks
- Fill the chain bar lube (if applicable)
- Clean debris from around hydraulic oil cooler
- Check drive motor mountings (if fitted)
- Check delimb pivot pin retaining bolts (if fitted)
- Check drive arm pivot retaining bolts (if fitted)
- Check rotator hanging bracket retaining bolts (where appropriate)
- Check safety features
- Check chain tension
- Clean the cab windows
- Clean the cab

Periodic maintenance (e.g., weekly)

- Check main valve mounting bolts
- Check shims and bushes on all pivot points
- Check chainsaw sprocket (if applicable)
- Check bar condition (if applicable)
- Sharpen delimb knives if required
- Check all hoses and associated fittings for security and tension
- Clean out soil from between the carrier rollers
- Check track tension/tyre pressures
- Check fire suppression equipment

Mechanised delimbing procedures

Preparing to delimb tree lengths

Assessing the tree lengths

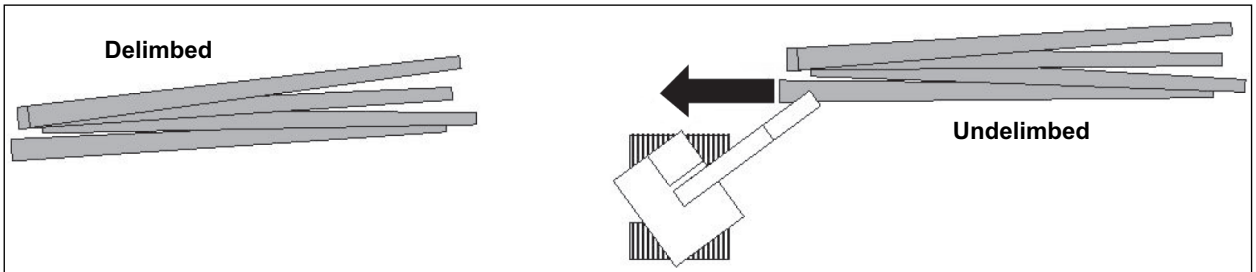
It is a good idea to assess the general characteristics of the trees or stems to be delimbed before starting the operation. This will allow the machine operator to assess whether the machine is capable of delimbing the stems, and allows aspects of the operational plan to be completed (area required, slash management, need for motor-manual delimbing, position of logs in the stockpile). This assessment will depend on when and where the delimbing is to be done.

Positioning of the machine

The accurate positioning of the machine will ensure that stems pass through the delimber knives and on to the bunch or stockpile with maximum efficiency. Delimbing tends to be a linear process with the machine positioned between the two stockpiles.

1. Position the machine so that the undelimbed stems point past the machine. Ensure the stems are outside the tracks.
2. Position the machine so that the undelimbed stems can be reached with the boom and slewed down the side of the machine without the stems having to bump against the track frame.
3. It may be preferable to position the machine so that the stems pass down the cab side of the machine. This will ensure that the operator has a good view of the stem as it exits the head, and is positioned in the stockpile.

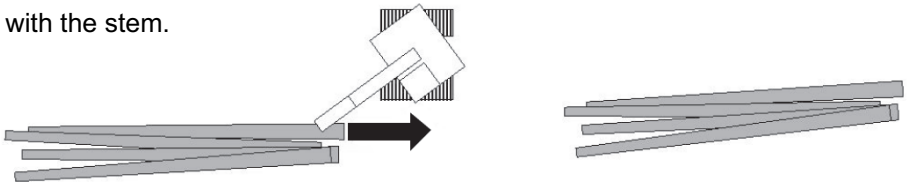
Machine delimbing and bunching stems off a slope



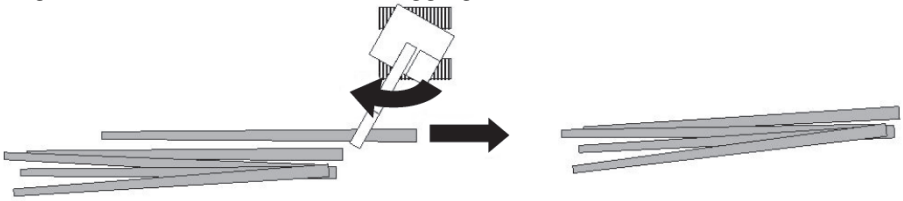
Example of the machine position relative to the delimbed and undelimbed stems

Handling and delimbing tree lengths

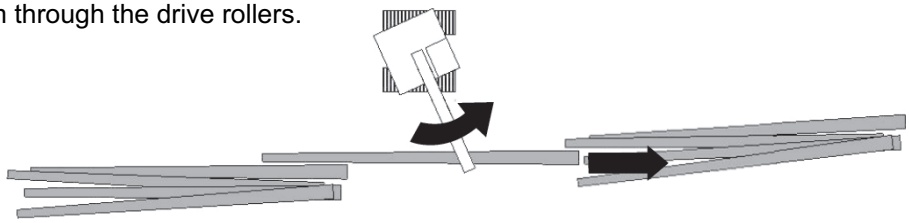
1. Grab a stem and position it in the drive rollers and delimber knives — the use of “harvester down” function will aid this. If selecting from a stockpile, select one from the top.
2. Slew the machine square with the stem.



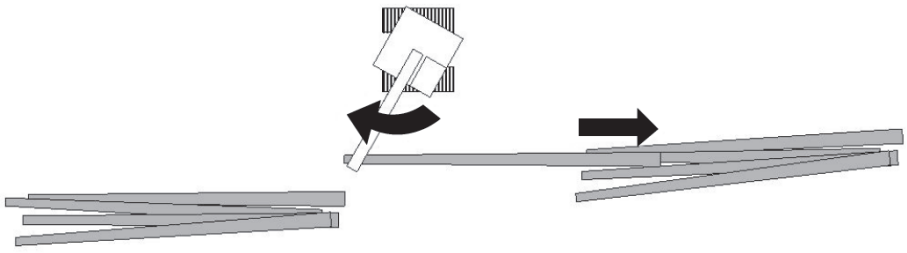
Activate the drive rollers and slew the machine towards the stem at the same time. This reduces the chance of the front knife lifting off and/or the delimb knives digging into the stem.



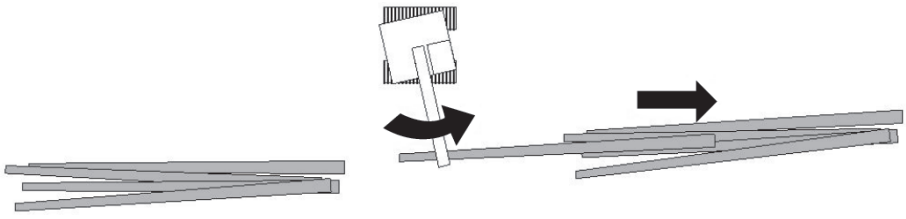
3. Continue to feed the stem through the drive rollers.



4. As the delimbing knives reach the top half or third of the stem and/or the butt hits the ground/bunch, slew the machine in the opposite direction while still feeding the stem through the delimber knives. This will aid in removing larger branches and provide more momentum for the delimbed stem as it passes on to the delimbed stockpile.



5. Once you have delimbed to the end of the stem, move the head back down the stem then clamp it. Slew the stem on to the delimbed stockpile. Try to keep the butt of the stem riding over the the other stems (if present) to avoid jamming or burying the stem. If laying down the first few stems, take care not to hit a stump while slewing and/or feeding the stem to the stockpile - the sudden impact may shatter the stem.



It may be necessary to pass the stem through the delimber knives several times to ensure a quality job. This will be the case for clearfell compared to production thinning (where the delimbing and log-making are often made in one full stroke of the stem).

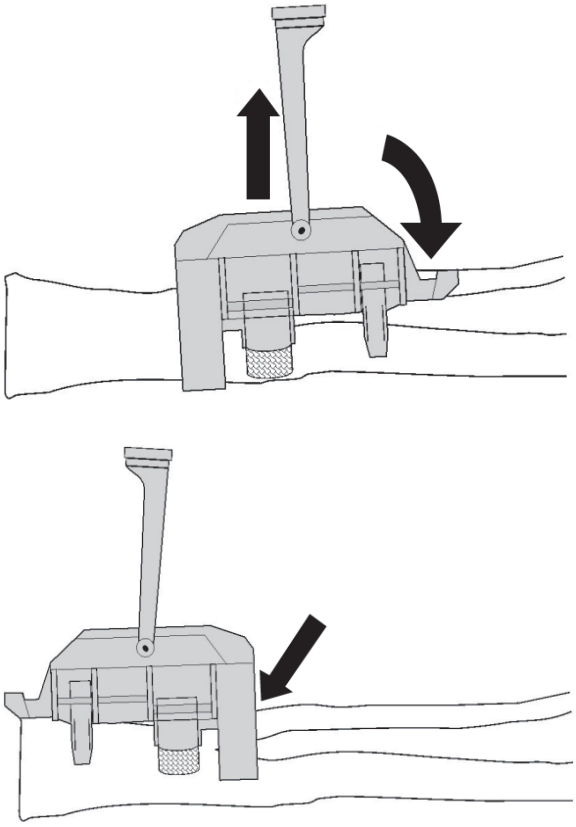
Avoid allowing the feed rollers to lose traction and cause damage to the stem. Also ensure that the feed roller pressure is not too high, causing damage to the stem.

- Where there is excessive nodal swelling that cannot be removed, release the knives and go past the whorl.
- Where the stem has multiple leaders, remove the secondary leader by grasping it in the head and lifting it until the crutch splits. The shattered end can then be cut off and the rest of the leader delimbed as a separate stem. An alternative method is to turn the head around and cut the leader off with the saw.
- When encountering a large whorl of branches, slew the head towards the whorl in tandem with the activation of the drive rollers to give it sufficient momentum to slice through the branches.

Dealing with tree lengths beyond the machine's capability

When presented with a stem that is beyond the capability of the machine to handle, the stem will need to be motor-manually delimbed. This may be necessary when the diameter of the tree is too large for the delimbing head, or there is excessive malformation and/or large branches.

Large trees can be picked up further down the stem where the diameter is smaller and partially delimbed as lond as the machines' stability is not compromised.



Dealing with a stem with multiple leaders by breaking the secondary leader out of the crutch (top) or cutting it off with the cutting unit (bottom)

Clearing debris

Where the delimbing machine is located in the same position for an extended period, accumulations of slash will build up and hinder the operation. This slash should be removed to a safe position in accordance with environmental policies. When delimbing on a landing, the placement of slash should consider the safety of other operations and people working downhill of the landing.

If clearing debris with the head, use the delimbing knives only to avoid pulling debris into exposed hoses and components.

Maintenance procedures

Maintenance procedures are specific to the type and make of harvester / processor. Always follow the manufacturer's maintenance or service requirements and procedures.

Complete the following precautions before maintenance each day:

- The machine is in a safe area and on flat, clear ground.
- The head is either grounded or chocked up to prevent it from falling.
- The machine's hydraulic lock-out lever is engaged (if fitted) and the engine shut down.
- The computer control is turned to the "off" position (or to "manual" if an authorised serviceman requires pressure to the head for diagnosis).

The following are guidelines only, and should not replace manufacturer's recommendations.

Daily maintenance

Before commencing work each day, complete the following:

- Lubricate grease points
- Check for damage or wear of the knife cutting surfaces and fittings
- Check chainsaw chain, bar, and fittings for damage or wear
- Check all hoses and associated fittings for oil leaks
- Check drive motor mountings (if fitted)
- Check delimb pivot pin retaining bolts (if fitted)
- Check drive arm pivot retaining bolts (if fitted)
- Check rotator hanging bracket retaining bolts (where appropriate).

Periodic maintenance (e.g., weekly)

- Check main valve mounting bolts
- Check all hoses and associated fittings for security and tension
- Check floating top knife (if fitted)
- Check drive roller condition, spikes, thumbnails, etc.).

Static delimber procedures

Preparing to delimb tree lengths

Assessing the tree lengths

It is good practice to assess the general characteristics of the trees or stems to be delimbed before starting the operation. This will allow the delimber operator to determine whether the machine is capable of delimbing the stems, and allows aspects of the operational plan to be completed (area required, slash management, need for motor-manual delimbing). This assessment will depend on when and where the delimbing is to be done.

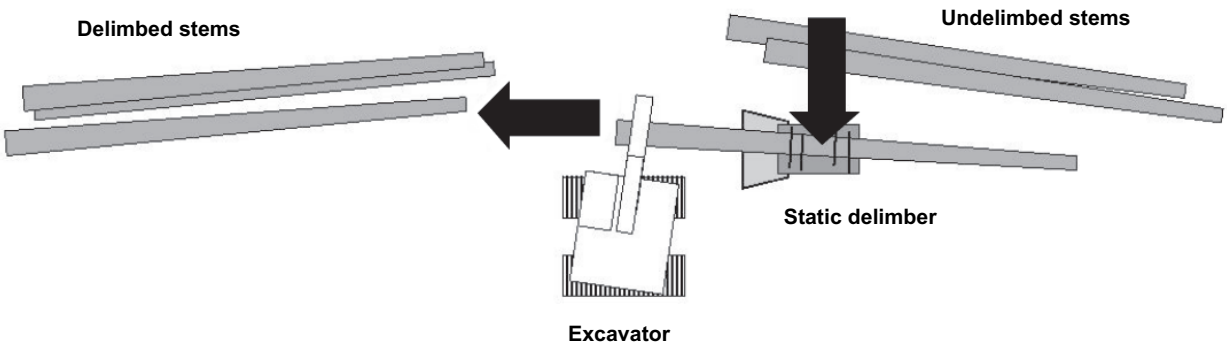
Positioning of the delimber and the pull-through machine

The positioning of the static delimber and pull-through machine needs to be considered in relation to the stockpile of undelimbed stems, the type of pull-through machine used, and the requirements of the next phase of the operation. Delimbed stems may be stockpiled for extraction or laid out on bearers in the processing area (if a cable skidder is being used, stems should be laid out, one stem high, to avoid hazards caused by unstable stems).

The static delimbing operation tends to be a linear process with the delimber positioned between the undelimbed stems and the delimbed stems or processing area.

When using an excavator loader:

1. Position the static delimber to the side of the stockpile and slightly back from the butt end of the undelimbed stems. This will allow the stems to be lifted across and into the delimber knives.



Static delimber positioning when using an excavator loader

2. Position the machine so that the undelimbed stems can be reached with the boom and slewed down the side of the machine without the stems having to bump against the track frame.

   If the momentum has to be paused to reposition the excavator, make sure the stem is backed up to give a reasonable run in distance and that the final movement completes the delimbing process.

3. It may be preferable to position the machine so that the stems pass down the cab side of the machine. This will ensure that the operator has a good view of the stems as they are positioned in the delimbed stockpile.

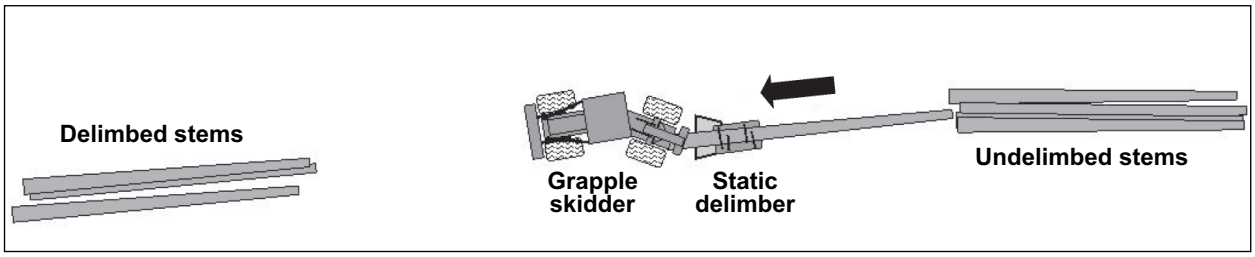
4. Avoid hitting the delimber knives with the grapple.

5. Use the crowd, slew, extend functions to feed the stem through the delimber. Alternatively, walk the excavator back further along the designated trail to pull the tree through the delimber.

A grapple skidder pulling stems straight through a delimber

When using a grapple skidder:

1. If pulling off a stockpile, position the delimber in front and slightly to one side of the butts. Alternatively, the static delimber may be positioned just to the side of the extraction track (to allow the skidder to pass) allowing extraction and delimbing to be completed efficiently.
2. Ensure there is adequate space between the delimber and the delimbed stems for the skidder to travel the length of the stem without deviating from the near-straight line.
3. Make sure the delimber can rotate to align with the skidder as it pivots to straighten up.



Using short logs to support the stem and help anchor the delimber

When using a Bell loader:

1. Position the delimber either next to the undelimbed stockpile or in front of it. The positioning will depend on whether you are lifting stems across to the delimber or pulling them up parallel then lifting over.
2. Ensure there is adequate space between the delimber and the delimbed stems for the Bell to travel the length of the stem without deviating from the near-straight line. Ideally, the path will be slightly downhill to reduce the effort needed to pull the stem through the delimber.
3. Keep the boom in close and low to improve machine stability.
4. Avoid hitting the delimber knives with the grapple of the Bell.

When using a grapple skidder or Bell loader, prevent the delimbing knives digging into the top of the stem by providing additional support to the stem as it is being delimbed. This can be achieved by laying down a log or slash bed at either end of the delimber. This stops the stem from bowing excessively as it passes through the knives (it can also help anchor the delimber). The use of an excavator loader can overcome this problem by re-grappling the stem part way down its length.

Position the delimber on stable ground

Anchoring the delimber

Locate the delimber on an even, stable site.

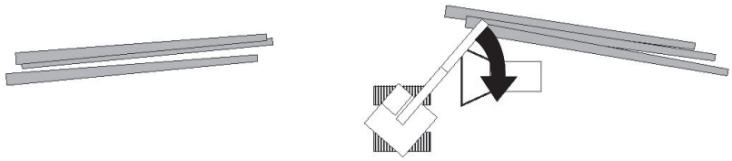
Ensure it is securely anchored before starting to use it. This may be done by placing a stem in the delimber knives and pulling it forward and down. In some cases it may be necessary to place a short length of log on the frontal anchor to hold it secure (this log can also serve as support for the stem).

Handling and delimbing tree lengths

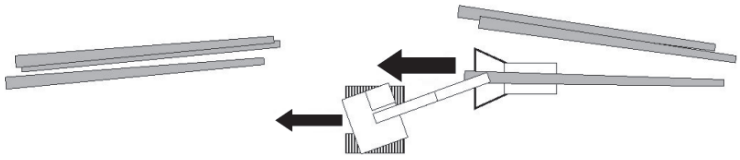
Using an excavator loader

1. Grab an undelimbed stem by the butt from the top of the stockpile. Lift it across into the delimber. Take care not to hit the delimber with the grapple.

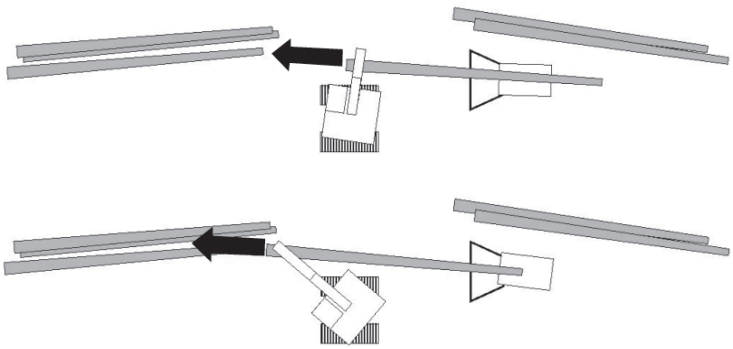
   To align the top of the stem, apply a downward and sideways force on the butt to swing the top of the stem in the opposite direction.



2. Activate the delimber knives (either by pushing the delimb arm closed remote or applying downward pressure on the spiked roller - Harvesttech only).
3. With the butt secured in the grapple, reverse the excavator away from the delimber. Alternatively, start the slew motion as described below.

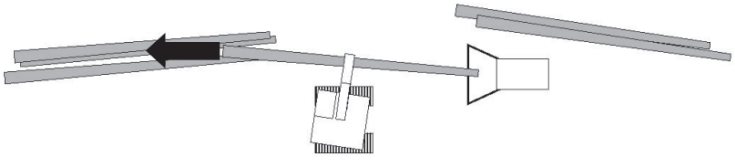


4. After delimbing a portion of the stem, stop reversing and complete the delimbing motion by slewing, crowding and extending the boom.



Crowding then extending the boom when slewing ensures that the stem remains straight

5. Once the slew motion has been completed, drop the stem, slew back in the opposite direction and re-grab the stem if necessary. Repeat the slew motion to complete delimbing the stem and/or position it in the stockpile.

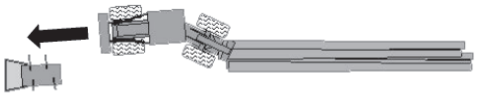


6. If building a stockpile of delimbed stems, ensure that there is an adequate bed of stems that are tightly packed. This will allow the butts of later stems to slide easily without becoming jammed in gaps between the bed stems.

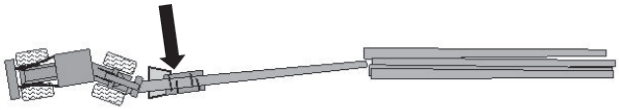
Using a grapple skidder or bell loader

Pulling stems through the static delimber with a grapple skidder or Bell loader requires more room to accommodate the travel distance. Stems are typically picked up from a stockpile. Either a grapple skidder or Bell loader can use the following generalised procedure. In addition, the Bell loader can lift stems sideways off the stockpile to place them in the delimber knives.

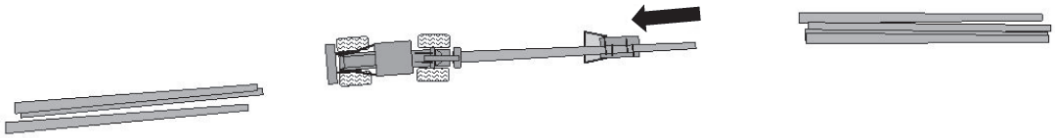
1. Grab a stem (by the butt) from the top of the stockpile.



2. Pull the stem parallel with the stockpile towards the side of the static delimber.
3. Swing the stem across in to the delimber knives. This may require articulating the back of the skidder, or swinging the Bell loader towards the delimber.



4. Align the stem (if necessary) by applying a downward and sideways force on the butt.
5. Activate the delimber knives.
6. With the stem positioned straight through the delimber knives, move the machine away from the delimber, keeping the stem straight. The machine should be aimed to the nearest side of the delimbed stockpile.



7. Continue the machine movement until the top of the stem is delimbed.
8. Position the stem on the stockpile by either articulating the back of the skidder towards the stockpile, or turning the Bell loader.

9. Once the stem has been satisfactorily positioned, return to grab the next stem.

Dealing with tree lengths beyond the delimber's capability

A stem that is beyond the capability of the static delimber to handle, will need to be motor-manually delimbed. This may be necessary when the diameter of the tree is too large for the delimber, or there is excessive malformation and/or large branches.

Clear debris from around the delimber when it starts to hinder the operation

Clearing debris

Where the delimber is located in the same position for several days or longer, accumulations of slash will begin to hinder the operation. Debris around the delimber may also cause a fire hazard.

This slash should be removed to a safe position in accordance with environmental policies. When delimbing on a landing, the placement of slash should consider the safety of other operations and people working downhill of the landing.

Maintenance procedures

Maintenance procedures are specific to the type and make of delimber. Always follow the manufacturer's maintenance or service requirements and procedures.

The following sections are guidelines only, and should not replace manufacturer's recommendations.

Before commencing work each day, complete the following:

- Lubricate grease points
- Check fuel and oil levels as appropriate
- Check for damage or wear of the knife cutting surfaces and mounts
- Check all hoses and associated fittings for oil leaks
- Check central pivot point and mounting bolts
- Check the movement of the guide rollers.

Mechanised processing procedures

Preparing to make logs

Assessing the stand

The general characteristics of the tree or stems to be processed should be assessed before starting the operation. This will allow the operator to assess whether the machine is capable of processing the stems, and allows aspects of the operational plan to be completed (area required, slash management, need for motor-manual processing). This assessment will depend on when and where the processing is to be done.

Log grade specifications and the cutting instructions

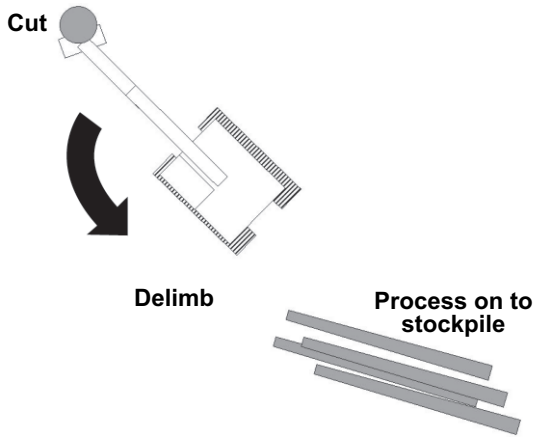
Before starting to process, ensure that you have the latest copy of the log specifications and the cutting instructions. The cutting instructions (lengths, diameters, and priorities) will need to be programmed into the processor's computer system.

Check that the information entered coincides with that issued by the forest owner (in most circumstances, the cutting instructions should be less than a week old — check the dates).

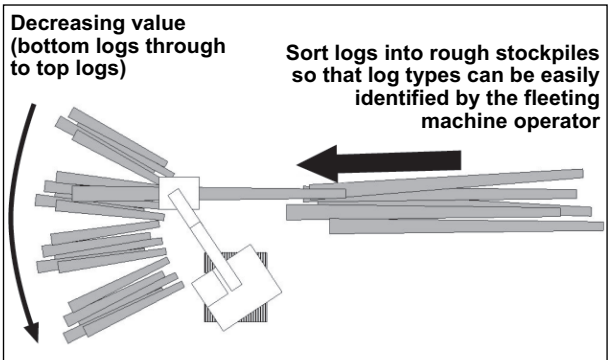
Mechanised processing requires the machine operator to assess the quality features of the stem before selecting a log grade and length to be cut. Make sure you have a thorough understanding of the log grades before starting to process.

A product number or code is assigned to each grade and length. Generally, these are ordered sequentially to reflect the priorities. Make sure you have a thorough understanding of these numbers or codes before starting to process the logs.

The product mix in the cutting instructions will affect the degree of sorting of cut logs. The number of sorted stockpiles will be influenced by the available area, the position of the machine and the operating procedures.



Example of machine positioning for cut-to-length



Example of machine positioning in road edge and landing processing operations

Positioning of the machine

Processing can occur at the stump, at the road edge, or on a landing.

The accurate positioning of the machine will ensure that stems can pass through the processing head, and that cut logs can be sorted and stockpiled as required.

Using the cut-to-length system requires a flowing motion. The tree is cut in front of the machine, and delimbed while being slewed down the side of the machine. The log cutting and stockpiling occurs to the side or behind the machine, thereby clearing the way in front of the machine, and keeping the operator out of the line of possible "chain shot". These motions are all achieved from the felling position. This differs from production thinning operations, where the stems are delimbed and processed to the side of the machine.

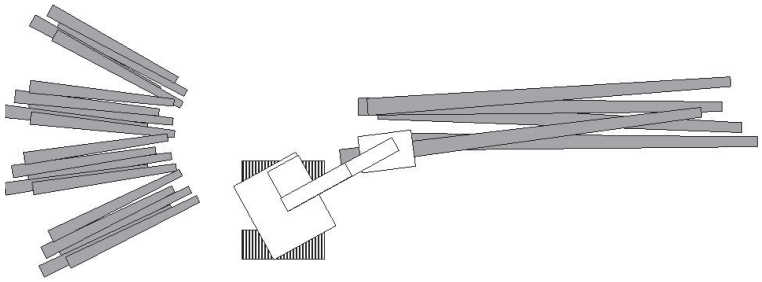
In road edge or landing operations:

1. Position the machine to the side of the stockpiled stems so that the undelimbed stems can be grabbed, then slewed and cut, and the log placed on the stockpile(s). Ensure the stems are outside the tracks. Pulling logs across the tracks can cause damage to the carrier rollers and may also damage the stem.

2. Position the machine so that the stems pass down the cab side of the machine. This will ensure that the operator has a good view of the stem to assess quality and accurately position it in the stockpile.

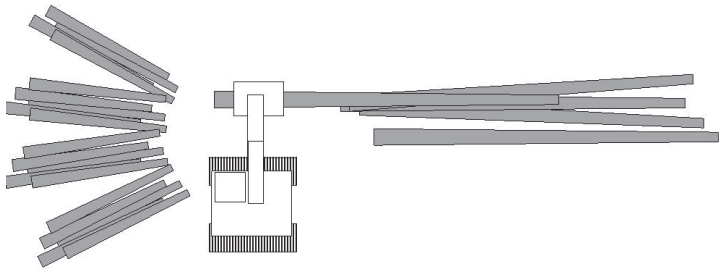
Making logs

1. Before handling or cutting stems, ensure that there are no workers or machines in the hazard zone around the processing operation.
2. Grab a stem off the top of the stockpile while using “harvester down” function.
3. Assess the quality of the stem. If delimbing prior to processing, view the entire length of the stem looking for quality features and branching. In addition, view the length and diameter information displayed by the computer. Sweep and butt defects can be assessed by slewing towards the stem to allow a view down the length of the stem.



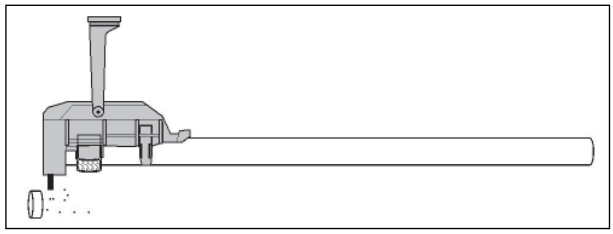
**Slew to the right to see the butt defects and sweep.
Do not risk machine damage by over-crowding the boom and pulling the stem and head towards it.**

4. Reposition the boom and stem so that they are square on to the stem stockpile.

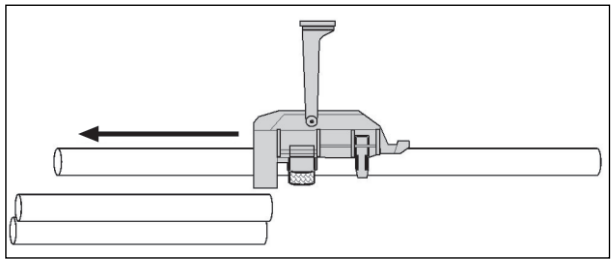


Position the boom and stem square on with the stem stockpile

5. Cut the sloven if required. This may zero the length measurement. Alternatively, zero the length measurement manually. Avoid cutting very thin slovens, as the saw may tend to cut out of the log end causing an angled end cut.

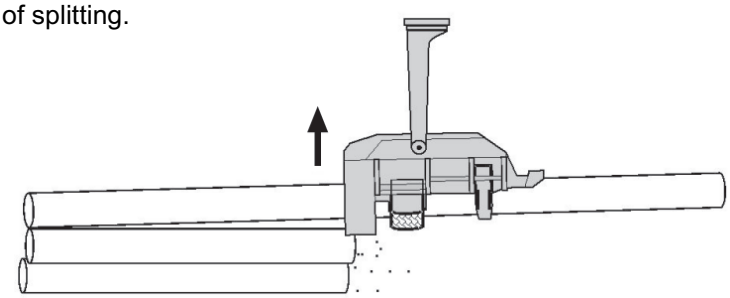


6. Slew the machine so that the log is over the appropriate stockpile.
7. Enter the appropriate log grade and length number or code into the computer to allow the cutting unit to move to that point. View the measurement wheel while measuring to ensure that it does not slip. If it does, re-measure the log.

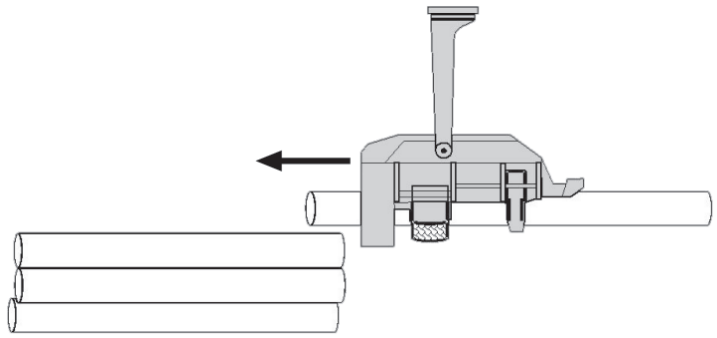


8. Once at the cut zone, verify that the diameter and length are within specification and that the log meets the chosen grade. Either accept the log or over-ride to the next highest priority log grade and length. Reposition the head.

9. Activate the cutting unit, ensuring that the stem is firmly gripped. Provide support for the end of the log by laying it on another log.
10. As the cut nears completion, the saw will speed up. If supporting the log end, lift the main boom to ensure that the cut remains open. Lifting too early or fast may cause a split on the lower side of the log. If the log end is not supported, drop the head slightly in unison with the finishing of the cut to reduce the chance of splitting.



11. Position the log on the stockpile.
12. Enter the log grade and length number or code for the next log to be cut.



Dealing with tree lengths beyond the machine's capability

When presented with a stem that is beyond the capability of the machine to handle, the stem will need to be motor-manually processed. This may be necessary when the diameter of the tree is too large for the processing head, or there is excessive malformation and/or large branches (if delimbing and processing).

Clearing debris

Where the processing machine is located in the same position for several days or longer, accumulations of off-cuts and slash will begin to hinder the operation. These should be removed to a safe position in accordance with environmental policies. When processing on a landing, the placement of debris should consider the safety of other operations and people working downhill of the landing.

Maintenance procedures

Maintenance procedures are specific to the type and make of processor. Always follow the manufacturer's maintenance or service requirements and procedures.

Before maintenance of any kind is undertaken, the operator must ensure the following:

- The machine is in a safe area and on flat, clear ground.
- The head is either grounded or chocked up to prevent it from falling.
- The machine's hydraulic lock-out lever is engaged (if fitted) and the engine shut down.
- The computer control is turned to the "off" position (or to "manual" if an authorised serviceman requires pressure to the head for diagnosis).

The following are guidelines only, and should not replace manufacturer's recommendations.

Daily maintenance

Complete the following each day:

- Lubricate grease points. Operators may choose to lubricate the machine in the middle or at the end of the day because:
  - The machine is hot and grease flows more readily
  - It is easier to see in daylight
  - It is usually warmer
  - They need a break.
- Check the cutting unit and fittings for damage or wear
- Maintain chainsaw chain (sharpening)
- Check for worn or damaged cutting surfaces and fittings on the knives (if fitted)
- Remove branches caught in between hydraulic hoses
- Check all hoses and associated fittings for damage or oil leaks
- Fill the chain bar lube (if applicable)
- Clean debris from around hydraulic oil cooler
- Check drive motor mountings (if fitted)
- Check delimb pivot pin retaining bolts (if fitted)
- Check drive arm pivot retaining bolts (if fitted)
- Check rotator hanging bracket retaining bolts (where appropriate)
- Check safety features
- Check chain tension
- Clean the cab windows
- Clean the cab

Periodic maintenance (e.g., weekly)

- Check main valve mounting bolts
- Check shims and bushes on all pivot points
- Check chainsaw sprocket (if applicable)
- Check bar condition (if applicable)
- Sharpen delimb knives if required
- Check all hoses and associated fittings for security and tension
- Clean out soil from between the carrier rollers
- Check track tension/tyre pressures
- Check fire suppression equipment

Calibrating the log-making equipment

The accuracy of the length and diameter measurements should be checked daily. Where logs are subjected to quality control, the need for calibration will be clearly evident. The calibration process will vary with different makes and models of processor. Therefore, follow specific manufacturer's guidelines.

Glossary of terms

Attributes	Features of a log or stem that define the log grade.
Back cut	Release cut. The felling cut made from behind the intended direction of fall. On a larger tree, the back cut may be preceded by a front cut.
Bed processor	A fixed processor with a chain driven carriage that cradles the stem and delimbs it with delimbing knives as it is moved down the stem.
Butt	The large, lower end of a stem.
Code	The Approved Code of Practice for Safety and Health in Forest Operations.
COPS	Cabin Operator Protective Structure designed to protect the operators of excavator-type machines in the event of a rollover. Can only be specked to Grade 2.
Crowd	The process of bringing the stick and attached implement in close to the machine.
Cut face	The surface of a log without bark where a branch or stubs has been cut flush with the log surface.
Cut-to-length	The felling, delimbing, and processing of logs at the stump for forwarder extraction.
Cutting unit	The means of cutting a tree or stem.
Diameter	Usually the mean of two measurements, the first taken as the shortest measurement through the geometric centre of a log end, and the second at 90° to the first. Expressed in units specific to the scaling method being used.
Defects	Features of a stem or log that reduce the quality and value of a log.
Delimber knives	Sharpened steel knives that either rest against or grip around the stem, designed to slice through the branches where they join the stem.
Disk saw	A circular saw fitted to a feller-buncher head. Can be continuous (always rotates) or intermittent (activated by the operator).
Drive rollers	Motor-driven wheels or rollers designed to feed a stem or log through a processing head.
Double cut	A felling cut requiring a front cut followed by a back cut.
Double-shift	To operate a machine over an extended period by having two operators on the machine, one shift after another.
Feller-buncher	A cutting head capable of hydraulically controlling the fall and placement of a tree, provided it is within the capacity of the machine.
Feller-director	A (dangle) cutting head that controls the fall of a tree by moving the butt of the tree away from the intended direction of fall or pushing it with the boom.
Fixed carrier	A tracked or wheeled machine base without a slewing function that must be driven to each tree and can only cut from behind the intended direction of fall.
Fluting	A depression in the surface of and along a log, usually at the butt.

Glossary of terms (cont...)

FOPS	Falling Object Protective Structure designed to protect the machine operator from falling objects that hit the cab.
Front cut	The first cut made when using a double or triple cut method. When completed, the front cut should be 90° to the intended direction of fall.
Grade	A class of product with the same quality characteristics.
Growser	Vertical traction cleats on the pads of self-laying tracks.
Hazard zone	A zone about a machine or operation within which hazards make it unsafe for exposed manual workers and other machines to be in.
Kink	A short deflection from straight, within part of a log.
Knot	Portion of a branch enclosed in wood by the natural growth of a tree.
Large-end diameter (LED)	The diameter of the larger (or lower) end of the log, usually expressed under bark.
Length	Can be either the actual length or the nominal length. When actual lengths are required, it is the shortest distance between the log ends.
Log cutting instruction	A list of log grades in order of priority to be cut showing the lengths, diameters, allowable defects, etc. The machine operator or log-maker uses the cutting instruction to optimise the value of logs cut from a stem.
Log grade specification	Dimensional and quality features that define a grade.
Malform	A stem defect involving branch or stem growth. Malformations include fork, sweep, kink and wobble.
Mechanisation	The use of machines to carry out selected tree harvesting phases including felling, delimbing, and processing.
Motor-manual	Involves the use of an operator-held chainsaw.
OOS	Occupational Overuse Syndrome. Work-related disorders of the musculo-skeletal system.
OPS	Operator Protective Structure designed to protect the machine operator from objects entering the cab.
Ovality	Refers to the shape of a non-round log end.
Over cut	Additional part of a log over its specified length to allow for deviations in length cutting.
Phase	A step in the logging process. For example, fell, extract, process, load.
PPE	Personal Protective Equipment designed and worn to provide protection for workers. Includes helmet, hi-vis, safety boots, earmuffs.
Production	The volume or weight of logs handled in a day by either the whole operation (e.g., crew daily production) or for an individual phase (e.g., trees felled per day).

Glossary of terms (cont...)

Productivity	The volume or weight of logs handled in a productive hour (excluding delays). Usually relates to individual phases (e.g., machine felling productivity of 55 trees per productive hour).
Production thinning	Cutting selected stems from a stand for extraction and sale.
ROPS	Roll Over Protective Structure designed to protect machine operators of wheeled and tracked (non-slewing) machines in the event of a roll over.
Sapstain	Blue-stain fungus that discolours wood.
Self-levelling	The ability of the machine cab and/or main boom to level itself when operated on a slope. Designed for increased safety, production, and operator comfort on tree felling machines.
Shatter	Breakage of fibres within the stem.
Shears	Scissor-like cutters used on feller-buncher heads. Suited to low-value small-sized trees.
Single cut	A single felling cut made from the back to the front of the tree.
Single-grip harvester	A harvester head capable of felling, delimbing, and processing logs without having to release and re-grab the stem.
Skid worker (Skiddy)	A worker on the landing typically involved with trimming, cutting up stems, and quality control.
Slab	Loss of wood from the side of a stem or log usually at a cut end. It is often caused by incorrect and/or unsupported cutting.
Small-end diameter (SED)	The diameter of the smaller (or upper) end of the log, usually expressed under bark.
Spike knot	An elongated knot formed by a steep-angled branch.
Split	A crack or fracture of the log visible in the cut log end.
Static delimber	A delimber consisting of a hydraulically operated knife set through which the stem is pulled. The pulling machine is either an excavator, Bell loader, or grapple skidder.
Stem presentation	Relates to how the stem is aligned for the next phase. For example, butt angled towards the landing for butt pull.
Stroke-boom processor	A delimber-processor machine with an overhead sliding boom fitted with delimber knives and two cross-cut saws, one in the sliding boom and the other in the main lifting mechanism.
Sweep	A single deviation from a straight line along the length of a log.
Swing boom carrier	A wheeled or tracked carrier capable of slewing the main boom away from the centreline of the machine.
Tolerance	A length allowance defined by the forest company or customer to accommodate variations in log length about the specification length.

Glossary of terms (cont...)

Twin-grip harvester A harvesting machine with a boom-mounted felling head and a chassis-mounted delimber/processor unit. Trees are felled and positioned in the delimber/processor unit.

Wobble More than one bend over the length of a log, or sweep in more than one plane.