FORESTRY TRAINING CENTRE INC

COURSE IN REDUCED-IMPACT LOGGING

Acknowledgements

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FTCI's mission is to promote the use of Reduced-Impact Logging Techniques, to enhance efficiency and to promote rationalization in the forest industry in Guyana and the region by providing hands-on training to forest managers, supervisors and operators in the forestry sector, including governmental agencies, NGO's and hinterland communities

This manual has been derived from the following training and operation manuals:

Training manuals provided by the Fundação Floresta Tropical of Belém, Pará, Brazil

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- New South Wales (Australia) Chainsaw Operator's Manual
- Skogsarbeten (Forest Operations Institute of Sweden) Felling Manual
- Stihl AG: 066 Owner's Manual
- IMAZON: Floresta Para Sempre - RIL manual
- Allied Systems Co.: Ranger F68 Skidder Operators Manual
- Caterpillar Performance Handbook Editions 16-32 (1985-2002)
- Caterpillar: 966F Series II Wheel Loader Operation and Maintenance Manual
- Caterpillar: 528B Skidder Operation and Maintenance Manual
- Caterpillar: D6D, D6E & D6E SR Track-type Tractors Operation and Maintenance Manual
- Equipment Manufacturer's Institute: Wheel Loader Safety Manual
- URS' "Training of Trainers in RIL" course notes and lesson plans
- Notes by Frank Cole (URS)
- The Guyana Forestry Commission's Code of Practice for Timber harvesting.

- Steve Conway: Logging Practices – Principles of Timber harvesting Systems. Miller Freeman Publications

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MODULE 1: FOREST MANAGEMENT PLANNING

Benefits of Planning

- Opportunities for better use of forest resources.
- Reduce logging costs.
- Identification of production forests.
- Identification of protection forests.
- Reduce damage to the forest, to soil and to water.
- Consideration of long-term events.
- Ensure the integration of legal obligations.

Levels of Planning

Long-term planning

To carry out a logging operation at minimum cost and with minimum adverse impact on the environment, it is necessary to plan the operation in detail. Figure 1 shows the order of operations in a well-planned operation. It is important to realise that a logging operation is a chain of interlinked activities. This is what makes planning indispensable in any logging operation.

Planning can only commence when information on the resource is available. Proceeding from long-term to annual planning, the required detail of the information increases progressively.

For the **strategic plan**, a reconnaissance level inventory should be carried out to identify areas to be excluded from logging, non-productive and protection areas, as well as production forests. Standards of logging, road construction, etc. should be described. Equipment to be used should be indicated as well as the amount of personnel and their designations.

For the **5-year plan**, it is recommended to conduct a 2% management-level inventory to demarcate annual coupes and to obtain information on the volume per unit area that can be expected in each compartment. The cutting order of compartments and dry/wet weather logging areas should be identified and indicated. Compartments should be divided into 100-ha working units (blocks).

Roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation. Once volume to be harvested per hectare and unit costs are known for felling, skidding, loading, transport and road construction and maintenance, the most efficient spacing of roads can be derived by looking at the cost tradeoffs between skidding distance and road spacing.

Annual planning

An annual plan should outline the previous and the following year's activities based on the 5-year operational plan. It should include maps, which indicate areas that were logged and areas that were inventoried the previous year and that will be logged or inventoried the

upcoming year. It should indicate infrastructure (roads, camps, etc.) that was constructed the previous year and infrastructure that will be constructed the coming year. Tables should be included where appropriate. An annual plan should describe among others:

Operations completed the previous year

- Compartment(s) and blocks logged
- Number of trees and volume (in m3) harvested by compartment and by block
- Management level (2%) forest inventories completed
- Blocks where 100% forest inventory has been completed
- Roads (main,, secondary, feeder) constructed
- Base camps erected or rehabilitated
- Road and/or waterway access rehabilitation undertaken
- Forward logging camps erected
- Other operations conducted
- Social issues addressed
- Recruitment and training of personnel

Operations planned for the next year

- Compartment(s) and blocks to be logged and their cutting order
- Number of trees and volume to be harvested by compartment and by block
- Management level (2%) forest inventories to be conducted
- Blocks where 100% forest inventory will be conducted
- Roads (main,, secondary, feeder) to be constructed
- Base camps to be erected or rehabilitated
- Road and or waterway access rehabilitation to be undertaken
- Forward logging camps to be erected
- Other operations to be conducted
- Social issues to be addressed
- Recruitment and training of personnel

In case the operations of the previous year deviate from what was planned for that year, the reasons for the deviations should be given. It should also be indicated which measures have or will be taken to improve the level to which the annual plan is implemented.

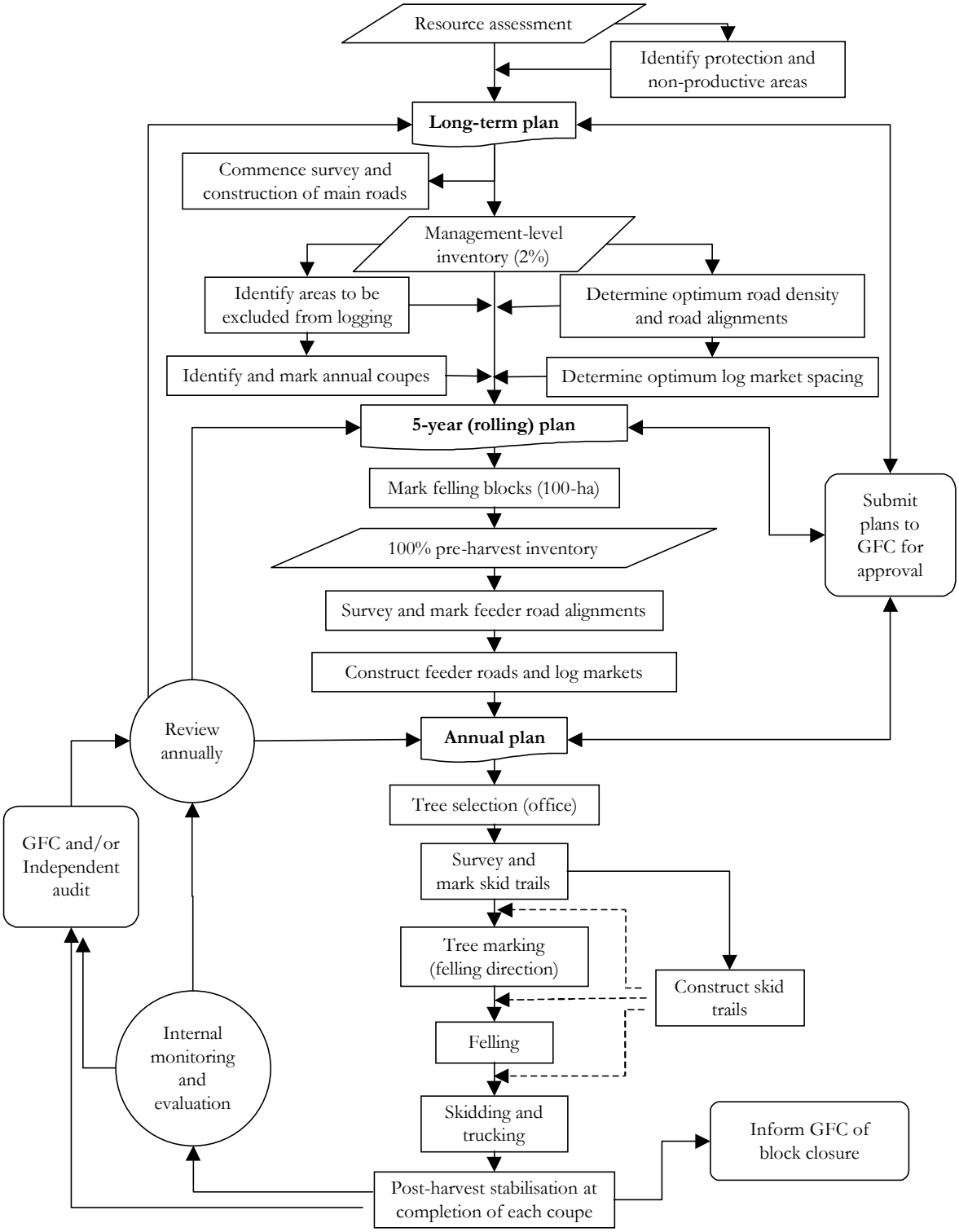


Figure 1 Order of operations in well-planned harvesting

Areas to be Excluded from Logging

Exclusion Areas

- Areas excluded from logging e.g. conservation areas, areas of cultural importance, declared protected areas.
- Area of forest kept around a sensitive site e.g. conservation areas, watercourses. (buffer zones or strips)
- Slopes > 40% (22°) for all ground based extraction systems

Buffer Strips

Type	**Minimum required buffer strip protection (Fig 2)**	
Conservation and declared protected areas	20 metres	
Cultural areas	Villages, farms, settlements and cultural, spiritual or historical heritage areas	20 metres
Sites susceptible to degradation	No additional buffer required	
Watercourses	Buffer width is measured horizontally from the top of the watercourse bank, or the edge of the flood plan when present, or the point above the high bank where the slope becomes less than 50% (27°) - whichever provides the greatest distance from the edge of the watercourse bed. Rivers — 30 metres each side. Retain vegetation on both sides (felling not allowed) Creeks — 20 metres each side. Retain vegetation on both sides (felling not allowed) Gullies — Merchantable trees may be felled but extraction equipment is not permitted within 10 metres of either side Waterways — Merchantable trees may be felled but extraction equipment is not permitted within 5 metres of either side	
Lakes, swamps and other wetlands	20 metres from the peak level mark or edge of typical wetland vegetation	

Management of Exclusion Areas and Buffer Strips

- No trees shall be felled within exclusion areas or their buffer strips, except for gully and waterway buffer strips.
- Machine access within exclusion areas and their buffer strips is not allowed, except at designated watercourse crossing points. Where permitted, access should be by the shortest possible distance
- No earthworks, or spoils from earthworks, shall end up in a exclusion area or its buffer strip
- No harvesting debris shall be pushed into exclusion areas or their buffer strips.
- Trees should be felled away from buffer strips and watercourses
- Where trees inadvertently fall into a watercourse or its buffer strip, the head as well as any accompanying logging debris should be pulled clear, unless unacceptable damage to the bank or buffer strip is likely to occur.

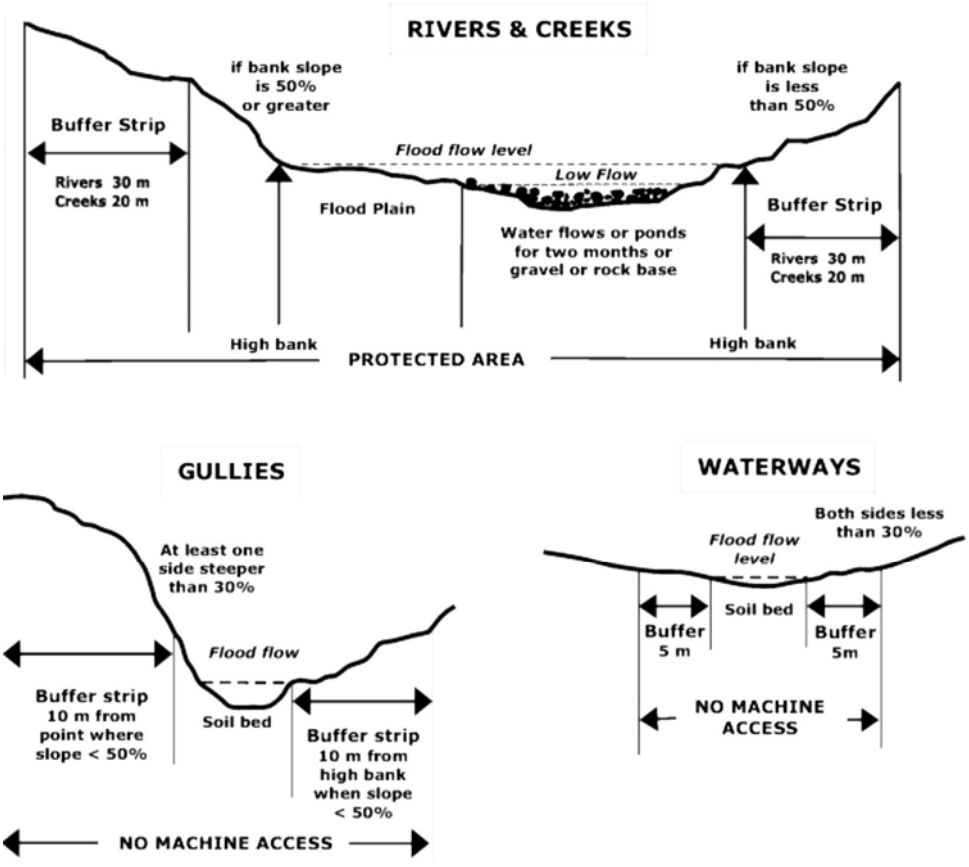


Figure 2 Buffer zones for different types of watercourses

Module 2: Reduced-Impact Logging Concepts

Origin of RIL

Until after the Second World War, logging operations in tropical forests were for the most part highly selective and manual. As such, they involved mainly small, easily accessible areas of forest and had little impact on the resource. The close of the Second World War marked a time of radical change in forest utilisation resulting from the expansion in the global trade in wood products, rises in local demand for sawn timber, and advances in timber processing technologies - the development of plywood, veneers and other panel products. In addition mechanised logging technologies, developed in industrialised countries, were introduced into the tropics with the result that the scale of and intensity of forest operations and their impact on the environment changed substantially. Foresters and policy makers began to recognize that many industrial logging operations were leaving forests in a degraded condition. At the same time, other foresters had begun the development and testing of prescriptions for mechanised logging that would minimise damage to residual forest stands and soils.

By 1992, when the United Nations Conference on Environment and Development was held in Rio de Janeiro, it had become clear that at least in some instances the mechanisation of logging operations in the tropics posed a serious threat to the long-term sustainability of the resource, not only in terms of sustaining timber yields but more so if impacts on non-timber values (water quality, biodiversity, etc.) were added to the equation. Since then new ways have been identified to manage forests in a more sustainable manner. Criteria and Indicators (C&I), covering economic, social and environmental aspects of forest management , have been developed to assist the planning, monitoring and assessment towards the new – broader – concept of sustainable forest management.

Around the same time, the first publications were appearing, in which the term "reduced-impact logging" was used. Somehow this term and its acronym "RIL" proved more broadly acceptable than "environmentally sound timber harvesting", an alternative terminology that was being promoted by the FAO forestry department. In recent years, a great deal of attention has focused on RIL, as one means for moving toward sustainable forest management.

RIL consists of technologies and practices that are designed to minimize environmental impacts associated with industrial timber harvesting operations embedded in a systematic approach to planning, implementing, monitoring, and evaluating forest harvesting. There is no single, globally applicable definition of what constitutes RIL because many of the specific procedures, environmental standards, and types of logging equipment vary with local conditions. Nevertheless, a RIL operation in tropical forests normally includes a certain basic set of practices.

Conventional Logging

RIL implies a different approach to logging. In the Guianas, logging is selective, whereby a minimum felling-diameter is prescribed to ensure future harvests. Most companies follow the regulatory requirements demanded by the GFC or SBB. So, why is this not good enough?

The main reason is that harvesting areas are usually given out to logging teams (one or two extraction machines and one or two felling teams). These teams are relatively free to move around the area and cut trees according to the felling list of the company. The logging teams are not familiar (educated) with matters like efficiency or environmental concerns. The result is often that logs are felled in any direction, a lot of time is spent on searching for logs, and long, snaking skid trails are created, all resulting in a lot of wasted machine time, high wear and tear of expensive machinery, lost logs, and poor recovery. From the environmental perspective, damage to the residual stand, to the soils, and to water quality and drainage patterns is much more severe than it would be if a more careful, planned approach were to be used.

In Conventional Logging

- There is no pre-harvest inventory of stocking or terrain in the harvest area.
- Skid trails are not planned.
- Logs are cut on sight by chainsaw operator without any predetermined falling direction .
- Skidding is done in random pattern, without taking into account watercourses and slopes, therefore causing more than necessary damage to the surrounding trees and soil.

Potential impacts of timber harvesting and extraction on the forest ecosystem

- **Impact on soils**. Soil disturbance is caused particularly by ground skidding, resulting in soil compaction and erosion. Nutrient loss may occur through felling and extraction. Soil compaction caused by the passage of heavy machinery reduces the soil's water absorption capacity, resulting in water logging and increased surface run off (leading to erosion). Plant roots grow poorly in the anaerobic and acidic conditions on compacted soils.
- **Impact on the residual stand**. In selective logging, felled trees damage and break other trees as they fall. Vines (lianas) tie tree crowns together and may pull other trees down. Skidders or bulldozers and logs being extracted by these machines scrape bark off mature trees, and crush smaller trees and seedlings. Typically, for every tree, which is logged, ten trees (diameter > 10 cm) are affected, half of which are destroyed or damaged beyond recovery. The forest canopy is opened drastically when trees are felled in clumps. Such large openings favour the establishment of - mainly non-commercial - pioneer trees and vines. The destruction and competition by pioneers may affect the ability of the harvested species to regenerate and therefore the prospects for future harvests.
- **Impacts on water**. Extraction of logs by dragging them across watercourses can interfere with the water flow. Increased levels of soil erosion on roads and trails cause increased levels of sediment in waterways.
- **Other impacts**. The impact on wildlife and disruption to breeding and nesting as well as the impact on biodiversity may threaten the integrity of the forest ecosystem

The Basic Elements of RIL

Forest organisation:

- Operational plan, compartments, blocks

Planning:

- Pre-harvest inventory and mapping of individual crop trees and terrain,
- Cutting of vines
- Pre-harvest planning and indication of roads, skid trails, and landings (on maps)

Pre-harvest activities

- Locate and demarcate roads, skid trails, and landings on the ground
- Determine felling direction for each tree based on skid trail lay-out and environmental guidelines
- Mark protected trees (potential crop trees, seed trees, habitat trees) near trees to be felled and along skid trails
- Prepare roads, skid trails, and landings
- Construct roads, landings so that they adhere to engineering and environmental design guidelines.
- Pre-construct skid trails (optional)

Harvest

- Use directional felling and proper bucking techniques, to minimize damage to the residual stand, to avoid waste, and to maximize volume and value recovery
- Winch logs to planned skid trails and ensure that skidding machines remain on the planned skid trails at all times.

Post-harvest

- Restore drainage along skid trails by deactivating skid trails after the operation (e.g., by cross ditching) to minimize erosion or water logging conditions.
- Restore drainage of log landings
- Conduct post-harvest assessments to provide feedback to the timber concession holder and the logging crews.

For RIL practices to be applied in a cost-effective and environmentally sound manner, the following prerequisites are essential:

- It is all too often the perception that RIL is essentially a strategy of techniques based largely on technical aspects of planning and extraction. Yet, without a firm commitment from management, it is unlikely that technical practices alone will ensure the successful adoption and implementation of the RIL strategy.
- A detailed set of operational and environmental standards must exist to which the logging operation will conform, and the managerial, planning, and logging crews must all be thoroughly familiar with these standards.
- The planning and logging crews must be trained in their respective functions, and they must understand not only what is to be done and how to do it, but also why it is important.
- Crews must be provided with proper safety equipment and must be trained in its use and maintenance.
- Knowledgeable, well-trained supervisors must be present in the field to oversee the work, to maintain prescribed standards for the operation, and to ensure that the schedule of activities is followed.
- All logging equipment must be suited to the operating conditions and must be maintained in good working condition.
- Planning and operational activities must be thoroughly integrated in order to ensure that the plans are properly implemented.
- A management and control system must be in place that will provide timely operating information to the concession holder, the logging manager, and external auditors. Such a system includes detailed job descriptions, staffing information, equipment inventories, standard operating procedures, and similar information.

CONCLUDING REMARK

It should be realized that sustainability will not be achieved through the adoption of RIL alone and that other aspects of sound forest management (e.g. determining and applying the allowable cut, determining and applying the appropriate cutting cycle) must be considered as well.

MODULES 3: INTRODUCTION TO SURVEYING

Definition

Surveying is the art of locating points or lines on the ground by measuring angles, directions and distances

Objectives

- To determine the horizontal position and elevation of points and other features - e.g. buildings - on the ground.
- To determine the direction and length of lines, boundaries, roads and watercourses
- To determine the configuration of the ground for mapping purposes
- To determine areas delimited by lines or boundaries (roads, rivers, fences, cut lines or any combination of these)
- To plot the location of trees on maps

Measurements in surveying (less expensive methods)

- Measuring horizontal distances by tape or chain
- Measuring angles and directions by compass (orientation)
- Measuring differences in elevation indirectly by clinometer

Linear measurements in ground surveys

- In surveying, the distance between two points is commonly meant to be the horizontal distance.
- Horizontal distances are used in the preparation of maps and in the computation of areas
- Information on maps is in two dimensions, which is a projection of a three dimensional reality. On a topographic map, the third dimension -elevation - is indicated by "contours".

Measuring horizontal distances

The horizontal distance between two points may be measured. (See Fig. 3):

- directly by keeping a measuring tape horizontal (a) or
    - by measuring along the sloping ground (b) and
    - applying a correction to the measured distances or
- by reducing the slope distance to horizontal distance by trigonometry (or use clinometer and a correction table) (See Fig. 4)
- or by breaking the chain (c)

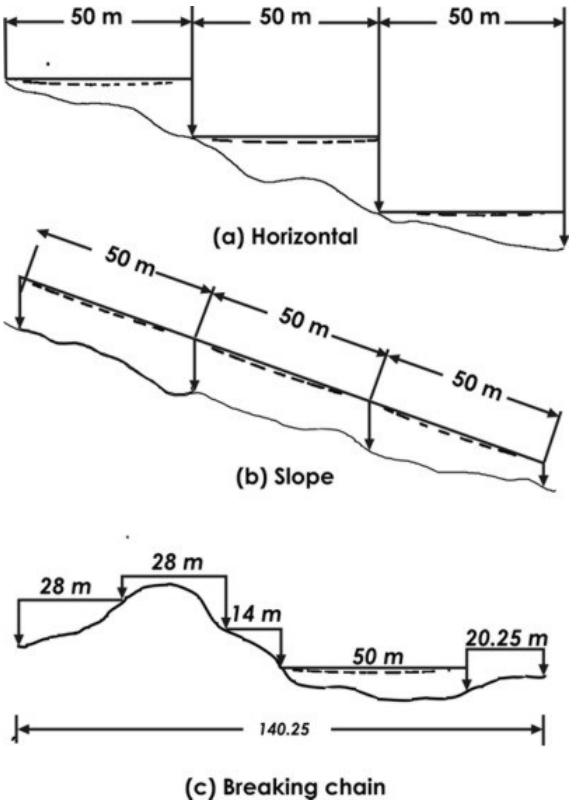
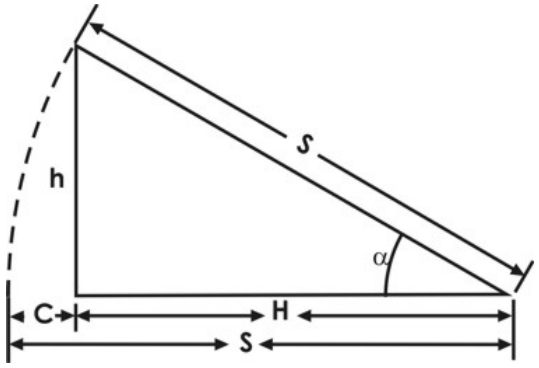


Figure 3 Ways to measure horizontal distance (directly and indirectly)



S = slope distance
h = difference in elevation (S × sin α)
H = horizontal distance (S × cos α)
C = correction or (S - H)

Figure 4 Trigonomic relationships used to construct slope correction tables

Principal sources of error in linear measurements:

1. incorrect length of the tape (stretched, mended, kinked)
2. tape not horizontal (one holding the tape high, one low or sloping ground)
3. tension not standard (too much tension causes a tape to stretch)
4. sag (belly)
5. improper alignment (pickets not aligned properly or distance not measured straight between pickets)
6. tape not straight (vertical or horizontal)
7. moving or slanting the pickets between measurements
8. taking the wrong point for zero
9. reading wrong numbers (e.g. 89 for 68)

Measuring directions

- Direction is the angular relationship between two lines passing through two points and intersecting or converging at a third point
- The angle is usually made with a reference line called a meridian.
- The angle can be measured in degrees, minutes and seconds
- Direction may be expressed in the form of an azimuth or a bearing.
- In either case, there are four Cardinal Directions: North, East, South, and West.

Bearings

Bearings are acute angles associated with the four quadrants of a circle. Measurements may not exceed 90 degrees since there are only 90 degrees per quadrant. Bearings are measured from the north-south line and do not exceed 90° degrees. Bearings are expressed in the form of e.g. N 60 E or S75 W. See Figure 5

Azimuth

Direction expressed as an azimuth is measured starting at North, in a clock-wise direction through a full 360. It assumes that you, or the point you are measuring from on the map, are at the centre of the circle. See Figure 6.

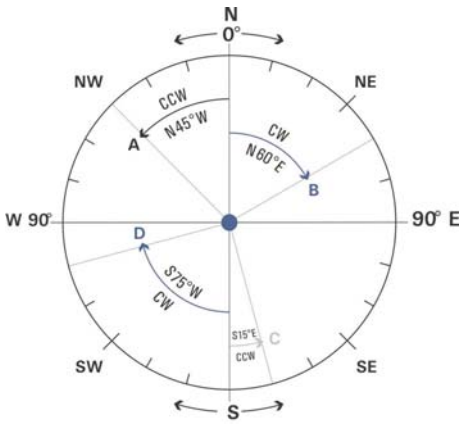


Figure 5

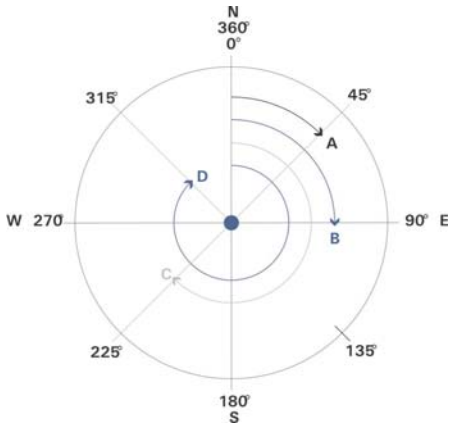


Figure 6

Compass

The compass is a directional instrument used to obtain a direction in accordance with lines that divide the earth into 360 equal divisions. These lines are called meridians and can be measured in degrees, minutes, and seconds.

Essential features of a compass (Fig. 7)

- A Compass Ring (Dial) that can be turned to set bearing or direction
- A Bearing/Sighting Line used to point the compass directly at an object
- A Magnetic Needle or thin strip of magnetized iron with a red tip that always points to the magnetic north
- An Orienting Needle, which is an arrow outline painted on the dial that rotates with the dial.
- Grid Lines which are used to align the compass with north on a map
- The North end of the needle is usually marked by an arrow.
- The magnetized needle is suspended on a low friction bearing in such a way that the needle is free to rotate in a horizontal plane.
- The needle is free to rotate when the compass base is held level to itself so that the needle points to magnetic north.
- In most compasses the needle is encased in a liquid which dampens both the vertical and horizontal movements of the needle
- Great care must always be taken when using the compass.
- Falling accidentally, squeezing or poor storage can cause cracks in the casing. This causes the liquid to evaporate and form bubbles. This would affect the accuracy of the instrument.

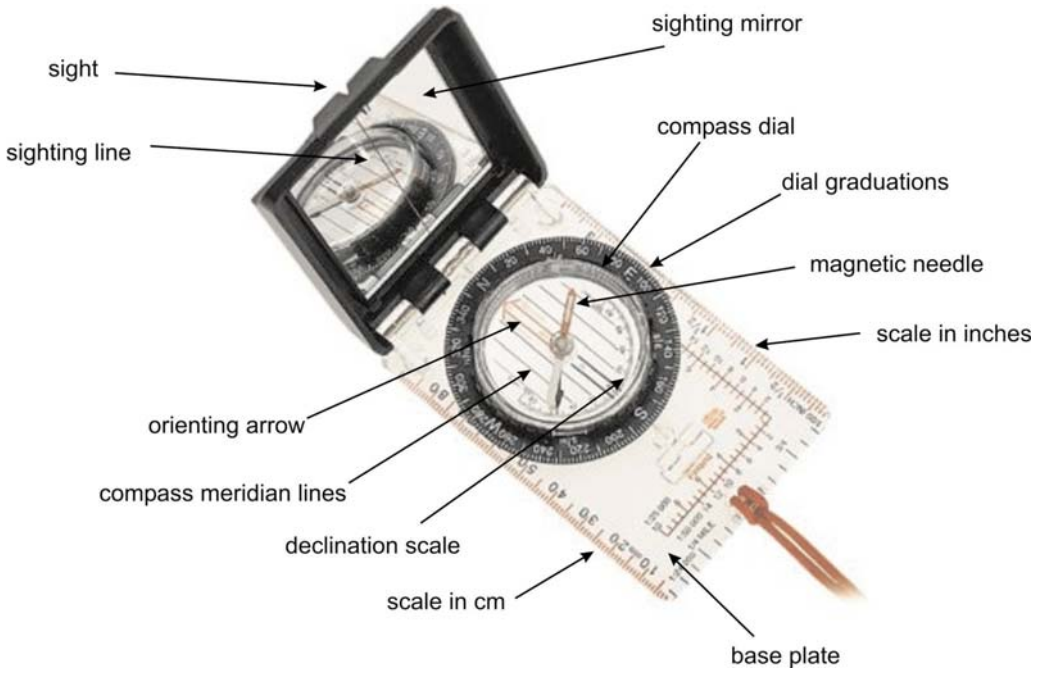


Figure 7 Illustration of the basic parts of a (mirror sighting) compass

Magnetic declination

- The earth acts like a great magnet. The source of magnetism is not concentrated at specific points but is distributed throughout the earth.
- The compass needle is magnetized and its direction is controlled by the magnetic lines of force at the surface of the earth. The magnetic needle hence points to the magnetic north.
- Magnetic declination is the angular difference between true north and magnetic north. The magnetic declination varies with the location and changes from year to year.
- At the present time, in Guyana, the magnetic north lies 14 degrees to the west of true north.

Magnetic and true bearings

- Magnetic bearing is the acute angle, which a line makes with a magnetic north-south line.
- Whether the bearing read from the compass is a true bearing or a magnetic bearing depends on the declination being set off on the compass.
- If the magnetic declination is set on the compass (the compass scale rotated left for west declination an angular distance equal to the declination) all bearings read will b true bearings,
- If the declination is not set off on the compass, the bearings observed will be magnetic bearings.

Local attraction

- Local attraction is a most common phenomenon occurring in certain areas.
- The lines of magnetic force, which orient the magnetic needle of the compass, can be altered by ore or mineral deposits, fence lines, and electrical transmission lines.
- Even such objects as choker cables, cutlasses, and metal mechanical pencils in a shirt pocket can cause the compass needle to deviate from its normal oriented position in the magnetic field.

Use of a field (mirror) compass

To use a field compass, the lid, which contains a mirror for viewing the compass needle, is tilted or raised up to find the bearing of a line

Taking a bearing

1. Hold the compass in the right hand at almost eye-height and take a sight on the line.
2. Rotate the compass dial with the left hand until the compass needle is centred over the orienting arrow
3. Determine the bearing of the line at the index pointer

To travel in a given direction

1. Rotate the compass dial and set the desired bearing on the index pointer.
2. Hold the compass squarely in front of your body
3. Rotate your body until the magnetic needle is aligned over the pointing arrow
4. Take a sight over the front V-sight, and pick an object (landmark) which is on line
5. While doing this sighting, observe the needle in the mirror to make certain that it coincides with the orienting arrow

To locate your position in the bush

- Choose two landmarks on your map
- Point the sight line toward one landmark.
- Rotate the compass dial until the red end of the needlepoint to the "N" on the dial.
- Read the heading at the index line.
- Place the compass on your map with the base plate edge touching the landmark.
- Pivot the compass until the red orienting arrow aligns with the magnetic north lines.
- Draw a line from the landmark along the side of the base plate on the map.
- Repeat this process with the second landmark.
- Your location is the spot where the two lines intersect.

Using compass and map

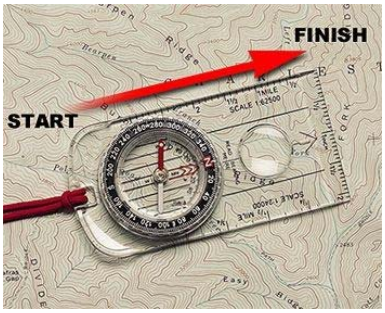


Figure 8

1. Place compass on map with base plate edge connecting to where you are (start "A") and where you want to go (finish "B"). Fig. 8

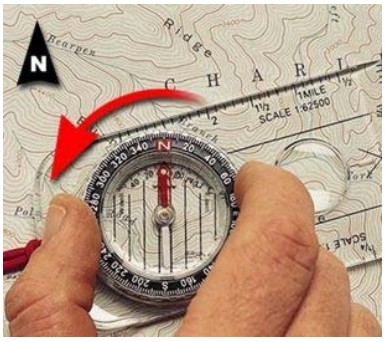


Figure 9

2. Turn the compass dial until the "N" aligns with magnetic north on map, with a compass without declination adjustment and with true north, with a compass with declination adjustment. Fig 9.

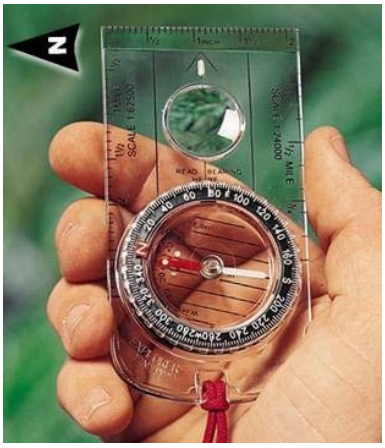


Figure 10

3. Hold the compass level in front of you with the sight line pointing straight ahead. Fig 10
4. Turn your body until the red end of the needle is directly over the red orienting arrow.
5. Look up and find a landmark.
6. Move to it. Repeat until you reach your destination.

Measuring vertical angles

Clinometer

A clinometer (Fig. 11) is a device used to measure vertical angles of a line of sight above or below the horizontal. The device is used by construction workers to measure grade angles, by forestry workers to measure the height of trees or slope angles.

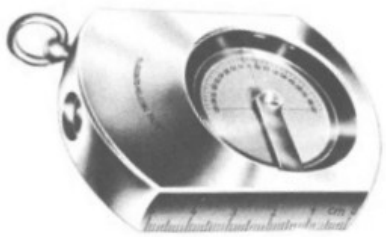


Figure 11 Example of a clinometer (Suunto)

Using the Clinometer

Note that there are two scales: the degree scale and the percentage scale as shown in Figure 12. The left-hand scale gives the slope angle in degrees from the horizontal plane at eye level. The right-hand scale gives the height of the point of sight from the same horizontal eye level, expressed as a percentage of the horizontal distance.

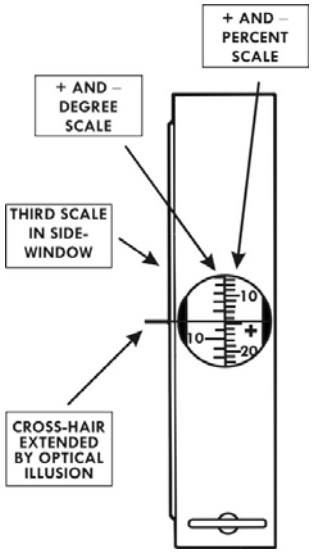


Figure 12 Eye view of a clinometer

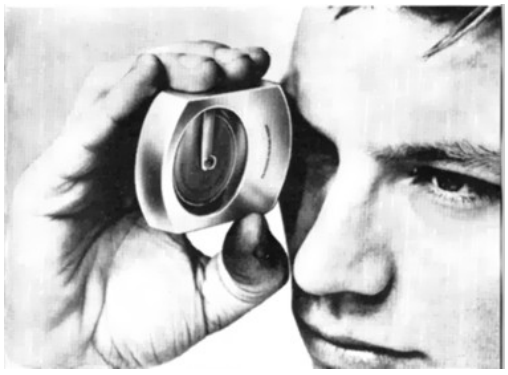


Figure 13 Illustration of the correct manner of holding the clinometer

The steps to follow are:

1. Take readings with the right eye as shown in Figure 13.
2. Both eyes should be kept open.
3. The supporting hand must not obstruct the vision of the other eye.

4. The instrument is held before the reading eye so that the scale can be read through the optics, and the round side-window faces to the left
5. The clinometer is aimed at the object.
6. Look through the eyepiece with one eye, and will see the angle measuring scale and a horizontal line.
7. Sight on the object you want to measure, like a treetop or a levelling rod, with the other eye.
8. Owing to an optical illusion the hair line (crosshair) seems to continue outside the frame and is thus easily observed combining the scale and the object
9. The instrument is raised or lowered until the horizontal line is sighted against the point to be measured.
10. When the horizontal line is aligned with e.g. the levelling rod, you simply read the scale to find the angle in degrees or percent.
11. To measure ground slope one has to aim at an object that has the same level as one's eye height.
12. Instead of using a levelling rod, a simple way to construct an object at the correct level is to tie a ribbon around a stick at eye height level.
13. Take your sighting three times and then average the results.

Calculating elevation

Calculating the difference in elevation between two points is easy once the slope percentage and horizontal distance are known (see Figure 4):

1. The horizontal distance is calculated as $H = S \times \cos \alpha$ or read from the slope correction table.
2. The clinometer percentage reading ($h/H \times 100\%$) is multiplied by the horizontal distance H gives the difference in elevation h.
3. Add the difference in elevation to the known elevation of your starting point

Global Positioning System (GPS)

The Global Positioning System (GPS) is actually a constellation of 27 Earth-orbiting satellites that communicate with receivers on earth (or in the air).

How does GPS work

- GPS satellites orbit and transmit signal information to earth.
- GPS receivers pick this information up to calculate the user's exact location.
- Essentially, the GPS receiver compares the point in time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is.
- With distance measurements from a few more satellites, the user's position is determined and displayed on the unit's electronic map.
- A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement.
- With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude, and altitude) Fig 14.
- Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

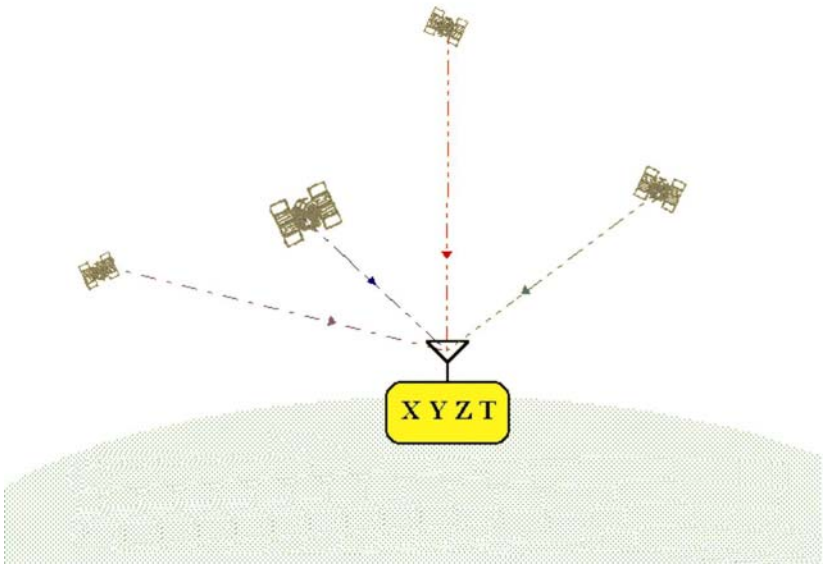


Figure 14 Measurements of signal arrival times from at least four satellites are used to estimate four quantities: position in three dimensions (X, Y, and Z) and GPS time (T).

The GPS satellite system

Figure 15

- The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us (Fig 15).
- They are constantly moving, making two complete orbits in less than 24 hours.
- These satellites are travelling at speeds of roughly 7,000 miles per hour.
- GPS satellites are powered by solar energy.

What is the signal?

- GPS satellites transmit two low power radio signals. The signals travel by line of sight, meaning they will pass through clouds, glass, and plastic but will not go through most solid objects such as buildings and mountains.

Sources of GPS signal errors

Factors that can degrade the GPS signal and thus affect accuracy include the following:

- The satellite signal slows as it passes through the atmosphere. The GPS system uses a built-in model that calculates an average amount of delay to partially correct for this type of error. Total error can be 10 metres.
- Signal multipath occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before it reaches the receiver. This increases the travel time of the signal, thereby causing errors.
- The receiver's built-in clock is not as accurate as the atomic clocks onboard the GPS satellites. Clock errors can result in 1-metre errors.
- The more satellites a GPS receiver can "see", the better the accuracy. Buildings, terrain, electronic interference, or sometimes even dense foliage can block signal reception, causing position errors, or possibly no position reading at all. GPS units typically will not work indoors, underwater or underground.
- Satellite shading — this refers to the relative position of the satellites at any given time. Ideal satellite geometry exists when the satellites are located at wide angles relative to each other. Poor geometry results when the satellites are located in a line or in a tight grouping.
- User mistakes, including incorrect geodetic datum selection, can cause errors from one to hundreds of metres.

GPS receivers

- When a GPS receiver (Fig 16) is turned on, it first checks that its almanac is current, and then updates itself if necessary. Next, it searches for, and logs the satellites in view, and then it computes a 'fix' from those satellites using the parameters set in the receiver.
- The receiver is designed to capture data, store the data and manipulate it within certain limits, display data visually and often download it to a computer. Fig 17)

- Most GPS receivers have difficulties in receiving signals through the dense canopies, making reliable use in forest dependant on using gaps in tree cover.

Figure 16

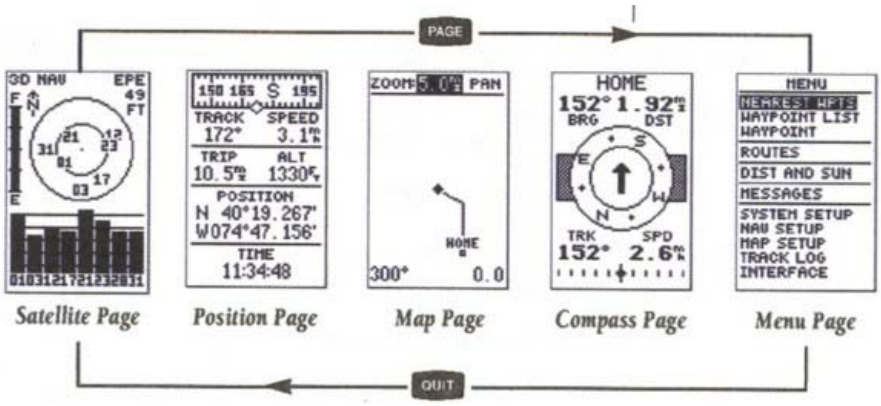


Figure 17

Uses of GPS

Being able to know the position of an object accurately is extremely useful and has many applications in forestry. Some of these are:

- Gathering position data for plotting on maps. This can range from the creation of new maps and plotting of boundaries to the plotting of individual trees.
- Providing data for finding a position again. This is especially useful in relocating Permanent Sample Plots, which may only be visited every five years.
- Navigation, either by reference to data stores in the receiver or to map coordinates. This is especially useful in retracing a route in order to return.

Waypoints

The machine records an actual position when the button is pressed. A series of these waypoints can be constructed along a route, enabling the return navigation to be from waypoint to waypoints. Some machines give directions in order to return to a given waypoints, using a compass bearing and distance.

Continuous Map

This records and display a digital map of a route followed. The major disadvantage, for a handheld device, is that battery use is high in this mode. Information can be downloaded to a computer and plotted on a map (GIS).

MODULE 4: BLOCK LAY-OUT

Block Demarcation

Definition

Blocking is the division of the productive forest area, in which forest management shall be carried out, into working units of generally 100 hectares

Objectives

- To organise forest operations into manageable units
- To increase the efficiency of the operations to be undertaken

Team

- 1 Team leader - booker
- 1 compass man
- 3 Field assistants Labourers

Materials

- GPS
- Compass
- Clinometer
- Measuring tape (30 or 50m)
- Aluminium tags / flagging tape
- Recording forms
- Slope correction table
- Clipboard
- Pencils, eraser, sharpener
- Permanent marker
- Cutlasses
- Cutlass file
- Paint & paint brushes
- Safety gear (helmets, high-visibility vests, safety boots)
- First-aid kit, snake-bite kit

Methodology

- Blocks are generally square and measure 100 ha (1000 m × 1000 m).
- Lines should have a width of 1 m minimum.
- The base and back lines are oriented E to W, the other two block lines N to S to make a square.
- GPS geographic coordinates are taken at the SW corner of the block
- Trees on both sides of the lines are painted with standardised colour.
- Block corners should indicate the block numbers.
- Pickets at 50m intervals along base and back line (E-W).
- Pickets at 20m intervals along the block lines (N-S).

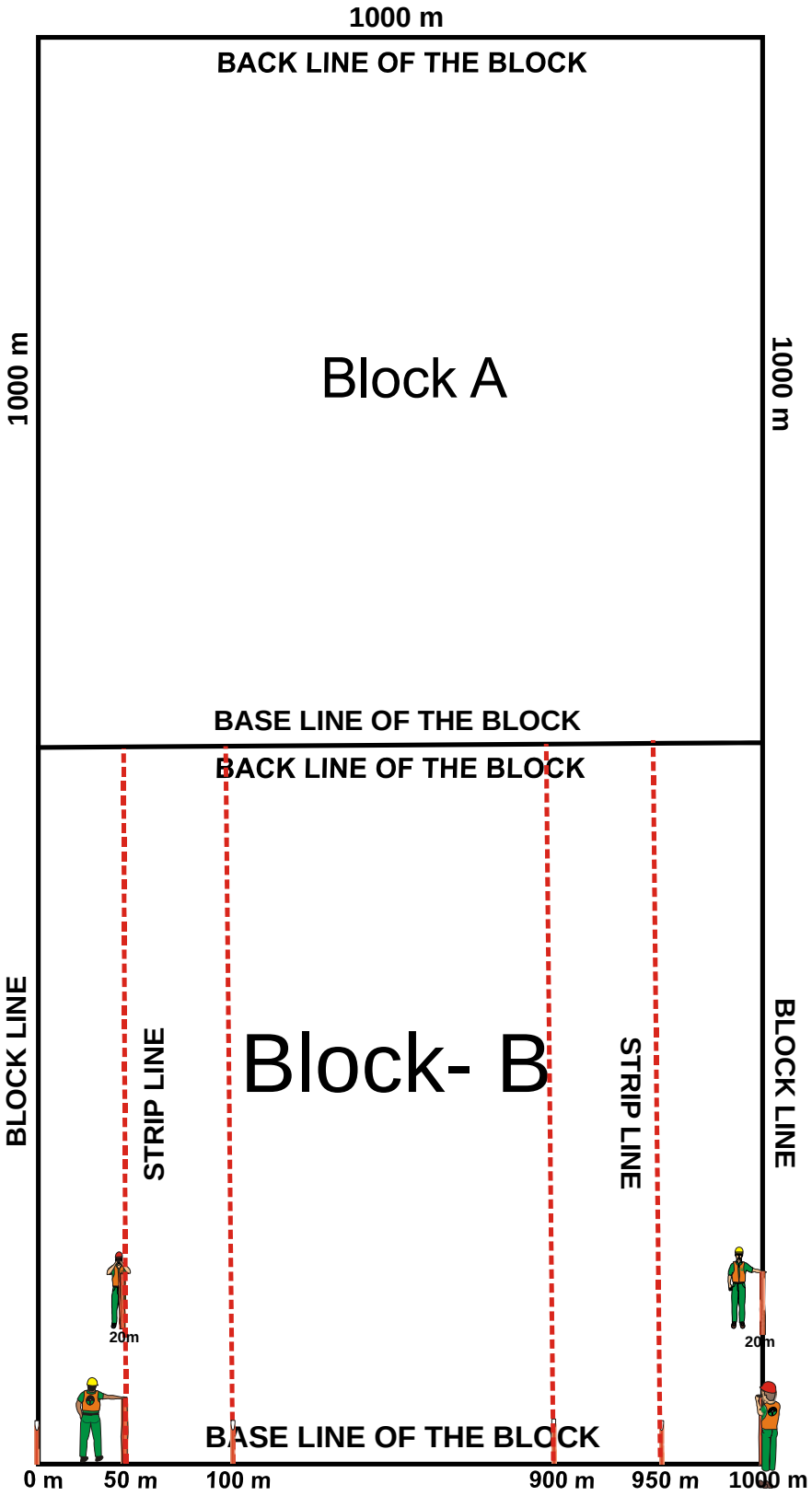


Figure 18 Setting out the perimeter of a square block

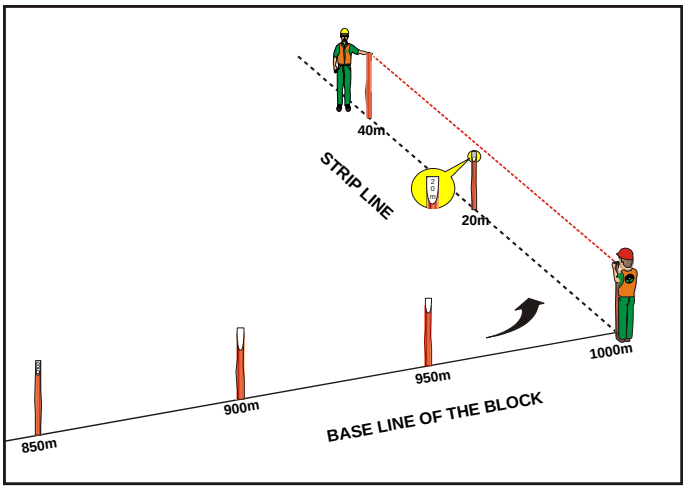


Figure 19 Establishing the base line and eastern block line

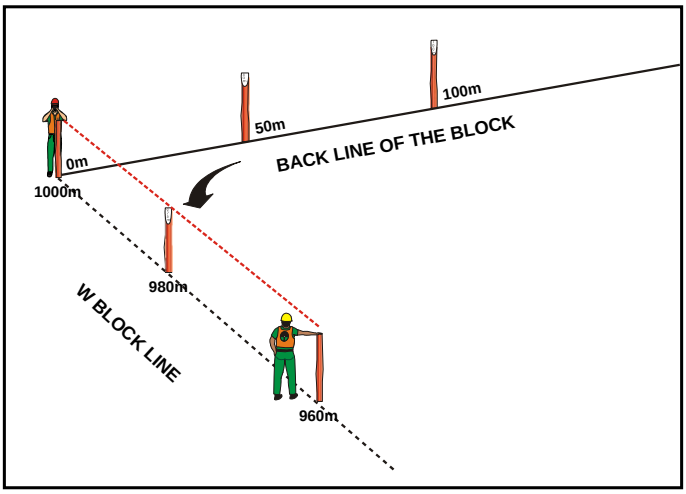


Figure 20 Establishing the back line and western block line

Advantages

- ☺ Improves forest management.
- ☺ More efficient logging operation.
- ☺ Facilitates activities such as 100% inventory, and the planning and construction of feeder roads and skid trails.
- ☺ Improved post-harvest activities.
- ☺ Appropriate identification given to each block to be harvested.
- ☺ Development of tree location maps.

Disadvantages

- ☹ Requires skilled labour
- ☹ Initial costs for equipment, tools and materials

Establishment of Strip lines

Definition

Strip line establishment is the division of the block into 1000-m long and 50-m wide strips running S→N

Objectives

- To facilitate 100% pre-harvest inventory
- To facilitate planning of skid trails
- To improve accessibility and orientation within the block
- To identify buffer zones, steep slopes and other exclusion areas

Team

- Same team as block demarcation

Materials

- Same tools and materials as block demarcation

Methodology

- At a bearing of 90° to the base line, lines are cut every 50-m extending to 1000-m to the northern boundary (back line).
- Pickets are placed at 20-m intervals
- All pickets along each strip line are labelled with its line numbers, and the distance along the line (base line is always zero (0m).
- Check bearing by measuring the width between the strip lines every 200-m
- All measurements are based on horizontal distance. If the ground is sloping, adjustment should be made by using a slope correction tables or "step-chaining"
- Indicate terrain features; creeks, gullies, swamps, old roads, old skid trails
- Record slope percentage between pickets

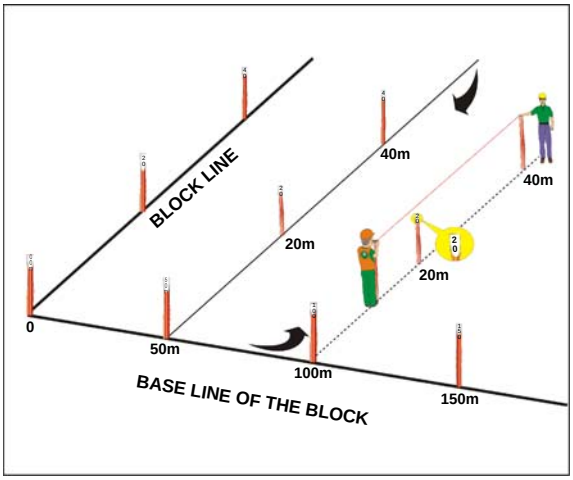


Figure 21 Establishing a strip line

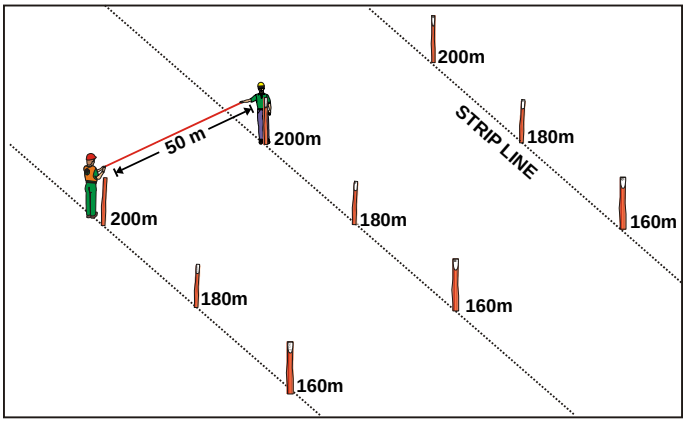


Figure 22 Checking for consistent strip width

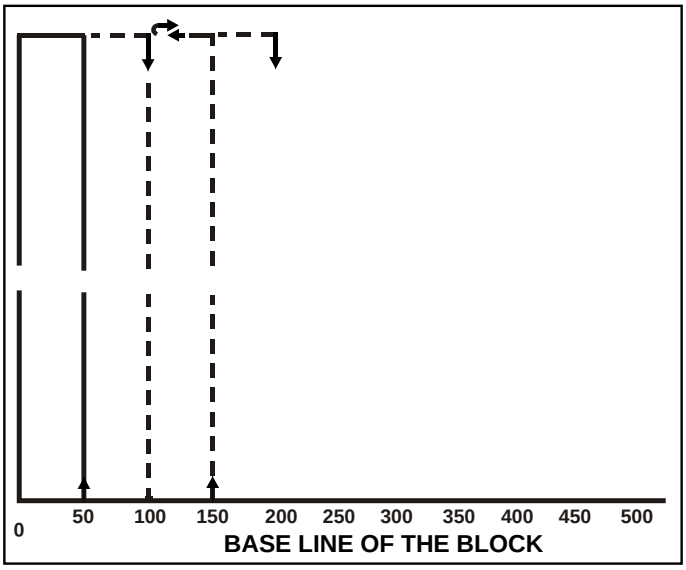


Figure 23 Sequence followed in establishing strip lines

Advantages

- ☺ Increases inventory productivity and accuracy
- ☺ Facilitates finding coordinates of trees for mapping
- ☺ Facilitates mapping of the physical aspects of the area such as watercourses and topography

Disadvantages

- ☹ Requires skilled labour
- ☹ Increases start-up costs

MODULE 5: 100% PRE-HARVEST INVENTORY

Definition

100% pre-harvest inventory is the measuring, assessing, and mapping of trees in the selected block, based on pre-determined technical and marketing prescriptions, including terrain features.

Objectives

- Identify and map crop trees and potential crop trees
- Map tree locations, topography and watercourses

Team

- One Booker - Team Leader
- Two Tree spotters
- Two tree location staff

Materials

- 2 Measuring tapes (30 m)
- 2 Diameter tapes
- Clinometer
- Aluminium tags or flagging tape
- Hammer & nails
- Permanent markers
- Data sheets
- Clipboard, sheet holder
- Pencils, eraser, sharpener
- Cutlasses / hatchets
- Safety Gear (helmet, high-visibility vest, safety boots)
- First-aid kit, snake-bite kit

Enumeration criteria for 100% inventory

- Species to be enumerated
- Minimum diameter limit (for each species group)
- Minimum log length, log quality

Variables to be collected

- Tree number
- Common name
- Bole diameter (at breast height)
- X and Y coordinates
- Commercial Bole length
- Tree in Buffer Zone
- Tree on slope > 40%
- Proximity trees
- Observations (topography)

Methodology (Fig 24)

1. The tree spotter and location assistants find the first tree along the strip line;
2. The tree spotter identifies the species and the assistants take its X and Y coordinates;
3. The tree spotter measures diameter (at breast height) and the booker records the information on the field sheet;
4. The tree receives a numbered tag

Terrain (ridges, slopes, swamp), drainage (creeks, gullies) and other features (old skid trails, forest type) should be observed and mapped at the same time by assistants and booker.

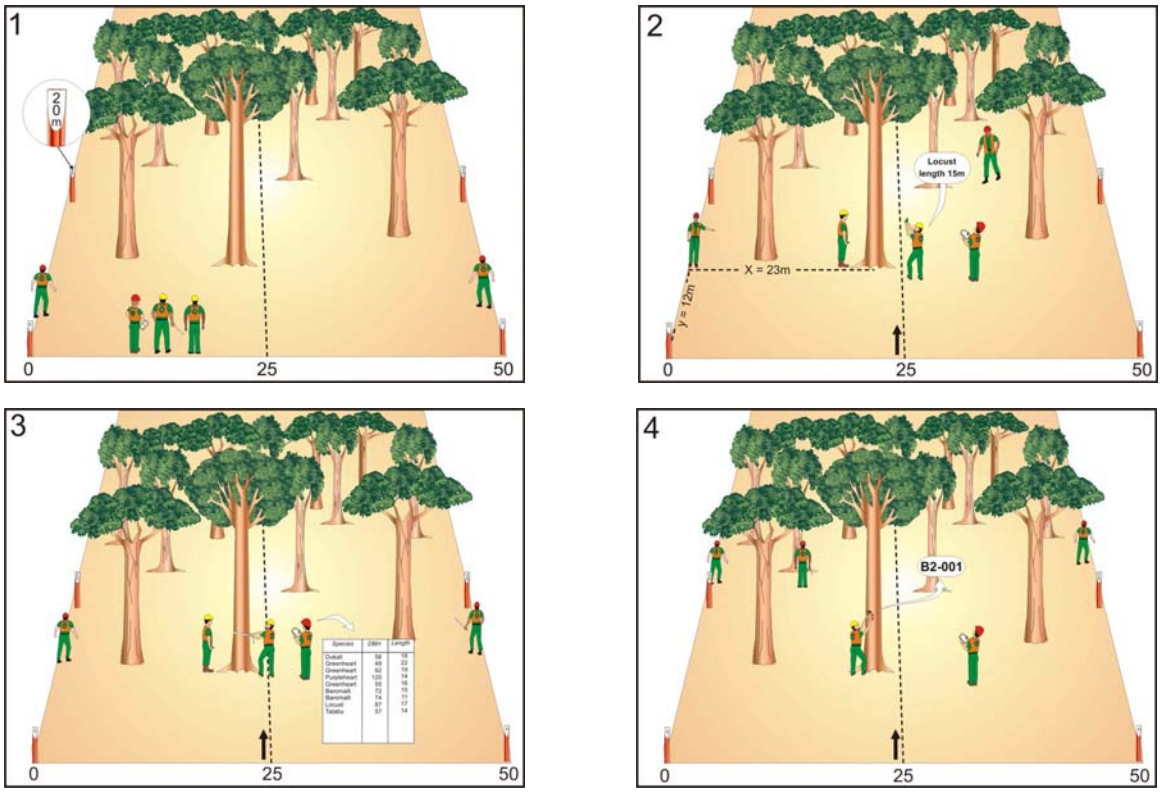


Figure 24 Procedure for enumerating crop trees

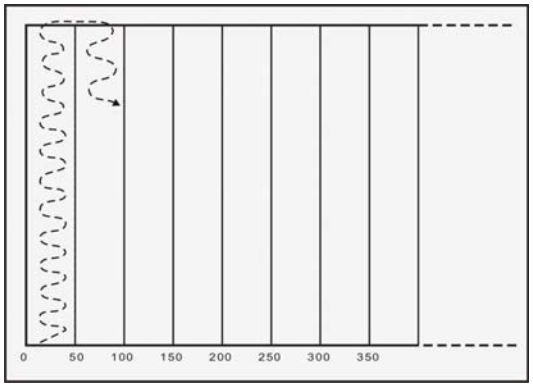


Figure 25 Course followed during 100% inventory in a 100-ha working unit

Assessing stem quality

Normally, only sound trees are enumerated, whereby the minimum commercial bole length is considered. A commercial bole should be free from decay and straight (Fig 26).

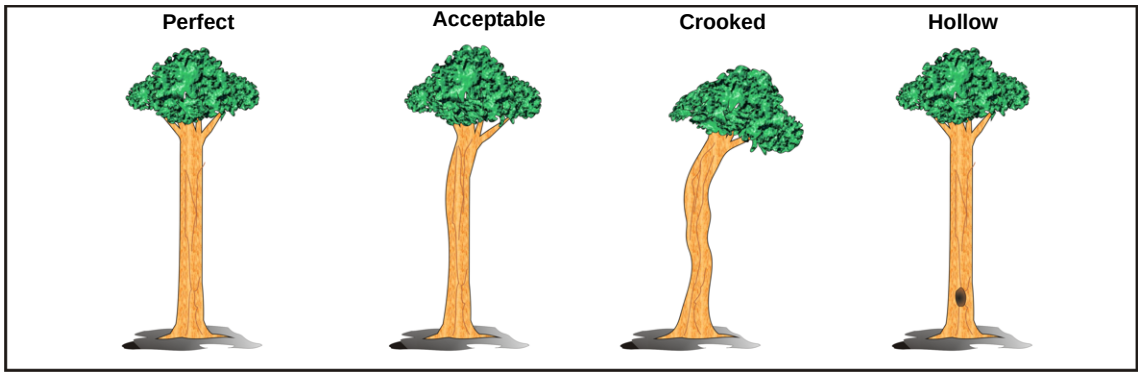


Figure 26 stem quality

Presence of hidden defect (internal rot) cannot always be determined, but there are a number of telltale signs that can be used (Fig. 27). In case of doubt, enumerate the tree still. The tree will be checked again during tree marking and just be fore felling.

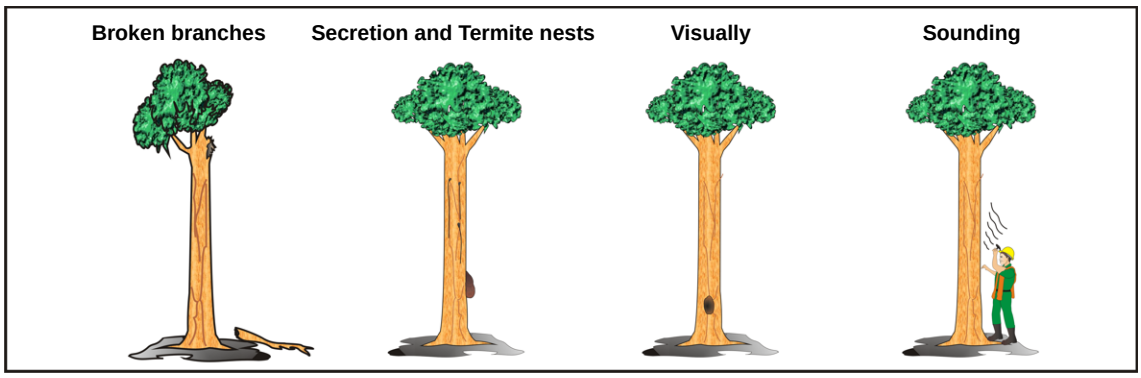


Figure 27 Signs of defect

FORESTRY TRAINING CENTRE — PRE-HARVEST INVENTORY FIELD FORM

Concession: TSA 4/90 | Compartment: 5 | Sheet #: 8 | Or:

Block number: 2k | Strip Number 6 | Date: 23/06/03 | Direction of enumeration: N

Min. DBH (cm): 45 | Min. log length (m): 6 | Crew Members: TH,FS,IJ,GR,AG

No	Species	DBH (cm)	Log length (m)	X coordinate (m)		Y coordinate (N-S) (m)	Buffer	Proximity	Slope
				line	offset				
110	Greenheart	45	6	12	20	12	-	-	1
111	Greenheart	72	12	13	13	14	-	-	2
112	Purpleheart	92	15	12	5	18	-	-	1
113	Kereti	60	12	12	8	22	-	-	1

One hectare map

Scale: 1:1000 (1cm=10m)

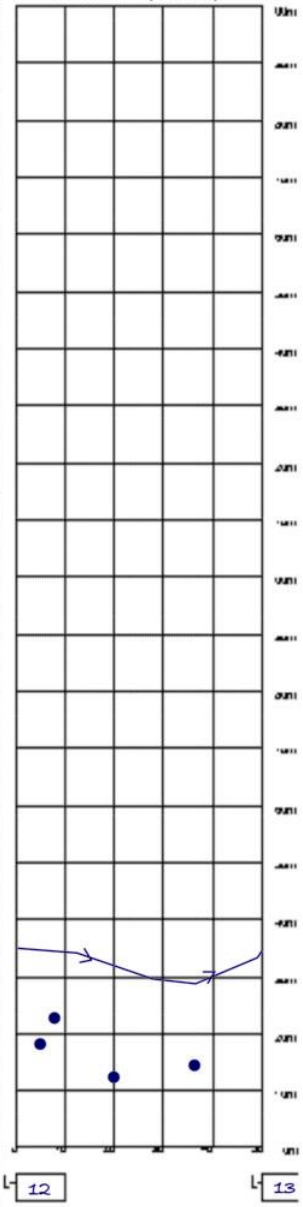


Figure 28 Sample of a 100% pre-harvest inventory datasheet

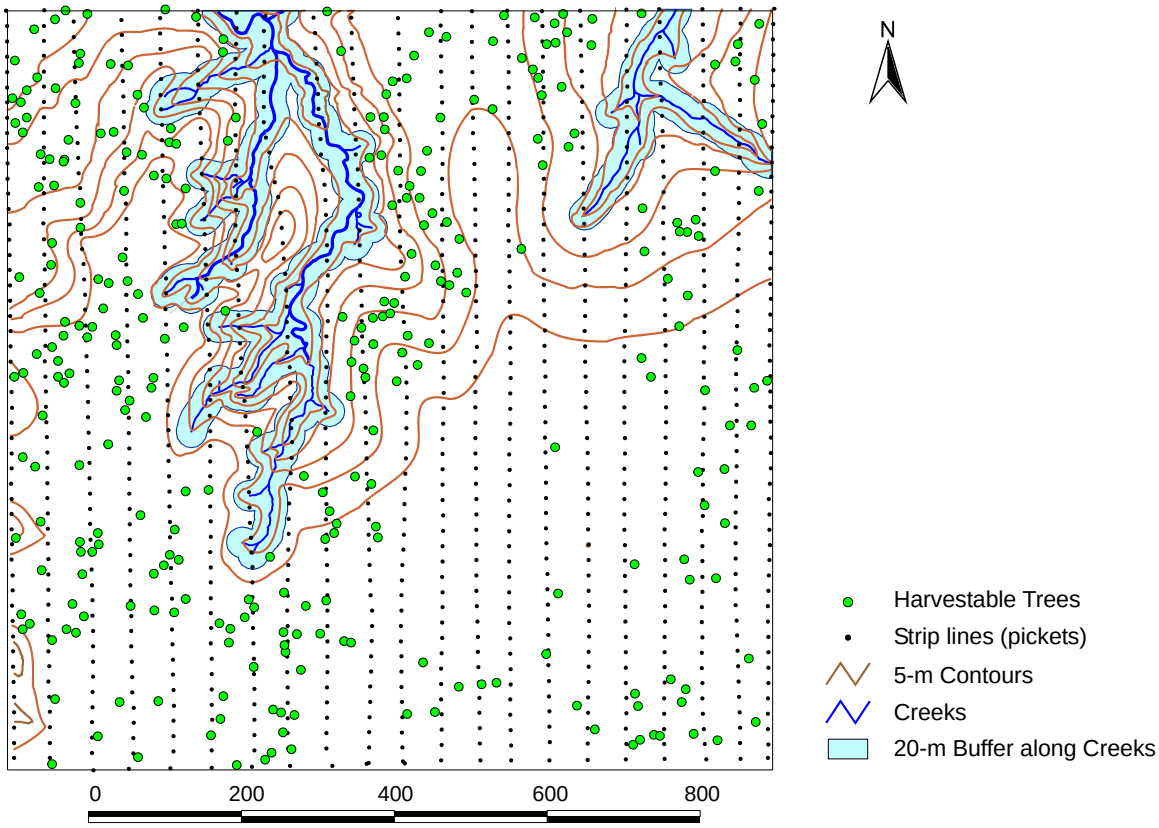


Figure 29 Tree stock (base) map of 100-ha block

Advantages

- ☺ Previous knowledge of timber stock
- ☺ Allow timely marketing of timber
- ☺ Location of trees facilitates planning of subsequent activities
- ☺ Location of creeks and topographic information facilitates the planning of infrastructure

Disadvantages

- ☹ Additional activity compared to conventional logging.
- ☹ Costs recuperated one year later (or when logs are harvested).

Variations

- 100% inventory of commercial and potentially commercial trees dbh ≥ 35 cm
- 100% inventory of commercial trees dbh ≥ 45 cm
- Diameter limits differ per species (group)

Alternative methods

- 4 Tree Spotters, one booker, with sketch map (no x, y coordinates)
- Line based (left and right) system

Diameter measurements

A Diameter Tape is a measuring tape with normal metric increments printed on the one side and diameter increments on the other (Figure 30).

The Diameter Tape is used by Foresters to estimate the diameter of trees. Measurements are made at 1.3m (4.5 ft; designated 'breast height') above the ground.

It gives a direct estimate of diameter, though one measures the circumference of the bole, without the need for any further calculation. If a tree's cross section would be a perfect circle, the circumference (or girth) of a tree is e.g. 150 cm, then the equivalent diameter will be equal to 150 cm divided by the value 'π' (pronounced '*pi*' which equals approximately 3.1416) = 47.7 cm. Therefore, the side of the tape with diameter increments would read 47.7 cm.

Use

- The tape is wrapped around the tree stem and pulled tight. (Figure 31)
- The tape should not be kinked, twisted, or influenced by bark or branches.
- The diameter scale should be facing out and the tape held at right angles to the plane of the stem.
- The zero mark on the tape should be held firmly against the tree.
- As the tape is wrapped around the tree, the other end should be overlaid such that the diameter scale can be seen.
- The diameter scale opposite the zero mark on the tape is read off as the diameter of the tree.

Figure 30 Diameter tape; note that the scales on either side are different

Measuring Tree Diameter

During stock survey, measurements are usually rounded to the nearest cm. For trees with buttress, the diameter is measured 30 cm (1 ft.) above the buttress (figure 32).

In case of high buttresses, the bole cannot be measured directly, but has to be estimated. This is best done with the aid of a stick or with two persons using the other side of the tape (Figure 33).

Estimating bole length needs some practice and regular checks by estimating bole lengths measured with the aid of a 30-m tape and a clinometer (Figure 34).

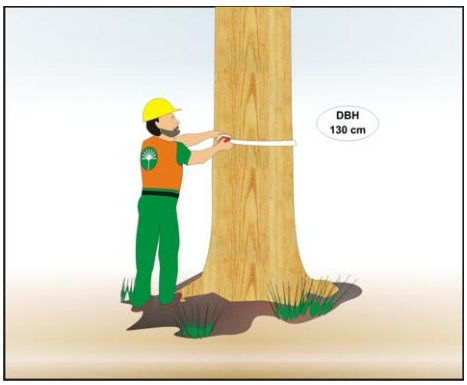


Figure 31 Measuring trees without buttress

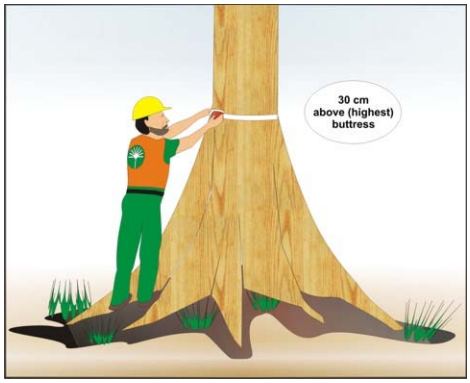


Figure 32 Measuring trees with buttress

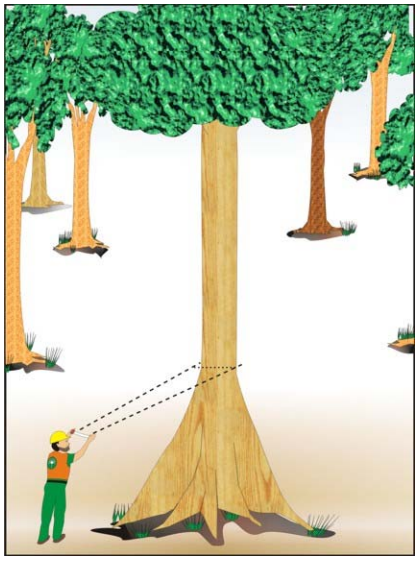


Figure 33 Estimating diameters above buttress

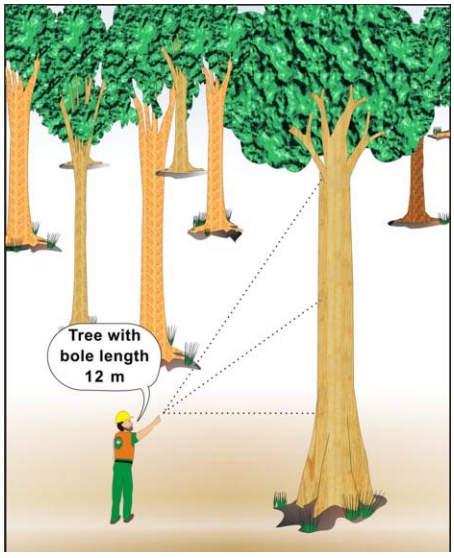


Figure 34 Estimating commercial bole lengths

MODULE 6: DATA PROCESSING AND MAPPING

Data processing

Definition

The processing, analysis and transferral of data and information collected in the field from field forms to a database or databank

Objectives

Organise field data to facilitate the planning and organised execution of harvest and post harvest activities, and to forecast production in terms of species, numbers, and sizes.

Team

Manual data processing

- 1 clerk

Computerised data processing

- 1 trained computer operator
- 1 data entry clerk - who understands the software used

Material & Equipment

- Compartment Map
- 100% pre-harvest inventory field (data) sheets
- Felling list with the species, and log diameter and length limits used by the company
- Stationery

Manual data processing

- Calculator

Computerised data processing

- Computer with adequate software (e.g. Excel, Access)

Methodology

Data processing could be achieved manually or with the aid of computers. Concessionaires whose annual harvest (coupe) is less than 300 ha/year, could process the data processing manually, but it is recommended that concessionaires whose annual harvest exceeds 300 ha, use computers for data processing (or subcontract this activity to specialised bureaus) to be able to handle the large amount of data to be processed.

In case of manual processing and mapping, the tree data collected in the field are summarised in tabular format giving total tree numbers and volumes by species by diameter class for each 100-ha block, using a pocket calculator.

In case of computerised processing, the information collected in the field is entered into a database or spreadsheet using a predefined template, which mirrors the layout of the field sheet and automatically calculates tree coordinates using the SW corner of the block as an

origin. Block summaries (e.g. volume or numbers by species) can then be easily produced in a spreadsheet using the pivot table feature

Advantages

- ☺ Facilitates planning and execution of pre-harvest, harvest and post-harvest activities for a determined area.
- ☺ Quick access to information on potentially harvestable trees in terms of quantity (volume).
- ☺ Permits prior planning of sales.
- ☺ Planning of silvicultural activities.

Disadvantages

- ☹ Requires equipment and software (computer, printers etc.).
- ☹ The initial cost is high in terms of equipment and trained personnel.

Variations

- Handheld Data Collectors could be used in place of field forms for concessions that harvest over 10,000 ha/year to reduce data entry time.
- Data processing should be done in an automated manner to increase productivity.

Stock map preparation

Definition

Map preparation is the process of transferring information collected in the field unto a flat surface (paper).

Objectives

Provide planners and forest teams with a visualization of the area to be managed, with information such as topography, hydrology, tree location, roads, landings etc.

Team

- 1 Cartographer or draughtsman
- 1 Assistant

Material & Equipment

- Pencils, pens, erasers, markers/highlighter.
- Straight edge ruler, protractor, square, parallel rule.
- Inventory data.
- Paper (grid paper, vegetable or tracing paper).
- Drawing table.
- Computer

Methodology

There are two methods used to produce stock maps from inventory data and field sketch maps:

1. Computerised (using e.g. Arc View GIS)
2. Manually

Manual mapping.

- Grid paper is used to draw the base map at a scale of 1: 1,000.
- Block boundaries, strip lines, creeks, and topographic features are plotted onto the base map.
- Tree locations are plotted using the x and y coordinates, and the corresponding number placed near the point.
- Slope classes are indicated along strip lines using the following symbols: > 5-10%, >> 10-20%, >>> 20-40%, >>>> 40% and more, whereby the symbol points uphill. Slope data collected during strip line establishment (traversing) should be used to determine slope class.
- Harvestable and potentially harvestable trees are highlighted.
- The legend, scale, name of cartographer, direction, and date should be displayed clearly to make interpretation easy.

- Proposed skid trails and log markets are plotted on the map based on the location of individual trees or concentrations of trees to be harvested.
- Smaller copies of the map are made for use by the pre-harvest and harvest crews.

Computerised mapping

- Data entered previously in the databank (e.g. Excel, Access), are exported as a dBase (*.dbf) file.
- The file is added to an ArcView project as a "table". The table is then added to the "view" as an "event theme".
- Pictorial information on the sketch map on the field sheet is added manually. Create new themes for creeks, gullies, skid trails etc.
- Buffers can be added to any linear element.
- Slope classes are indicated in a similar way as with manual mapping.
- In case detailed elevation information is available (X,Y,Z grid with a spacing of 20 x 20 m), a contour map can be produced through interpolation (using the spatial analyst extension in Arc View).

MODULE 7: PLANNING OF SKID TRAILS

Definition

Skid trail planning is the activity through which the route for extraction of logs by a skidder or tractor is defined

Objectives

- To set out a pre-determined route by which the skidder operator retrieves logs from stump and conveys them to the log market
- To minimise machine round-trip time
- To reduce the environmental impact of the skidding activity

Team

- 1 Technician
- 2 Field assistants

Materials

- Tree location map
- Set square, Protractor
- Compass
- Clinometer
- Measuring tape (30m)
- Flagging tape (assorted colours)
- Note book
- Pencil, eraser, sharpener
- Permanent marker or crayon
- Cutlasses & cutlass file
- Safety gear (helmets, high-visibility vests, safety boots)
- First-aid kit, snake-bite kit

Considerations when planning skid trails

- The skill level of the technicians
- The reliability of the tree location map
- The agreed criteria for the planning

General prescriptions

Locate major skid trails:

- More than 50 m away from watercourses
- On ridges where possible to allow proper drainage

Maximum allowable gradient:

- Main trails: 20%
- Branch trails and tracks: 40% (Gradients > 20% only allowed for short distances (<30m) and only once adequate drainage provided).

Area occupied by skid trails:

- Less than 8% of the total area of the block
- Maximum skid trail density: 20 km per 100-ha block (or 200 m per hectare).

Curves and junctions:

- Minimum curve radius = 25 m
- Minor trails should join major trails at an angle < 60° (preferably < 45°).

Methodology

FIRST STAGE: PRE-PLANNING ON THE TREE LOCATION MAP

1. Locate log markets (landings) and main skid trails based on the general topography of the block (Fig. 35)

Consider:

- the location of the road, creeks and ridges;
- the number of trees to be harvested in each part of the block;
- the topography of the adjoining blocks;

The number of log markets and main skid trails will depend on these considerations.

2. Pre-plan branch trail network following a herringbone design (Fig. 36)

- Branch trails should make an angle of 45 degrees with the main trail
- Spacing between branch trails should be approximately 100 m
- Distance between branch trail starting points = approximately 140 m.

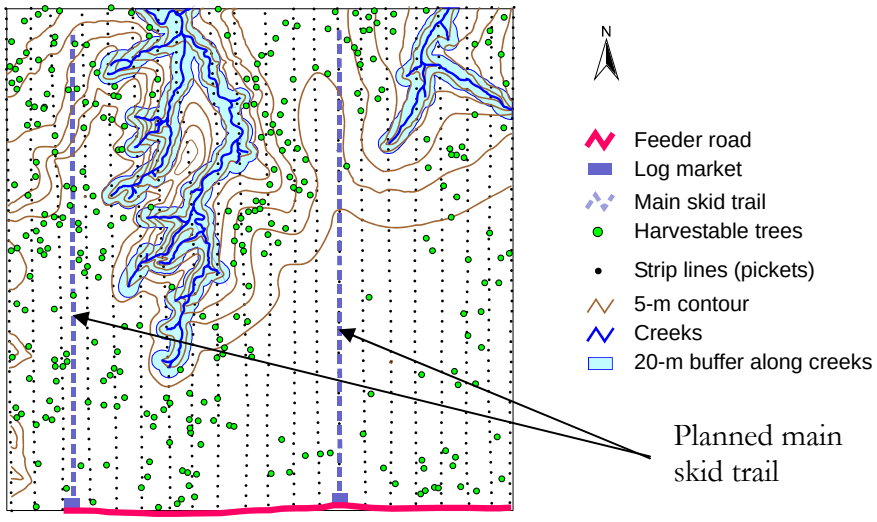


Figure 35 Locating log markets (landings) and main skid trails

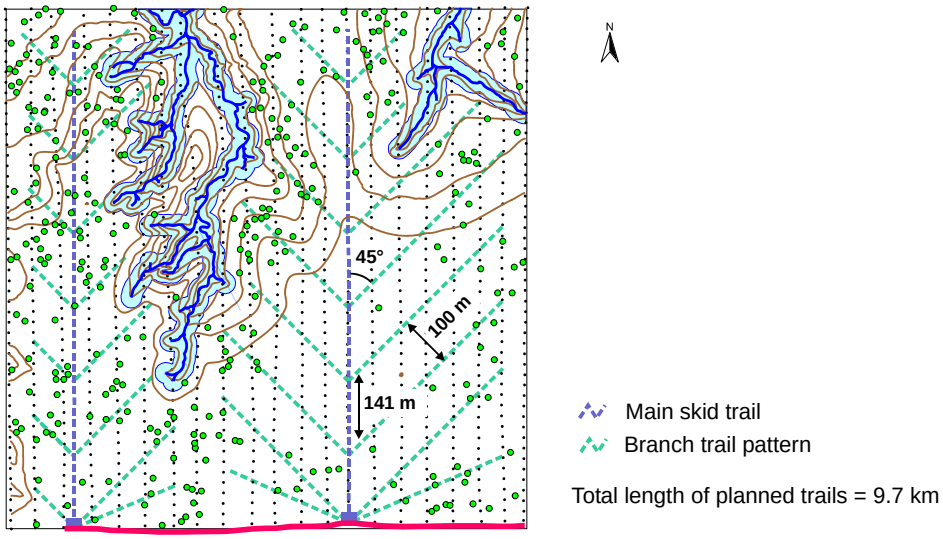


Figure 36 Basic branch trail pattern

Alternative: "Fan"-shaped skid trail pattern (Fig. 37)

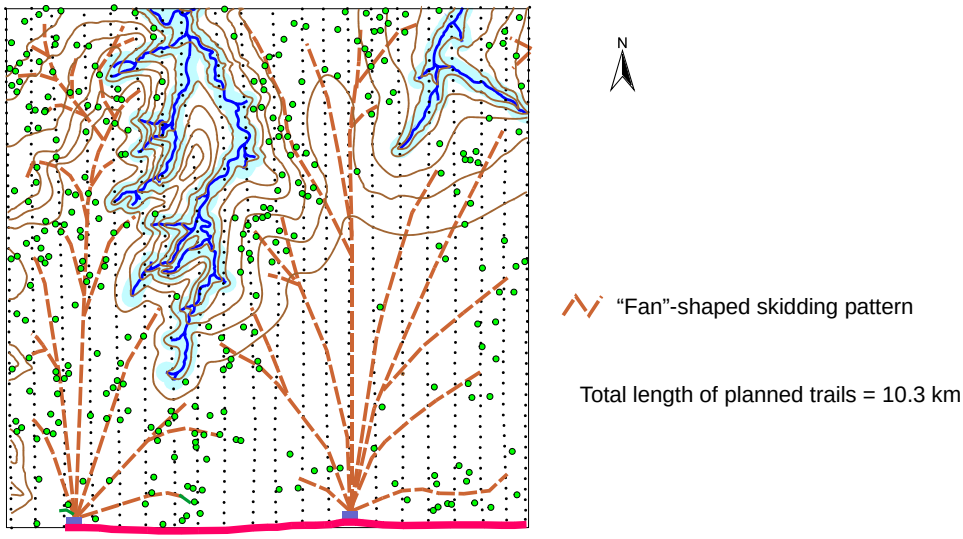


Figure 37 Alternative skid trail design

Advantages

- ☺ Allows the skidder to move faster between stump area and log depot
- ☺ Reduces the number of trips over the main trail (less tail deterioration, less soil compaction)

Disadvantages

- ☹ Time and cost to push trails is higher (± 25%)
- ☹ Increase of area affected (vegetation damage and soil compaction) by skidding (± 25%)

3. Adjust main and branch trail alignments according to the terrain conditions (uphill skidding) (Fig. 38)

- Main trails should always be located on the ridge top
- Stay on the ridge as much as possible
  - ☛ *Check distance between contour lines on map to ensure that gradients are acceptable*
- Plan to set out the skid trail as straight as possible
- Plan the skid trail considering the type of machine to be used, soil type, species to be harvested, topography and skidding distance
- The skid trail should start either at the back or the front of the log market

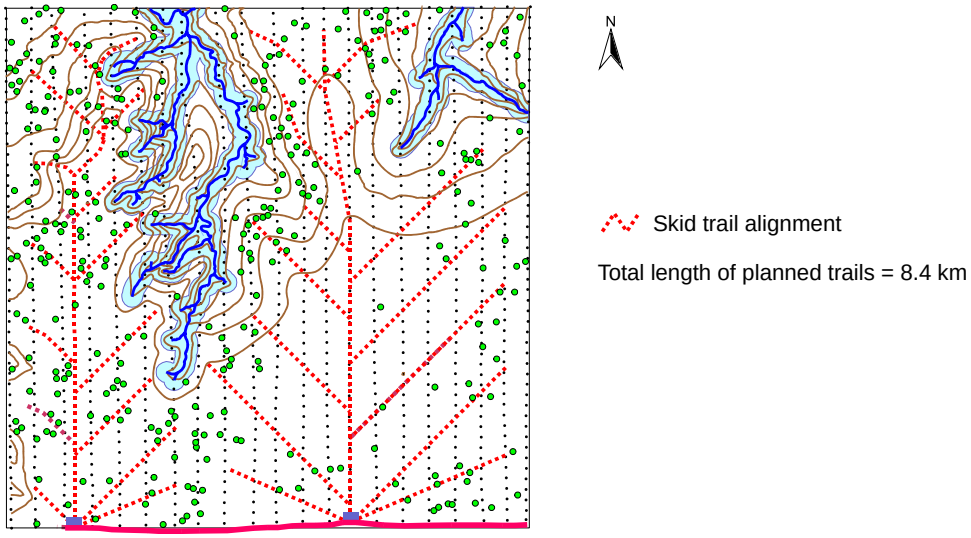


Figure 38 adjusting skid trail design to topography

4. Adjust branch trail alignments according to the tree distribution (concentrations) (Fig. 39)

- Reduce the number of branch trails in case trees occur in groups
- Adjust location and alignment to fit tree distribution
- All trees should be within 50-m distance to the trails
- Distance between branch trails should not be less than 100 m
- Watercourse crossings shall be marked as such on the tree location map and on the ground

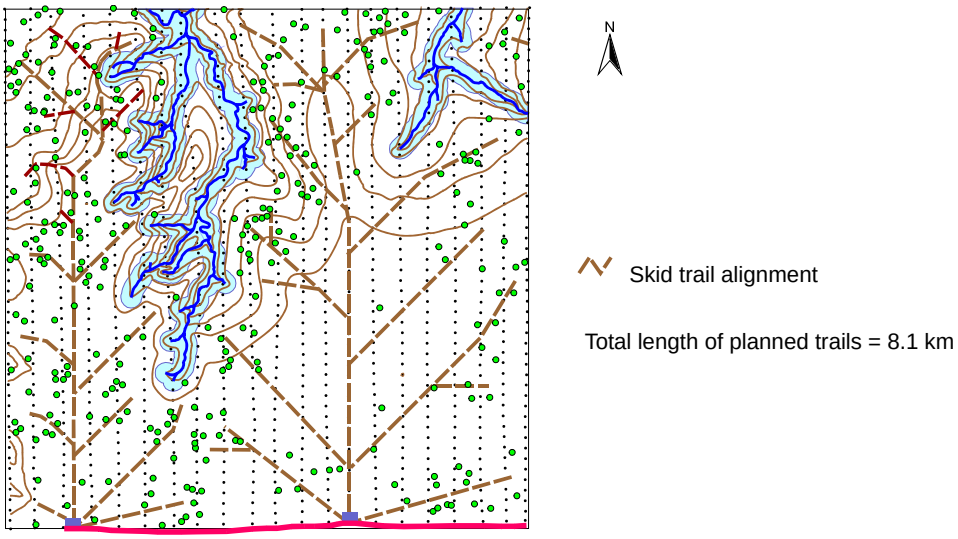


Figure 39 Removing unnecessary trails

SECOND STAGE: VERIFICATION AND IMPLEMENTATION OF PLAN IN FIELD

- Find the alignment as indicated on the map.
- Use line and picket numbers and/or compass bearings and/or location of harvest trees for orientation.
- Clip a narrow line while correcting the alignment according to topography.
- Check the gradient with clinometer.
- After reaching the end of the trail, return to adjust the alignment to avoid large, commercial, and protected trees (centre of trail more than 2 m away from root of tree)
- Walk the alignment again to smooth out any turns and "snakes"
- Mark the trail with flagging tape facing the direction where the skidder enters.
- Standardise the system of signals, signs, and markings.
- Mark points where fallen tree trunks ('takuba's') should be crosscut. (width to be cleared should be 4 metres at right angels to the trail)
- Indicate the adjustments on the map (Figure 40).

Demarcation of the alignment of skid trails (Figure 41)

- Main trails, one ribbon
- End of main trails, two ribbons
- Branch trails, one ribbon (colour different from main trail)
- End of branch trails, two ribbons
- Where branch trails join main trail, two ribbons (one of main trail colour and the other of branch trail colour)

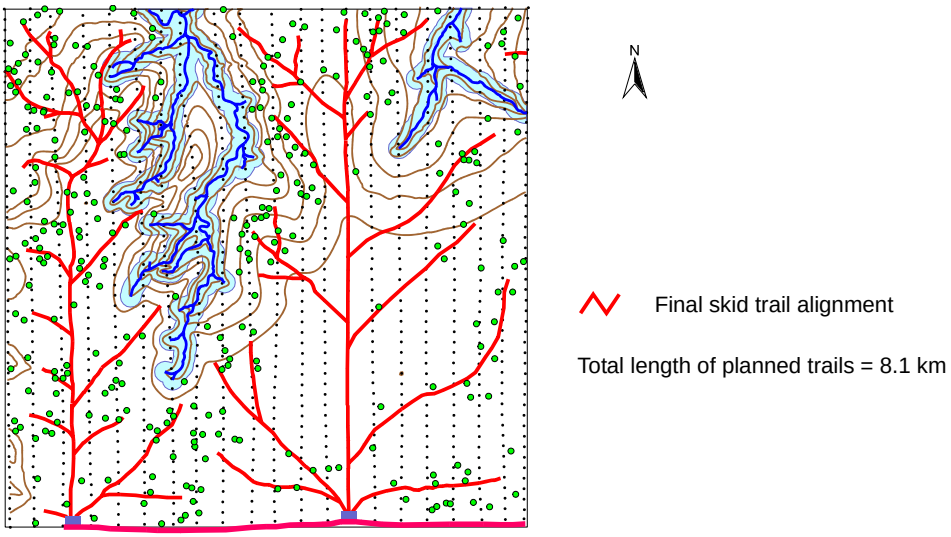


Figure 40 Final skid trail alignment

THIRD STAGE: SKID TRAIL PREPARATION

- Skidder and chainsaw operators (and their assistants) should inspect the proposed alignments prior to commencing construction
- Cut fallen tree trunks ('takubas') along the main and branch trails (Figure 41)
- Cut any lianas or vines that may cling to the machine
- Make preparations for temporary watercourse crossing if needed

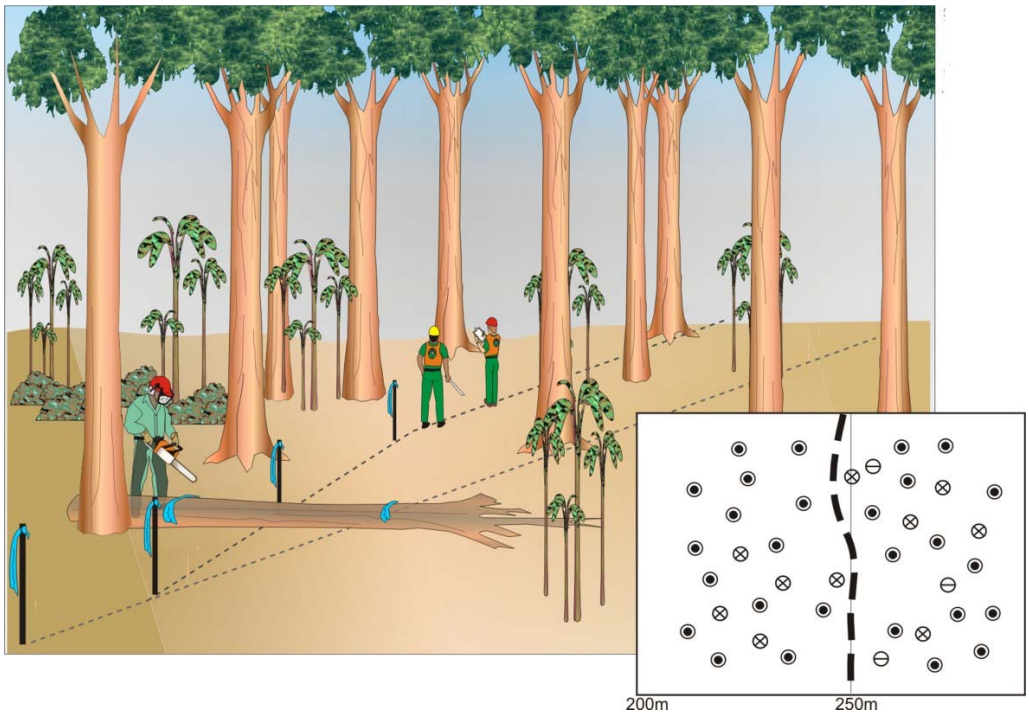


Figure 41 Verifying alignments of skid trails on the ground, flagging skid trails and indicating where fallen trunks should be crosscut

Advantages

- ☺ The operator knows the location and numbers of trees to be extracted
- ☺ The skidder will do less damage to the vegetation and will help regeneration of plants.
- ☺ Higher output of the skidding operation.
- ☺ The operator does not lose time making decisions.
- ☺ The operator does not waste time removing fallen tree trunks and other obstacles.
- ☺ Lower operational costs.
- ☺ Less wear and tear on the machines.

Disadvantages

- ☹ The team needs to be highly skilled
- ☹ Extra activity, extra cost

MODULE 8: TREE MARKING AND LIANA CUTTING

Definition

The marking of trees to be harvested, the determination of the felling direction for each harvestable tree and the identification and marking of those trees that should be protected

Objectives

- To mark trees selected for felling
- To indicate the preferred direction of fall of trees selected for felling
- To mark trees that should be protected from felling damage

Team

- 1 coordinator (with tree location map)
- 2 field assistants

  (The team should have knowledge of directional felling practices)

Materials

- Tree location map
- Flagging tape
- Compass
- Measuring tape (30m)
- Cutlasses & cutlass file
- Paint & paint brush
- Hammer (or hatchet) to "sound" the tree
- Safety gear (helmets, high-visibility vests, safety boots)
- First-aid kit, snake-bite kit

Tree marking involves the following activities:

- Locate the trees to be felled
- Re-check tree soundness
- Identify and mark protected trees
- Decide on the preferred direction of fall
- Mark the selected tree and indicate its preferred direction of fall
- Liana cutting

Nine principles surrounding felling direction:

1. Trees should be felled in a position that facilitates extraction
2. The natural 'lean' of the tree should allow the tree be felled in the selected direction
3. Trees should not be felled into watercourses or their buffer zones
4. Trees should not be felled down steep slopes

5. Protected trees should not be killed or damaged
6. Trees should not be felled across obstacles such as felled and fallen tree trunks (takuba's), rocks, etc.
7. Trees should not lodge in neighbouring trees (hang up)
8. Trees should be felled into existing canopy openings when present
9. Felling direction should not pose any danger to the saw man.

Assessment of a standing tree

When assessing a tree to determine the desired direction of fall, consider:

Natural lean of the tree

- It is difficult to fell a tree against all but a moderate lean

Weight distribution of crown

- Determine which side of crown has the most weight / mass.
- Branching or heavy growth on one side of the crown will tend to drag the tree in that direction

Check for defect

- Sound tree with axe, cutlass or hammer
- Look for external scars, dead wood in the crown, burnt sections, (wood-)ants, etc

Trees may be difficult to fell when:

- The tree is intergrown with adjacent trees (the tree's branches sticking in a neighbouring tree's crown or vice versa).
- Lianas (vines, "bush ropes") interwoven with adjacent trees.
- Trees brush against other trees. This may result in falling limbs, possible 'hangers'

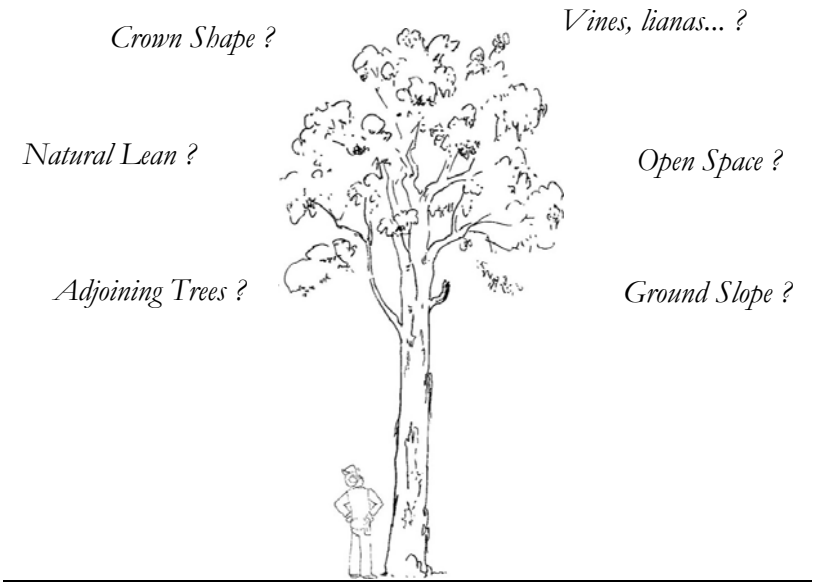


Figure 42 Assessment of a standing tree

Selecting a felling direction for ease of extraction

There are usually four general directions in which a tree can be thrown for easy extraction with the winch. In order of preference (except when tree is next to the trail, see Fig 43), these are:

Option 1:

Fell the tree away from the trail and opposite to the direction the skidder travels (stump - market), at an angle close to 45 degrees to the trail - the log is winched and skidded by the butt end (butt haul)

Option 2:

Fell the tree away from the trail and in the direction the skidder travels, at an angle close to 45 degrees to the trail - the log is winched on to the trail in the "wrong" direction by the butt, then unhooked and re-hooked at the tip of the log (top haul)

Option 3:

Fell the tree towards the trail and opposite to the direction the skidder travels, at an angle close to 45 degrees to the trail - the log is winched on to the trail in the "wrong" direction by the tip, then unhooked and re-hooked at the butt of the log (butt haul)

Option 4:

Fell the tree towards the trail and in the direction the skidder travels, at an angle close to 45 degrees to the trail - the log is winched and skidded by the tip (top haul)

The best angle to easily winch the log to the skid trail varies with the distance between the tree (stump) and the trail.

The tree is located close to the trail

Directions in order of preference

1. Away from the trail opposite to the skidding direction; angle: 15 - 45 degrees (butt haul)
2. Across the trail opposite to the skidding direction; angle 15 - 45 degrees (butt haul)
3. Away from the trail in the skidding direction; angle 15 - 45 degrees (top haul)
4. Across the trail in the skidding direction; angle 15 - 45 degrees (top haul)

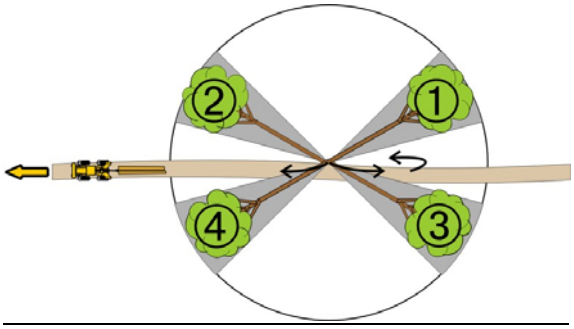


Figure 43 Felling directions when the tree is located close to the trail

The tree is located some 10 m away from the trail

Directions in order of preference

1. Away from the trail opposite to the skidding direction; angle: 0- 45 degrees (butt haul)
2. Away from the trail in the skidding direction; angle 0 - 45 degrees (top haul)

Note: no felling towards the trail because the tree will block the skid trail

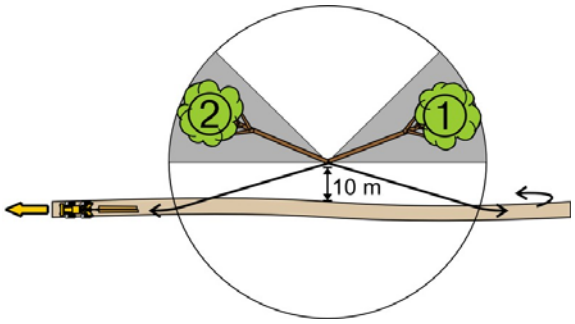


Figure 44 Felling directions when the tree is some 10 m away from the trail

The tree is located some 25 m away from the trail

Directions in order of preference

1. Away from the trail opposite to the skidding direction; angle: 15 - 60 degrees (butt haul)
2. Away from the trail in the skidding direction; angle 15 - 60 degrees (top haul)
3. Towards the trail opposite tot the skidding direction; angle 0 - 30 degrees (butt haul)
4. Towards the trail in the skidding direction; angle 0 - 30 degrees (top haul)

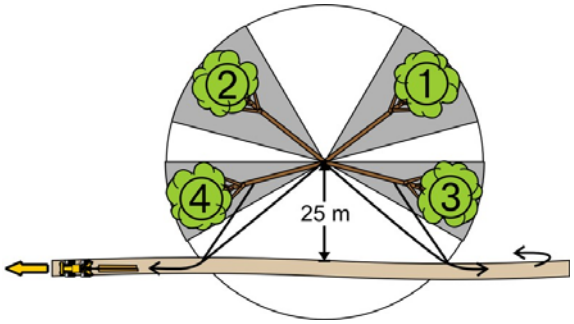


Figure 45 Felling directions if the tree is some 25 m away from the trail

The tree is located some 40 m away from the trail

Directions in order of preference

1. Away from the trail opposite to the skidding direction; angle: 30 - 75 degrees (butt haul)
2. Away from the trail in the skidding direction; angle 30 - 75 degrees (top haul)

3. Towards the trail opposite tot the skidding direction; angle 15 - 45 degrees (butt haul)
4. Towards the trail in the skidding direction; angle 15 - 45 degrees (top haul)

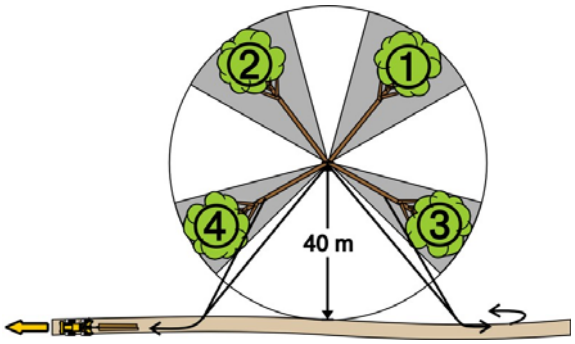


Figure 46 Felling directions if the tree is some 40 m away from the trail

Methodology

Step 1. Locate the tree to be felled.

Step 2. Identify and verify the status of the tree (re-check tree soundness).

Step 3. Locate the skid trail along which the log will be extracted.

Step 4. Check for Option 1:

a) Does the natural lean of the tree or weight distribution of its crown allow the tree to be felled in this direction? If no, go to Step 7. If yes, check (b);

b) Are there any obstacles such as felled or fallen tree trunks, rocks, etc in this direction? If yes, go to Step 7. If no, check (c);

c) Would the tree (crown) land in a watercourse or its buffer zone when felled in this direction? If yes, go to Step 7. If no, check (d);

d) Would the tree be felled (steeply) downhill when felled in this direction? If yes, go to Step 7. If no, check (e);

e) Would the tree lodge in or knock down a neighbouring tree when felled in this direction? If yes, go to Step 7 or adjust slightly. If no, check (f);

f) Would the tree (crown) block a skid trail when felled in this direction? If yes, go to Step 7 or adjust slightly. If no go to Step 5;

Step 5. Identify and mark protected trees in this direction in a 30-m radius over a 30º sector and then mark them with flagging tape or a painted white band.

Step 6. Adjust the target direction slightly to aim between protected trees if possible. If this is not possible, go to Step. 7 if it is possible go to Step 8

Step 7. Repeat Steps 4-6 for Option 2. If the result is negative repeat Steps 4-6 for Option 3, then Option 4.

Step 8. Mark tree to be felled with paint.

Step 9. Mark direction of fall on tree to be felled by blazing or painting a vertical line to the root of the tree

Step 10. Tie a piece of flagging tape on a sapling in the direction to guide chainsaw operator.

Step 11. Cut all vines (lianas, bush ropes) that are attached to the crown of the tree to be felled, and in addition, all vines attached to adjoining canopy trees.

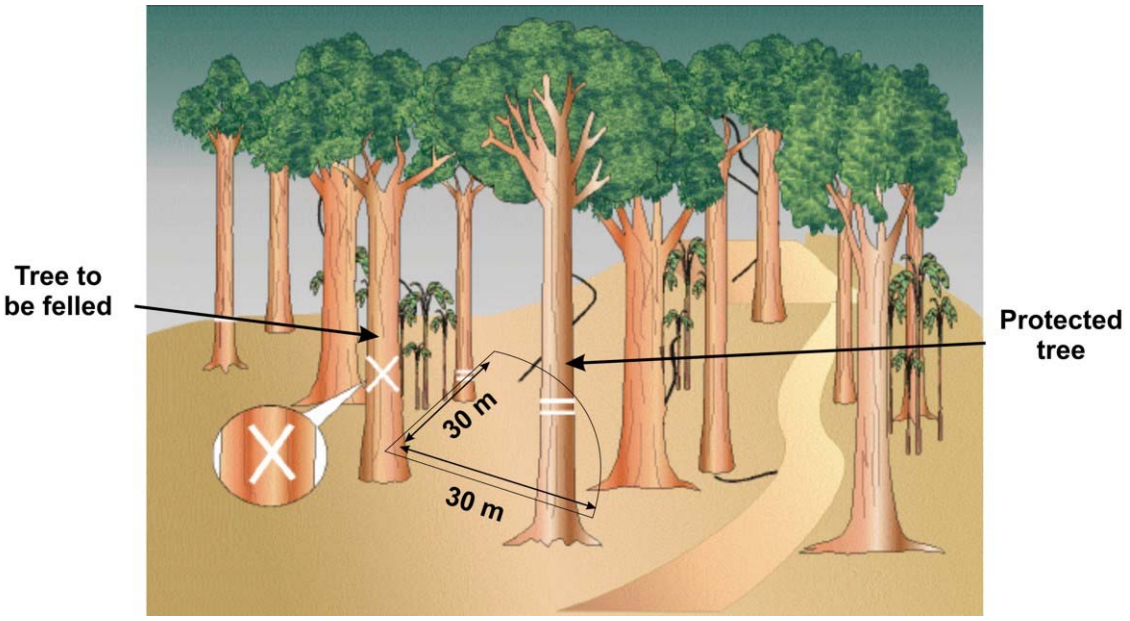


Figure 47 Method of physically marking trees selected for harvesting and protected trees

Variation

Do no marking in the field; only identify the trees on the felling and skidding maps (felling map is handed over to the skidding team after felling).

Advantages

- ☺ Efficiency of skidding improves.
- ☺ Better recovery of logs
- ☺ Less damage to the log during extraction
- ☺ Less damage to future crop trees.
- ☺ Chainsaw operator is allowed to concentrate on his work.
- ☺ Marking of trees and felling direction allows monitoring of proper felling methods.

Disadvantages

- ☹ Requires trained personnel to execute activity
- ☹ Increases initial costs

Liana cutting

Definition

To eliminate, by cutting, lianas connecting harvestable trees to adjoining tree crowns

Objectives

- To increase safety of chainsaw operator
- To reduce damage to residual stems
- To facilitate directional felling

Team

- 1 Coordinator
- 2 Field assistants

Materials

- Tree location map
- Cutlasses/hatchet (farm chainsaw)
- cutlass file
- Safety gear (helmets, high-visibility vests, safety boots)
- First-aid kit, snake-bite kit

Methodology

- Cut lianas attached to trees to be harvested
- Cut lianas attached to surrounding trees
- Cut a 1-m section of the liana 1 m above the ground

Figure 48 Cutting of lianas attached to trees to be felled

Variations

- Cut lianas during the 100% inventory
- Cut lianas in future crop trees

Advantages

☺ Reduce the size of canopy gaps
☺ Better control over felling direction
☺ Operational safety of RIL activities.

Disadvantages

☹ Increased operational costs
☹ May affect biological diversity

MODULE 9: OCCUPATIONAL HEALTH AND SAFETY

Introduction

- Forestry is one of the most hazardous industrial sectors in most countries around the world.
- Safety at work is not only ethically imperative but also makes economic sense.
- Good occupational health and safety performance in forestry depends on the awareness and required attitude of workers.

Employer's commitment

- Provide a safe working environment for employees.
- Install and maintain work systems and methods which are safe and without risk to employees' health.

Orientation and training

- Occupational health and safety orientation is necessary for all employees of all logging companies.
- The company should hold training seminars on safety.
- The company should have an accidents and incidents investigating committee.
- Training of employees should be both initial and continuing.
- Individual proficiency verification would be an asset for employer and employees.

Benefits of a safety programme

- Saves lives and prevent injury.
- Reduces damage to equipment.
- Increases job efficiency and production.
- Provides better job satisfaction and higher working morale.
- Results in greater goodwill towards each logging job.

Occupational health and safety practices

General

- All personnel who enter the forest whether as a worker or observer must be equipped with some basic safety apparel:
    - Safety Helmet
    - Safety Footwear
    - High Visibility Garments
    - Suitable Clothing

- Additional equipment should be carried in a manner that leaves the hands and feet free.
- Dangerous equipment e.g. sharp, edged tools should be sheathed, and operated in a safe manner.
- Supervisors must act to rectify dangerous behaviour.
- Persons should be made aware of potentially dangerous situations.
- Flammable fuels and oils, dangerous chemicals and explosives should be carried in approved containers, transported and stored in the approved manner and used in compliance with the appropriate laws and guidelines.
- All personnel should be made aware of the danger of falling objects within the forest.
- Never work in the forest under the influence of drugs or alcohol.
- Seek medical advice if taking prescription or over the counter drugs.
- Eye protection and protective apparel for other parts of the body should be worn whilst working with impact tools.
- Effective ear protection should be used.
- Chemicals used in the forest should be handled with care and protective apparel must be worn.
- The employer must maintain a register of all work-related illnesses, accidents, or near misses that occur at the work place.

The chainsaw and its operator

- Operators should be equipped with safety boots, high visibility garments, safety helmet, and ear and eye protection.
- Operators should be trained in all techniques to fell trees or to crosscut logs safely.
- Chainsaws should be equipped with all safety features available on a modern chainsaw, and the operator must be familiar with such safety features

Operating a chainsaw

- The operator should use either one of the two accepted methods of starting the chainsaw; on the ground start or standing start position.
- The chainsaw must be held with both hands during use, one hand on the front handle, the other on the rear handle.
- Always work from the safest side of the log.
- Keep all equipment in good serviceable condition by repairing any faults immediately.
- When moving between cutting positions during bucking the log, ensure that the chain is stopped.

Other Activities in your work area

- Be aware of other machinery working in the same area.
- Be aware of where others are positioned.
- Select a safe area to perform chainsaw maintenance.
- Ensure that logs are cut completely.

Felling

- A feller should receive adequate training in all aspects of felling.
- Felling should be done using the correct techniques.
- The felling team must clear two escape routes away from the line of fall.

Machine operations

General

- Never operate a machine under the influence of alcohol or drugs.
- Seek medical advice before operating a machine if taking prescription or over the counter drugs.
- If you are subject to dizziness or severe motion disturbances do not operate machine.
- Machine operators must know and adhere to all safety rules that apply to the machine they will operate (a copy of the rules should be in the machine).
- All machines must carry seat belts, lights, brakes, and audible alarms (horn) and all these features must be in working order at all times.
- All protective guards should be securely in place.
- The operator must wear the protective clothing and personal safety devices issued to you or called for by job conditions.
- Any passenger must wear the required safety equipment and/or apparel.
- The operator must know where the emergency equipment is stored and where to get help in a hurry should it be needed.
- The operator must know how to use the first aid kit.
- The operator must know how to use the fire extinguisher and where it is kept.
- The operator must read the manufacturer's operators' manual before starting the engine.

Bulldozer and skidder operation

- Keep the machine clean.
- Check the work area to avoid hazards when working.
- Before you begin to work, inspect the machine to ensure that all systems are in good operational condition.
- Always use the provided handrails and steps (3-point support) to mount and dismount from the machine.
- Be cautious when fuelling.
- Before starting the machine check that no person is close to the machine, warn all personnel that you are about to start the machine and wait for them to be clear of machine before starting.
- Fasten all seat belts before starting the engine.
- Skidders and bulldozers are one-person machines and no extra rider can do so in safety, unless they are provided with an approved seat.
- Learn all hand signals used in your operation and understand their exact meaning.

- Work in a direction that maintains the greatest vision over working area.
- Make sure that the pathway ahead is clear of personnel before pushing trees over.
- Watch for sticks, etc, that may penetrate the operator's cabin and cause injury.
- Check overhead. Remember the slogan "look up and live".
- When winching logs take directions from one person only.
- Ensure all personnel are well clear of the winch cable during loading.
- When handling a winch cable use leather gloves to protect your hands from wire spikes on the cable.
- On log markets (landings) and log yards travel at a safe speed to allow persons to move out of the way or wait for them to do so.
- Take directions from those who are in control of the log market/yard, but take directions from one person only.
- Machines lifting materials should never lift over personnel.

These occupational health and safety points do not encompass every situation and activity within the forest harvesting industry, but should serve to guide persons into the mindset of thinking safely. Thinking safely is the first requirement to be met to improve the safety and health of personnel within the forestry industry.

Happy and safe working!

MODULE 10: BULLDOZER

Definition

A bulldozer is a tractor that moves on two tracks made up of a number of track shoes. It normally has a vertical blade at the front and one of three attachments at the back: a ripper, a winch, or a grapple.

Purpose

- Road construction
- Earth works
- Cutting & filling terrain
- Land clearing (uprooting, grubbing, raking and windrowing)
- Winching and forwarding (ramping/stumping) logs

Machine selection

- The weight and horsepower of a bulldozer determine its ability to push (or rip). Note that various terrain and underfoot conditions limit the tractor's ability to use its weight and horsepower
- In land clearing (and pioneering roads) the size of the area, tree density, tree size, soil conditions, topography, job specifications and time limit to complete will influence machine selection
- Caterpillar D6 or Komatsu D65-D70 (140-165 hp) for light road construction (pioneering, cutting ditches, backfilling, side-casting) and logging operations
- Caterpillar D7-D8 or Komatsu D85-D155 (200-300 hp) for mining and major road construction.

Key components (Fig. 49)

- Canopy (ROPS, FOPS)
- Engine
- Transmission system
- Cooling system
- Hydraulic system
- Winch & mounting
- Blade & mounting
- Ripper

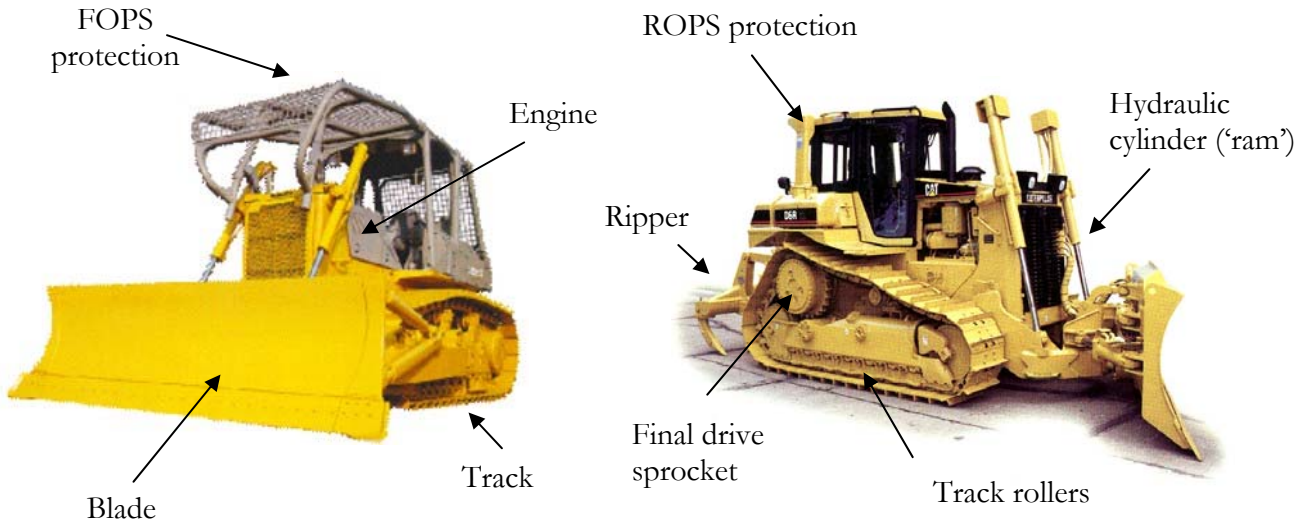


Figure 49 Key components of a bulldozer. The machine on the left has a fixed, outside mounted, universal blade. The machine on the right an inside mounted, power angle and tilt blade. The machine on the left is a forest machine with falling object protection system (FOPS).

Walk around inspection / Daily maintenance

Required to ensure smooth, safe, and continuous service throughout the working day. Check:

- Loose bolts
- Leaks (oil & water)
- Breakage/cracks
- Canopy mountings
- Track assembly
- Grease
- Engine (oil & fan belt)
- Radiator/coolant
- Transmission oil
- Hydraulic tank, cylinder, hoses
- Air filter, pre-clean element, bowl
- Gauges.

Pre-start checks

- Interior of cabin - debris
- Seat belt, fastener & adjuster
- Brakes/transmission lock (neutral)
- Implement and governor controls neutral
- Governor control
- Gauges pressure & temperature
- EMS (Electrical Monitoring System)
- Fire extinguisher

Start-up Procedure

- Check gear selector (Transmission lock in neutral).
- Turn start switch halfway
- Check EMS (Electronic Monitoring System).
- Start engine.
- Warm up engine for 3-5 minutes.
- Test hydraulics controls, raise & lower blade & ripper.
- General walk around inspection while engine warms up.
- Ensure area is clear before moving machine.

General rules of operation

- Blade must be raised while travelling
- No passengers except on instructions
- Winch rope must be reeled in or
- Grapple must be closed and raised clear of ground
- Area clear of all personnel
- Select low gear
- Match speed to ground conditions
- Use deceleration (used to control engine revs).
- Always check all controls, brakes, and transmission lock/drive prior to starting.
- Operate machine forward and reverse.

Operating techniques

Blade use

- Lower blade - do not dig too fast and deep
- Do not push earth too far: less than 40 m
- Control use of blade - amount of material
- Control depth - comfortable amount in blade
- Control speed - in accordance with terrain conditions
- Ensure steady smooth movements with the blade
- Always watch for personnel around you.

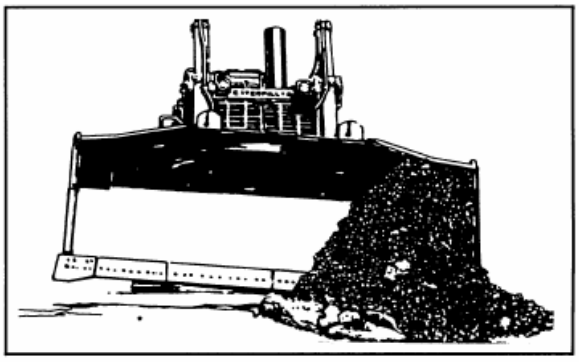
Winch handling

- Maintain area clear of personnel
- Agree on signals prior to operation
- Only one person to give signal to operator
- Use gloves when handling wire rope
- Choker man must be a safe distance away from machine.

- Winch logs to machine.
- Ensure that the work area is clear of personnel when you are driving
- Operator must watch winch rope carefully on the drum while winching.

Dozing

Straight dozing: If the blade digs in and the machine rises, raise the blade to continue even cut. When moving a heavy load causes travel speed to drop, shift to a lower speed and/or raise the blade slightly



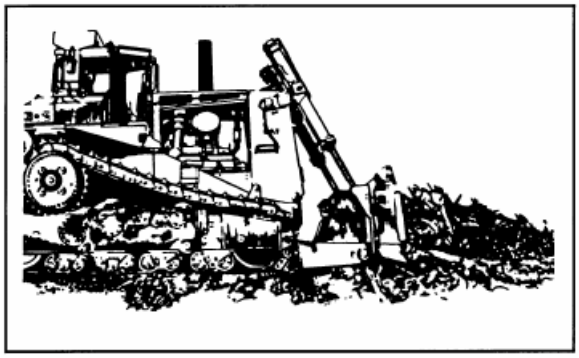
Tilt dozer ditching: Tilt the blade and work with the low side in the ditch centre. Level the blade when the required depth and slope are reached.

Land clearing

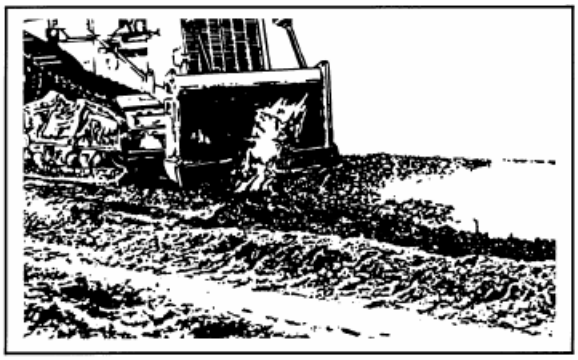
Tree removal:

1. Remove all dead limbs. Cut roots on side opposite the direction of fall.
2. Cut roots on sides parallel to the direction of fall
3. Ease into tree. Push in direction of fall with blade high. Build an earth ramp if higher contact is needed.
4. Do not drive onto stump while tree is falling
5. Back away immediately when tree begins to fall.

Large brush and medium size trees: Contact tree 30 to 40 cm (12 to 16 in) above the ground. Move forward while lifting the blade.

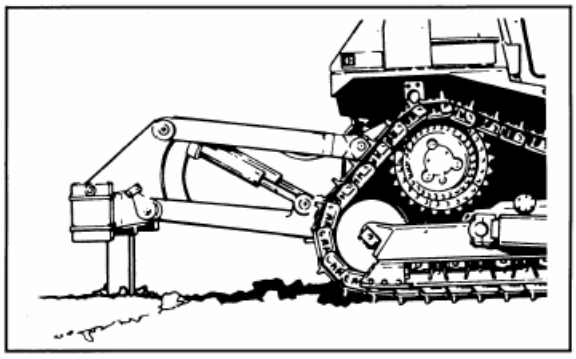


Brush clearing: Lower the blade slightly into the ground and move forward. Lift the blade when the brush is out, to loosen the earth from the roots.



Stump removal: Lift the blade while pushing

Ripping



Use first speed for most ripping operations. It is better to use additional shanks, than to increase speed. Always use centre shank when ripping with one shank. Cross rip only when necessary. Rip downhill whenever possible.

Do not turn or back the machine while shanks are in the ground. Twisting strain on the shanks and tips may cause failure.

In most cases, it is desirable to rip as deep as possible. Sometimes it is better to rip at partial depth and remove the material in its natural layers. Keep material on top of the unripped formation to cushion the machine and provide traction.

Shut-down procedure

- Park machine on level ground
- Lower implements (blade, ripper) unto ground.
- Transmission lock in neutral - Lock brakes
- Inspect all gauges (pressure & temperature)
- Run engine at idle speed for 3-5 minutes to cool down engine.
- Walk around inspection - oil, fuel, water leaks
- Shut down engine
- Turn off main master switch
- Mount and dismount using three points of contact.

Equipment safety

- Regular maintenance
- A safe cab which conforms to the Roll-Over Protection - ROP ISO 3471 structure and the Falling Objects Protection - FOP ISO 8083 structure standards.
- Hands and footholds to enter and exit machine.
- Serviceable safety belt.
- Protective wire mesh fitted to the rear of cab.
- Back up alarm
- First aid kit and fire extinguisher.

Steps to reduce operational impacts on the forest

- Use proper refuelling points
- Use proper fuelling devices; hand pump, funnels
- Where side cutting is not necessary, earth works should be limited to the width of the roadbed or ditches.
- While clearing, trees should be pushed into the road reserve and not into the adjacent forest.
- Topsoil should be stockpiled for use in cut and fill batters and/or in borrow pits.
- Avoid the use of machinery on saturated soils to minimise erosion, ponding, rutting, mixing and compaction of the soil.

MODULE 11: LOG MARKET AND SKID TRAIL CONSTRUCTION

PLANNING OF LOG MARKETS

Definition

This activity determines the number and distribution of log markets (landings)

Objectives

- Set the dimensions and number of log markets
- Select the locations for log markets
- Distribute the log markets along roads

Team

- 1 Technician
- 1 Assistant

Materials

- Tree location map
- Pencil
- Flagging tape (striped and polka dot)
- Measuring Tape (30m)
- Cutlass
- Compass
- Safety gear (helmets, high-visibility vests, safety boots)
- First-aid kit, snake-bite kit

Methodology

Pre-planning

- Determine the size of the log market in accordance with the volume to be harvested, type and size of logging truck to be used and loading system (front-end loader, otherwise)
- Distribute the log markets relative to the skidding distance
- Indicate the localities possible for the construction of the log markets on the map

Planning in the field

- Location of the log market
- Criteria for the selection of the location
  - Areas with a high density of lianas
  - Flat terrain
  - Areas with very "light" forest
- Mark the perimeter in the field

Advantages

- ☺ The operator does not lose time making decisions
- ☺ The operator does not waste time removing large trees
- ☺ Lower operating cost
- ☺ Less wear and tear on the bulldozer
- ☺ Higher production levels are achieved
- ☺ Damage to the forest is minimized
- ☺ Permanent infrastructure is established (can be used next cutting cycle)

Disadvantages

- ☹ The planning can only be accomplished after the processing of the inventory data

Variation

- Plan the depots at the same time as the feeder roads are planned

CONSTRUCTION OF LOG MARKETS

Definition

Log market construction consists of clearing a pre-determined area previously marked to serve as a temporary storage depot for logs to be skidded from a designated area of a block

Objective

To prepare the previously chosen and planned site for storage of logs as these are being skidded from within the forest until their transportation to the industry/sawmill.

Team

- 1 Bulldozer operator
- 1 Assistant (who should be skilled in the use of a chainsaw).

Equipment / Materials

- Bulldozer
- Chainsaw
- Cutlass & cutlass file
- Safety gear
- First aid kit

Methodology

- Before starting the construction, the operator and his assistant check the area for obstacles.
- If fallen trees are found, these are bucked. Check whether fallen trunks can produce merchantable logs.
- After completing the check of the area and having bucked all fallen tree trunks, the operator begins his work.
- The operator starts the construction by following the flagging tapes or other markings along the perimeter of the log market.
- The landing is built from the outside in (circular movements) with the bulldozer blade lifted, breaking all plant material. Do not push any trees outside the perimeter of the log market.
- After breaking all plant material, the bulldozer returns to the road and parks.
- The operator and his assistant check the area for obstacles, bucking of long stems pushed over by the bulldozer.
- After this bucking, the bulldozer returns to continue cleaning the area placing the plant material to the sides.
- Next the bulldozer lightly scrapes the soil.

- The operator's assistant cleans the roots, branches and/or lianas that remain on the log market.

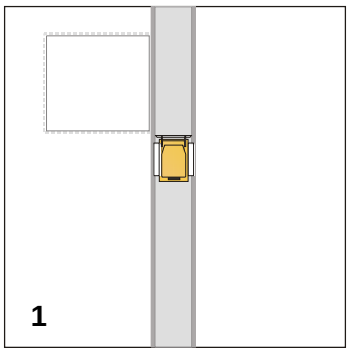
Advantages

☺ Less damage to vegetation around the landing.
☺ Increases the yield and productivity of machinery and the team.
☺ There is greater control over the size of the landing.

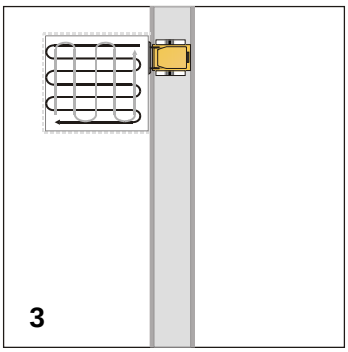
Disadvantages

☹ Requires a trained team

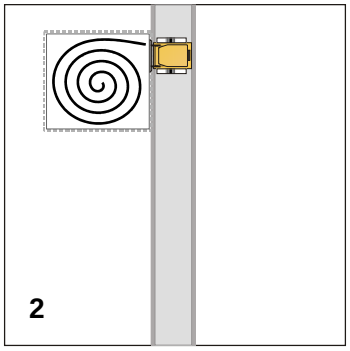
Method of constructing log markets



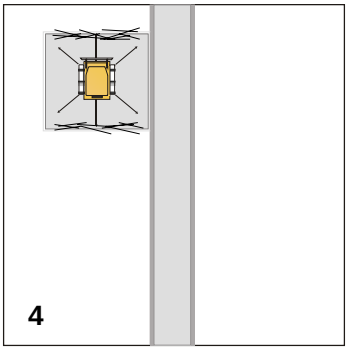
1. Locate area previously marked to serve as log market (landing)



3. Break up and redistribute the downed vegetation



2. First open up the perimeter of the log market following the flagging tape. Subsequently clear the area in a circular motion. Push trees towards the inside.



4. Clear the area by pushing the material to the sides. Front and back of the log depot must be left clear.

Clearing in a circular motion may not always be possible due to e.g. topography, forest density, etc.

In that case: start by "mashing" small trees first - in a zigzag motion; trees larger than 35 cm DBH should be left standing for the chainsaw operator to fell. Trees should be felled towards the inside of the log depot.

SKID TRAIL CONSTRUCTION

Definition

Consists of clearing a trail alignment previously chosen and flagged to serve as skid trail for logs that shall be skidded from stump to the log market

Objectives

- Assist the feller in determining direction of tree fall.
- Improve safety and efficiency of the logging operation.

Team

- 1 Bulldozer operator
- 1 Assistant (who should be skilled in the use of a chainsaw).

Equipment / Materials

- Tree location map (with skid trail alignment)
- Bulldozer
- Chainsaw
- Cutlass & cutlass file
- Safety gear
- First aid kit

Methodology

- The machine operator and his assistant walk the alignment and look for the flagging/marking that marks the trail to be built.
- The construction team goes all the way down the trail to be built, observing any detours and/or obstacles.
- After this verification, the team returns to the starting point of the trail to start construction.
- Using the bulldozer the operator follows the markings along the skid trail alignment, and opens up the trail, with the blade raised (Fig. 50)

Figure 50 Bulldozer follows flagged alignment in the forest.

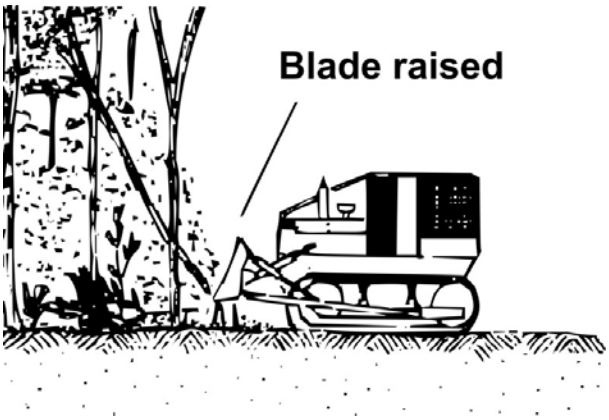


Figure 51 Bulldozer operation during log market and skid trail construction: while pushing the trail keep the blade raised at all times.

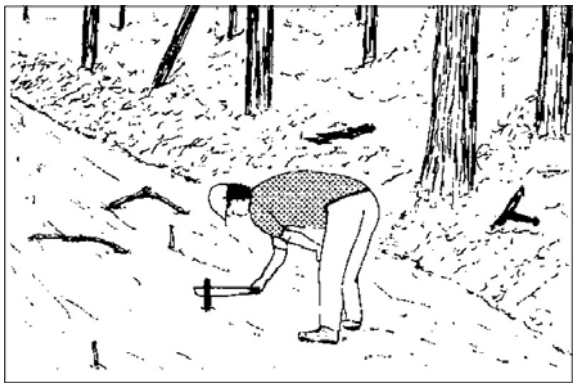


Figure 52 Remove stumps manually and not with the bulldozer so as not to disturb the topsoil, since this will lead to early rutting of trail and log market.

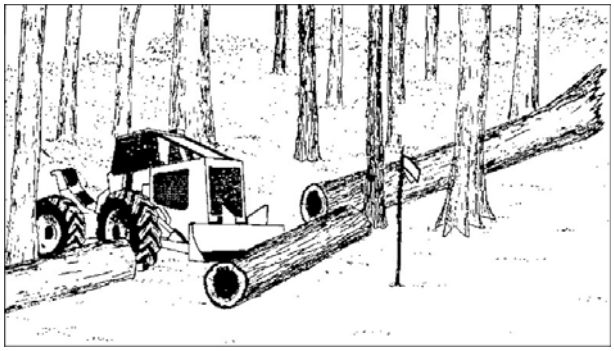


Figure 53 Because obstacles such as fallen tree trunks have been cut during skid trail preparation, removal of these is quicker, thereby increasing productive machine time and reducing wear and tear. In addition, less damage is inflicted to the forest.

Advantages

- Ease of extraction.
- The skidder operator does not lose time determining a route to skid logs.

Disadvantages

- Requires a trained team

Variation

- Pre-construct skid trail with the skidder instead of a bulldozer;
- Pre-construct skid trail with axe and chainsaw (stumping) – slow

MODULE 12: CHAINSAW SAFETY

Professional attitude

A professional operator:

- ✓ cares for his equipment
- ✓ can assess a tree he intends to fell
- ✓ can fell a tree in the "desired direction of fall"
- ✓ has a keen sense of safety
- ✓ has a sense of responsibility towards the environment and the final condition of the tree being felled.

Safety first

Working with a chain saw involves many different - sometimes-complicated - situations. The chain saw is a very effective tool, but it can also be dangerous if used improperly. In order to avoid accidents and unnecessary strain, you should use:

- ✓ a chain saw with functioning safety features,
- ✓ appropriate safety equipment and,
- ✓ correct techniques.

Occupational Hazards in Chain Saw Operation

- Falling Limbs, Lianas and Branches
- Eye Injuries
- Industrial Deafness
- Foot Injuries
- Reynaud's Phenomenon "White Fingers"
- Back Injuries
- Kickback
- Environment
- Safety Distance
- Hand Tools and Accessories

All safety equipment should be checked regularly to make sure it is complete and fully operational!

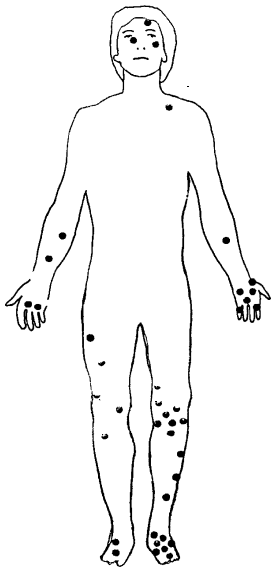


Figure 54 Main areas of chainsaw injuries

Personal Protection Equipment

- ✓ Safety helmet
- ✓ Ear muffs or plugs
- ✓ Visor or safety glasses
- ✓ Chainsaw protective boots incorporating steel toe cap and chainsaw protection
- ✓ Close fitting clothes
- ✓ Protective trousers or chaps with front protection in both legs
- ✓ High-visibility vest/shirt
- ✓ Gloves (with protective pad on the back of the left hand)

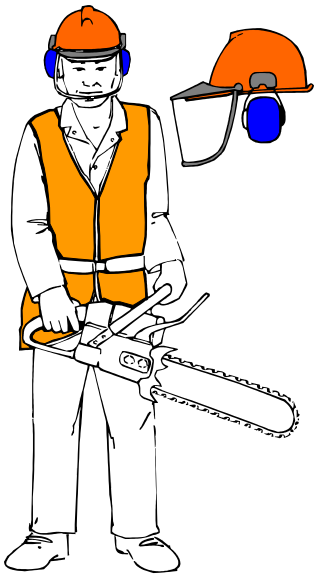


Figure 55 Personal protection equipment

Chain Saw Safety Requirements

A modern chain saw must be equipped with the following safety features:

- Kickback guard and chain brake
- Throttle lock
- Effective vibration reduction
- Chain catcher
- Right-hand guard
- Accessible master control

All safety equipment should be checked regularly to make sure it is complete and fully operational!

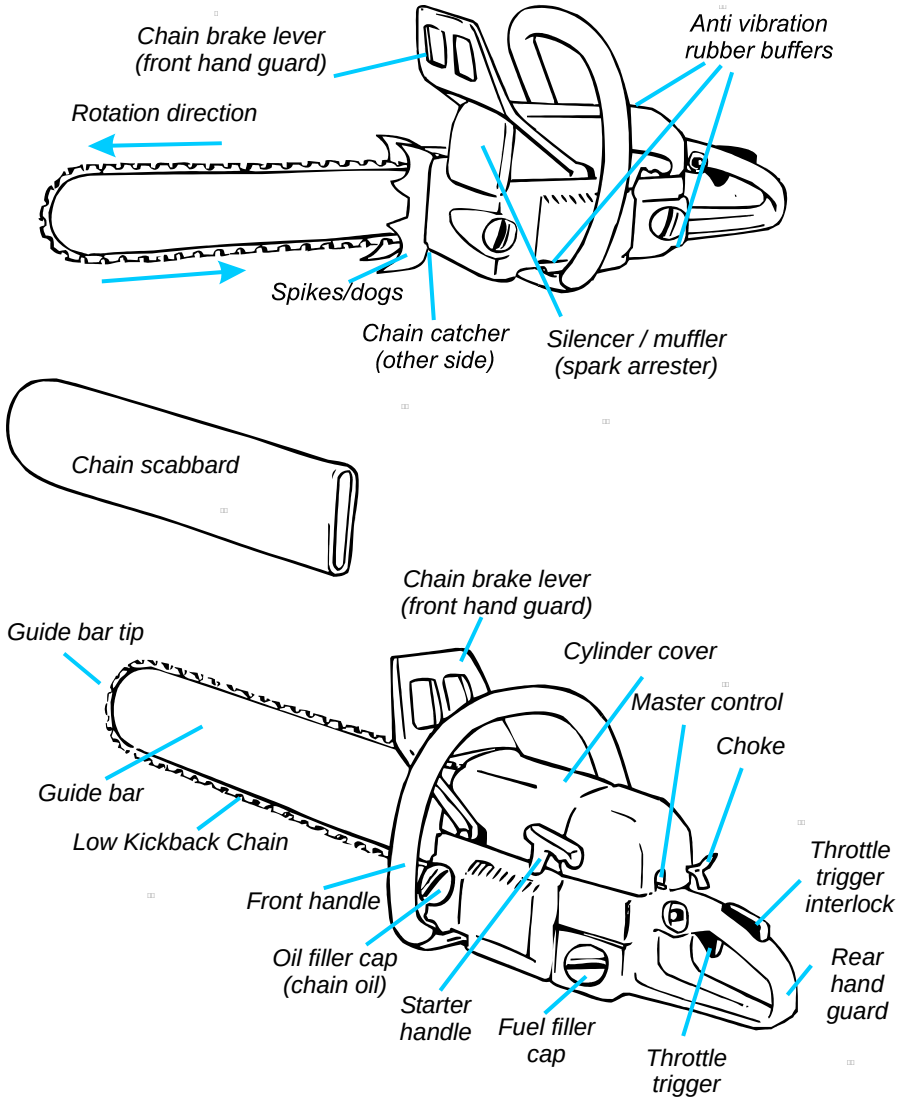


Figure 56 Safety devices on a chainsaw

Using a chainsaw safely

Carrying the saw.

- Make sure the chain does not move while you are carrying the saw.
- It is best to turn off the engine if you are going to carry the saw a long way, but you can also engage the chain brake to lock the chain.
- Fit a guard to the bar before carrying the saw any distance. Always carry the saw with the guide bar pointing backwards!

Thumb grip.

- Hold both handles firmly.
- Make sure your thumb is locked around the front handle.

Keep it close to you!

- Hold the saw close to your body. This gives better balance and makes the saw feel lighter.

Balance.

- Make certain you stand firmly with your feet apart. This will give you a good working balance.

Bend at the knees.

- Whenever you must use the saw in a low position, bend your knees. This will reduce strain on your back.

Refuelling

- Always stop engine before refuelling..

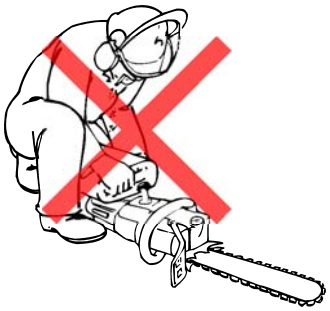


Figure 58 Do not smoke when refuelling

Figure 59 Do not start the saw at the place of refuelling

Starting a Chainsaw

The safest way of starting a chainsaw is by placing the saw on the ground and starting it from there.

Starting saw on ground

- Apply chain brake.
- Place saw on ground.
- Clear away any obstacles, particularly near tip of guide bar.
- Place the right foot through the rear handle and left hand on the front handle.
- Pull the starter rope with the right hand.

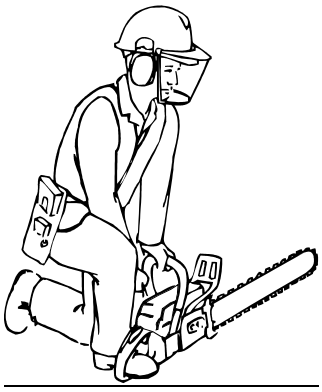


Figure 60 Starting saw on the ground

Starting saw off ground

- Apply chain brake.
- Grip the front handle with left hand, keeping arm straight.
- Grip rear handle between knees at the angle shown in the diagram.
- Use right hand to pull start rope.
- Maintain straight back, look straight ahead.

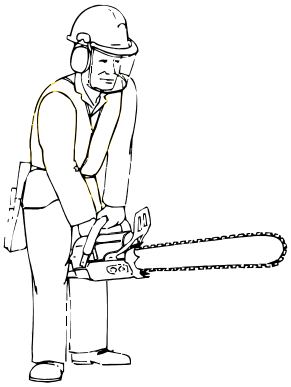


Figure 61 starting saw off the ground

Do not drop start!

Kickback

Kickback is one of the most common causes of chainsaw accidents. It occurs when a moving chain in the upper quadrant on the nose of guide bar contacts an obstacle, or becomes pinched, and rather than cutting through it, the bar is thrown out of the kerf (backwards and upwards) and can hit the operator if he/she is in line with the bar when this occurs.

Kickback can also occur when the depth gauge is too low or not rounded, because too much of the cutter will "bite" into the wood without being able to sever it.

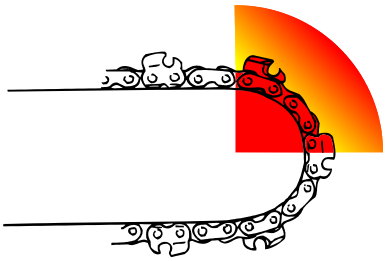


Figure 62 Kick-back zone (upper section of the tip)

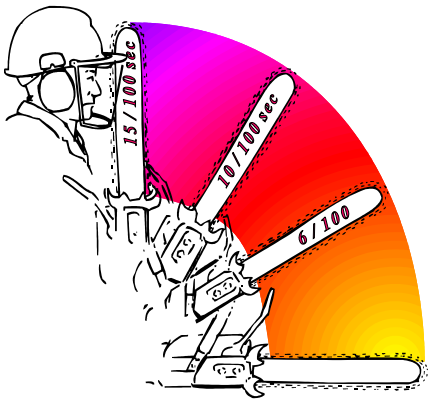


Figure 63 Time taken for guide bar to reach your face following severe kickback

- Automatic chain brake: 6/100 sec
- Standard chain brake: 10/100 sec
- Time taken to reach face: 15/100 sec

How to reduce kickback

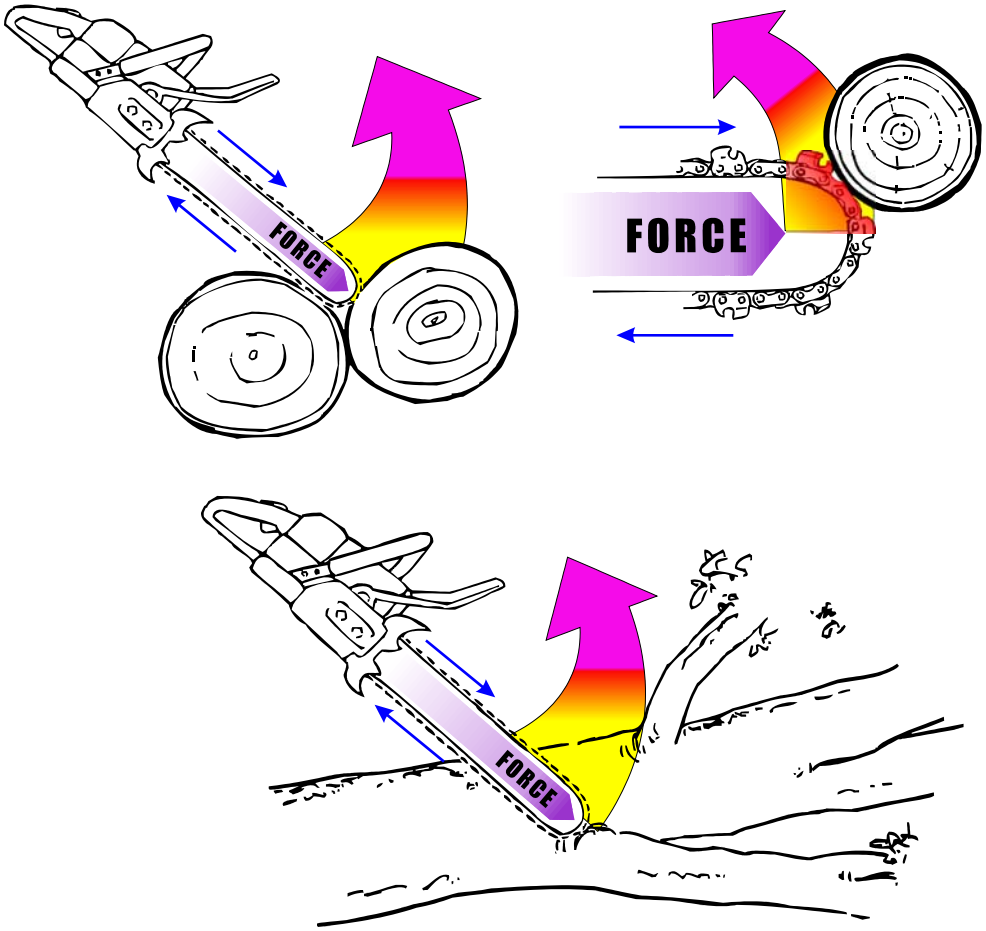


Figure 63 common kickback situations

- Maintain a firm grip (good footing, keep chainsaw close to body, straight wrist, and thumb behind front handle).
- Cut at peak revs (more chance of cutting through an obstruction).
- Be conscious of where the nose of the bar is at all times.
- Use correct boring techniques.
- Avoid delimbing with upper section of bar nose (tip).
- Sharpen chain correctly.
- Tension chain correctly.
- Correct depth gauge setting.
- Keep front of depth gauges well rounded.
- Ensure chain brake is functioning correctly.
- Only use reduced kickback chain for felling trees and bucking logs.

MODULE 13: CROSS-CUTTING TECHNIQUES

Definition

Crosscutting is making a cut across the grain or axis of a log).

Objectives

- To sever the crown or butt from the log
- To acquire a desirable length of log.
- To eliminate defective or unwanted portion(s) of a log.
- To cut two or more blocks (bucking)

A chainsaw's natural reaction when cutting wood

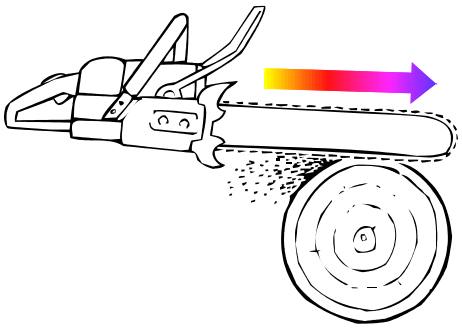


Figure 64 Pull-in

Pull-in occurs during cutting on top of the log, when the chain is pinched or encounters an object on the bottom of the bar. The reaction of the chain pulls the saw forward.

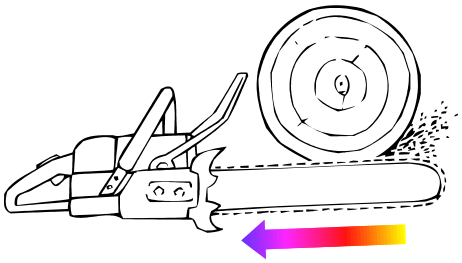


Figure 65 Pushback

Pushback occurs during cutting underneath the log, when the chain is pinched or encounters a object on the top of the bar. The reaction of the chain drives the saw straight back toward the operator.

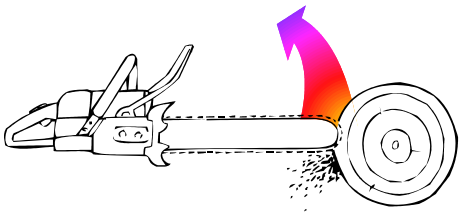


Figure 66 Kickback

Kickback occurs when boring straight into the log. Instead of boring straight, begin cut by applying lower portion of the guide bar nose; swing saw slowly into plunge-cutting position. Danger of pushback remains!

Techniques in minimising chainsaw's reaction (particularly kick-back) when beginning a boring cut

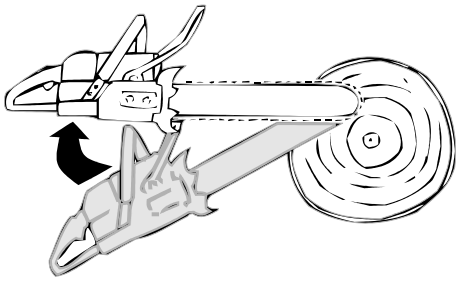


Figure 67 Starting at the top of the log

Starting at the top of the log

1. Commence cut with the lower section of the guide bar nose until the depth of the kerf is about the same as the width of the bar. (Fig. 67)

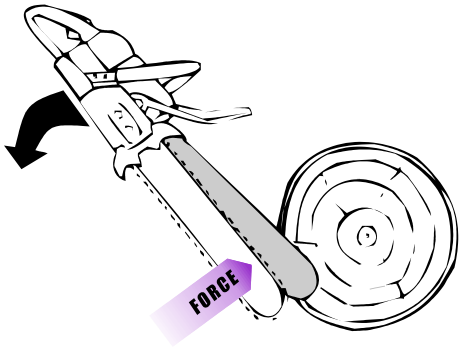


Figure 68 Starting in the middle of the log

Starting in the middle of the log

2. Keep the bar in line with the side of the log

3. Commence cut with the top section of the guide bar nose until the depth of the kerf is about the same as the width of the bar. (Fig. 68)

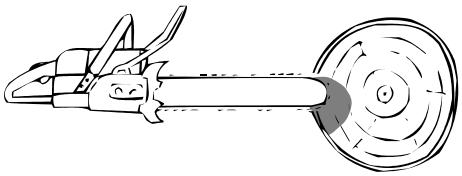


Figure 69 Swing into plunge cut position

3. Swing saw slowly into plunge cutting position. (Fig. 69)

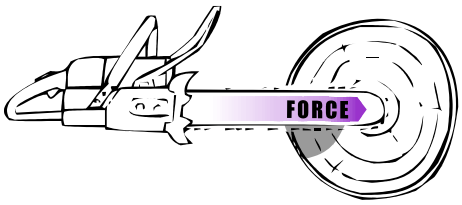


Figure 70 Bore at full throttle

4. With the saw at full throttle, insert the guide bar in the trunk. If possible, support the saw against your legs. (Fig. 70)

Beware of risk of pushback and kickback

Good crosscutting techniques will:

- Minimise the chance of injury.
- Minimise damage to engine and cutting attachment.
- Avoid pinching of the guide bar.
- Maximise utilisation of felled timber.

Basic principles of cross-cutting

- Do not stand on log while cross-cutting
- Always assess the bind relationships in the log and choose sequence of cuts to suit.
- Stand to one side of cut.
- If there is a chance of either half of the log springing, keep an escape route open.
- Stand on the opposite side to which a log will spring or roll (on the uphill side) (Fig. 71).
- Wherever possible cut the opposite side of the log first.
- Instead of strenuous cutting upwards, boring in and cutting downwards may be easier.
- Watch cut to see whether it is opening or closing.
- Use the saw as a lever and the log as a pivot point to minimise work effort.
- Insert a wedge in the cut if there is a high risk of the log dropping or twisting.
- Take special care when cutting shattered wood - sharp slivers of wood may fling in your direction

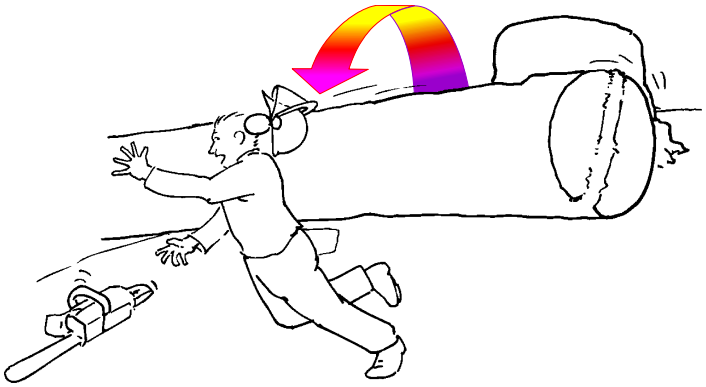


Figure 71 Stand on the opposite side to which a log will spring or roll

Assessment of internal stress

- In cross-cutting, always cut at the compression side first
- If the compression side is cut last, the saw will jam and/or the timber will split

There are four situations that can occur: top bind, bottom bind, side bind, and 'log trap'.

Top bind occurs when both ends of the log are supported (Fig. 72)

Figure 72 Top bind

Sequence of cutting to avoid top bind

Small log

Compression

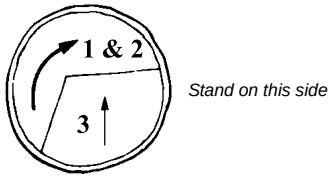


Figure 73 small logs with top bind

Large log

Compression

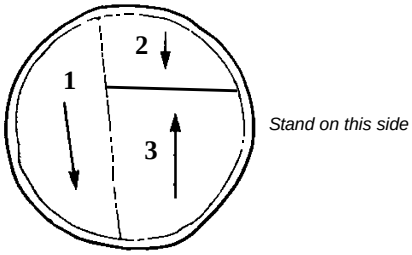


Figure 74 Large logs with top bind – alternative 1

Compression

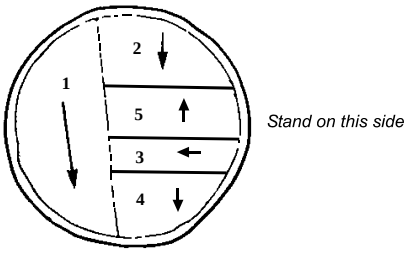


Figure 75 Large logs with top bind – alternative 2

1. Begin cutting on the side of the log away from you for about 1/3 of the log diameter
2. Bring the saw towards you and cut downwards for about 1/3 of the log diameter or until the cut begins to pinch the guide bar.
3. Continue from the bottom side of the log. Try to bring the two cuts together. (Figs. 73 and 74)

Or

3, 4, 5 Bore in and cut down, but finish the cut coming upwards

- When you cut from above the saw pulls itself against the log. This is safer and easier than cutting from below.
- When you cut from below the saw tries to move towards you.
- Grasp the front handle with your thumb underneath to ensure a firm grip. (Fig. 75)
- Keep the saw as close to the trunk as possible for maximum safety.

Bottom bind occurs when one end of the log is supported (Fig. 76)

Figure 76 Bottom bind

Sequence of cutting to avoid bottom bind

Small log

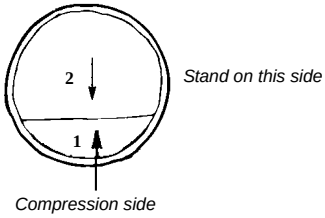


Figure 77 Small logs with bottom bind

Small log

1. Begin cutting upwards for about 1/3 of the log diameter or until the cut begins to pinch the guide bar.
2. Continue from the top side of the log. Try to bring the two cuts together.

Large log

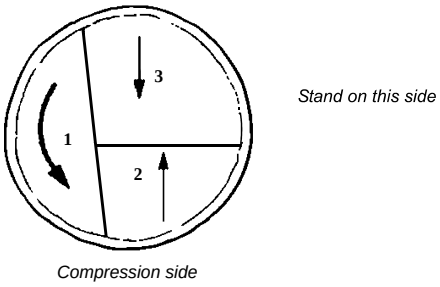


Figure 78 Large logs with bottom bind – alternative 1

Large log

1. Begin cutting on the side of the log away from you for about 1/3 of the log diameter
2. Take the saw out and cut upwards for about 1/3 of the log diameter or until the cut begins to pinch the guide bar.

or

2, 3, 4 Bore in and cut down, before cutting upwards

3 (5). Continue from the top side of the log. Try to bring the two cuts together.

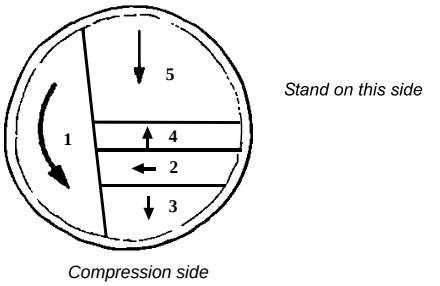


Figure 79 Large logs with bottom bind – alternative 2

A Log trap occurs when one end of the log is unable to move (Fig. 80)

If one end of the log is unable to move and the other end can drop away when cut, the saw will jam (or worse) when applying ordinary cross-cutting techniques

1. Begin by making a downward cut at the compression side
2. For the bottom cut an angled cut is used
3. Ensure that the angled cut is sloped to the correct side so that the release cut will not cause the guide bar to be trapped when one end drops away.
4. Alternatively, use a staggered cut for the bottom cut

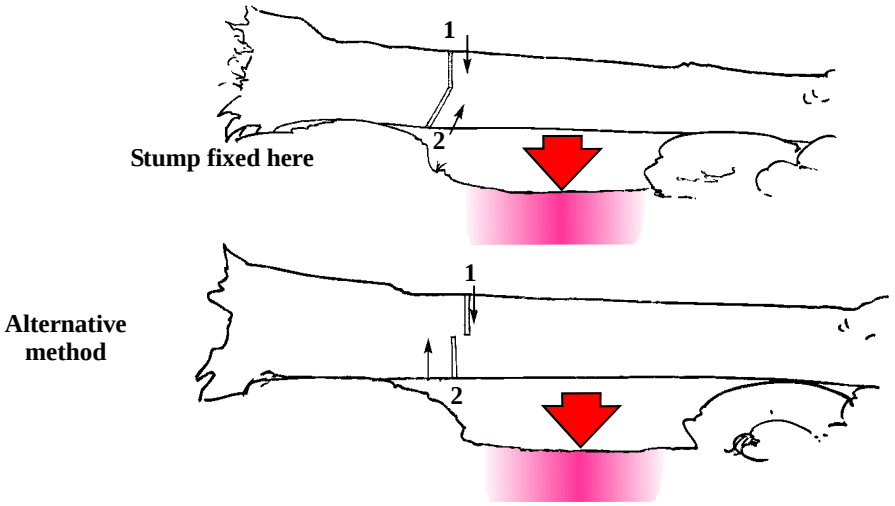


Figure 80 Sequence of cutting in case of a 'log trap'

MODULE 14: FELLING TECHNIQUES

Definition

Tree felling is the throwing (cutting) of the commercial trees previously selected, using the best directional felling techniques.

Objectives

- To reduce damage to the stem of the tree being felled,
- To reduce damage to protected and residual trees,
- To cause less damage to the forest,
- To avoid unnecessary, exaggerated gaps, and
- To facilitate proper skidding operations.

Team

- 1 chainsaw operator; properly trained to execute the felling and bucking activity
- 1 helper (choker man); a skilled person who will assist in tree location, tree cleaning, wedging and the transport of materials.

One of the team members should be trained in first aid.

Equipment & Materials

- Chainsaw (high power to weight ratio such as Stihl 066 or Husqvarna 395) complete with 30" (75 cm) guide bar with nose wheel

- Cutlass
- 3 aluminium felling wedges (10")

- 4 lb. Sledge hammer

- Safety gear feller

- Safety gear helper

- First-aid kit, snake-bite kit
- Spare felling chain
- Spare guide bar
- Round file (correct diameter for chain type)
- File holder
- Flat file (depth gauge)
- Filing gauge
- Tool kit for chainsaw
- Repair kit for chainsaw
- 2-in-1 Combination Jerry Can (2T gasoline, chain oil)

Considerations before felling a tree

It is important that tree felling be planned carefully. Trees must be felled safely, in the desired direction, without damaging the stem of the felled tree and with minimal environmental impact. Well-planned felling also makes it easier to continue the felling team's work.

Therefore, the operator should:

1. Consult the list of trees to be felled and their location on the tree location map
2. Plan the sequence of felling and work pattern (work from the end of the skid trail towards the log market; always consider ease of extraction by machinery; avoid covering up previously felled trees, or the base of the tree to be felled next)
3. Have regard for his own safety and for the safety of others
4. Verify the felling direction indicated by tree marker
5. Consider the nine principles in selecting the direction of fall
6. Assess the standing tree, before making a final decision on the direction of fall

Nine principles surrounding felling direction

1. Felling direction should not pose any danger to the saw man or others.
2. The natural falling direction of the tree should allow directional felling
3. Trees should not be felled into watercourses or their buffer zones
4. Trees should not be felled down steep slopes
5. Protected trees should not be killed or damaged
6. Trees should not be felled across obstacles such as felled and fallen tree trunks (takuba's), rocks, etc.
7. Trees should be felled in a position that facilitates extraction
8. Trees should not lodge in neighbouring trees (hang up)
9. Trees should be felled into existing canopy openings when present

Assessment of a standing tree (Fig. 81)

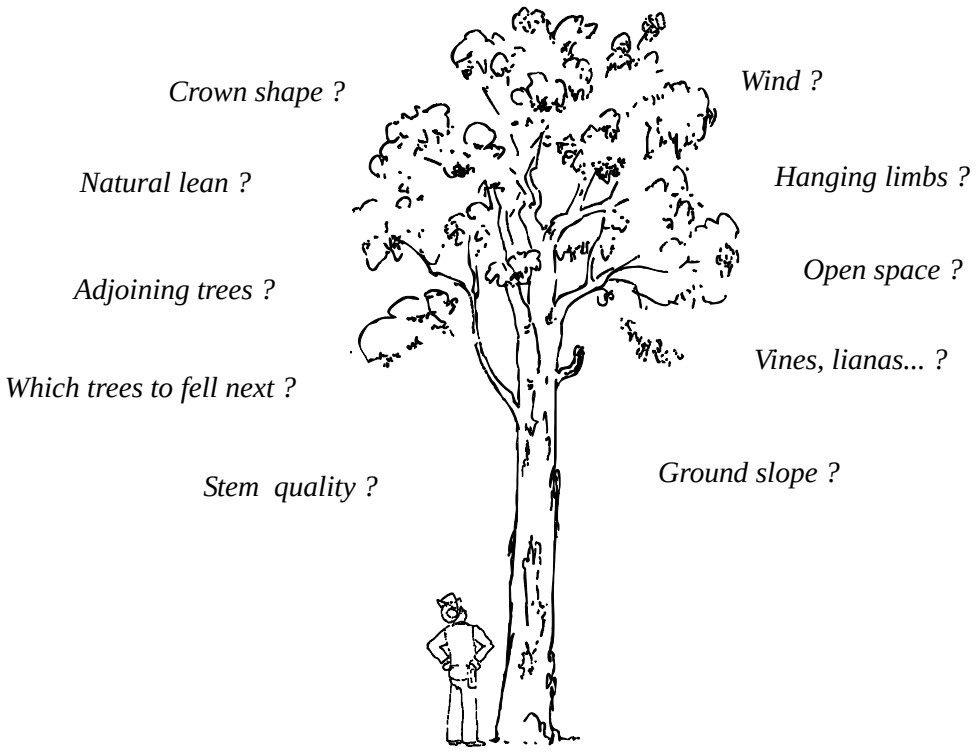


Figure 81 Factors influencing direction of fall

Natural lean of the tree

- It is difficult to fell a tree against all but a moderate lean

Weight distribution of crown

- Determine which side of crown has the most weight / mass.
- Branching or heavy growth on one side of the crown will tend to drag the tree in that direction

Check for defect

- Sound tree with axe, cutlass or hammer
- Look for external scars, dead wood in the crown, hollows, (wood-)ants, etc
- When in doubt, make a vertical plunge cut at the estimated felling height. If any abnormality is detected during the boring operation or if the bar is pulled into the stem, reject the tree. Indicate this on the tree location map

Trees should not be felled for safety reasons, when:

- The tree is intergrown with adjacent trees.
- The tree brushes against other trees.

Open Spaces

- Always aim to fell into open space.
- Avoid felling into other trees, stumps, rocks or logs if possible.

Wind

- Wind may be strong enough to overcome the tree's natural lean or lopsided crown.
- One may have to wait for "lull" in wind.

Hangers or Widow Makers

- Take extra care when felling a tree with a hanger in it. First movement of the bole may dislodge the hanger. Continue watching during escape.

Which tree to fell next?

Operator needs to consider sequence of felling trees to guard against:

- creating hangers or widow makers
- creating hang-ups
- creating extra work through placing heads of trees or limbs at the base of another tree to be felled.

Preparation before felling

Make sure no one is in the danger zone before you begin felling. Your danger zone is a distance twice the height of the tree you are felling

Prepare an escape route

- Most felling accidents occur within 4 metres of the stump.
    - If the butt kicks up as the tree falls, it will generally go straight backwards or to one side.
    - If tree splits up it will slab backwards from the line of fall.
    - If tree snaps in falling line it will generally come back straight over stump.
- Choose a line of retreat 45° diagonally backwards, away from the direction of fall. (Fig. 82).

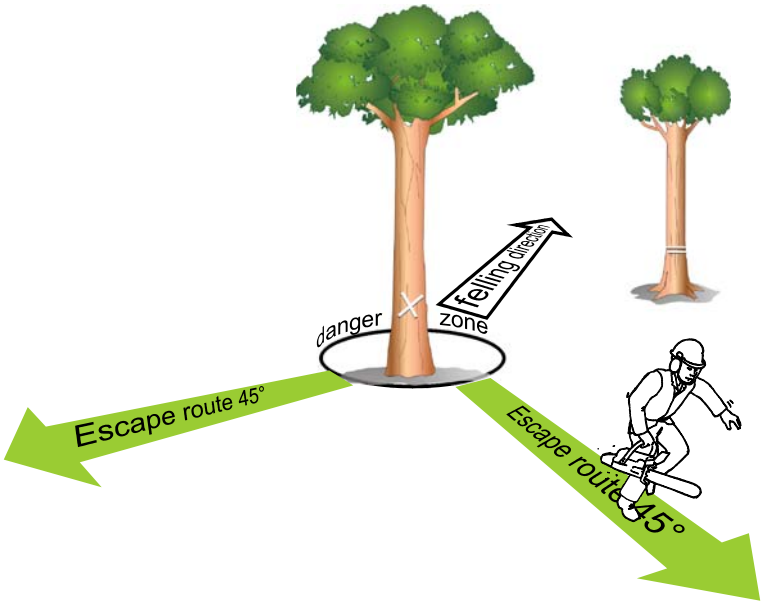


Figure 82 Create two escape routes

Clean Around Base of Tree.

- Prepare a clean work area around tree (Fig. 83).
- Remove small bushes to enable a good footing and to prevent "kick-back" through guide bar striking hidden obstacle.
- Clean dead wood, etc. along tree felling line.

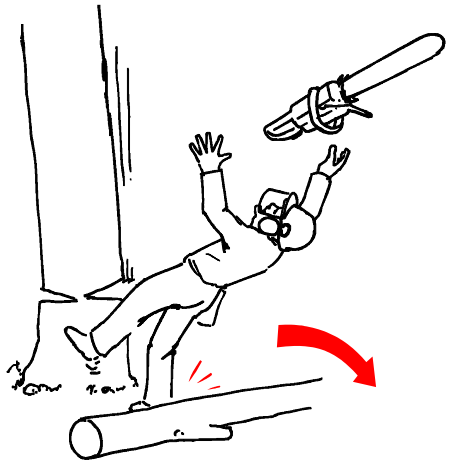


Figure 83 Clean obstacles around the base of the tree

Clean lower portion of tree base with cutlass or hatchet.

- Remove all obstacles from escape routes
- Place all tools and equipment, including fuel cans, a safe distance away from the tree, but not on the escape routes
- When felling is being carried out close to roads or tracks, a sign "*Tree Felling in Operation*" should be placed on either side of the road facing oncoming traffic.

Felling Theory

Directional felling - the basics

The first two cuts create the directional notch and are made on the side the tree should fall. After the directional notch has been cut out, the back cut is made on the side away from the planned fall and slightly above the bottom of the notch. However, the cuts must not meet. Depending on the size and thickness of the tree, some holding wood must be left uncut between the directional notch and the falling cut. This is the hinge on which the tree swings when it falls and is the key to steering the tree in a chosen direction.

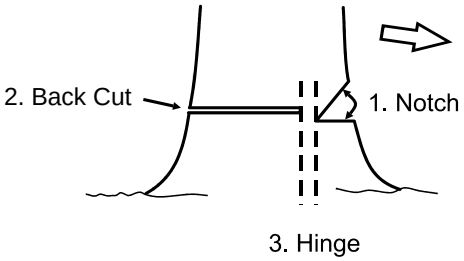


Figure 84 Basic cuts for directional felling

You can determine the direction a tree will fall by felling according to a specific system, applying:

1. Directional notch (scarf, "belly")
2. Back cut (felling cut).
3. Hinge (holding wood, key).

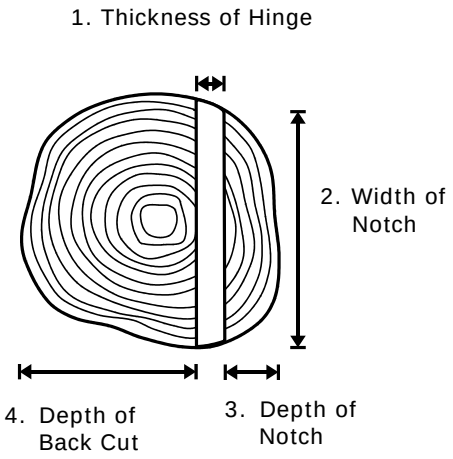


Figure 85 Dimensions of basic components

Important dimensions:

1. Thickness of hinge
2. Width of notch
3. Depth of notch
4. Depth of back cut
5. Opening of notch (angle between top and bottom cuts)

Notch

Functions of the notch:

- Determines the direction in which the tree will fall
- Controls tree during fall (allows smooth steady fall of tree)
- Serves as a means of breaking holding wood
- Helps to prevent tree from splitting up

Dimensions of the notch

Opening too narrow - notch closes too early - hinge breaks: poor control

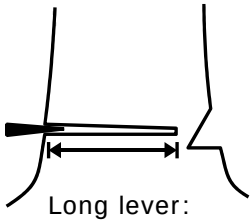
The opening of the notch should be between 45° and 70°.

- to control the tree's fall through as large an angle as possible
- If the opening is too narrow, then the notch closes too soon, hence breaks the hinge too early resulting in loss of control or the tree splitting

Opening large enough: good control

The notch should be deep enough to make the hinge sufficiently long to act as a strong hinge

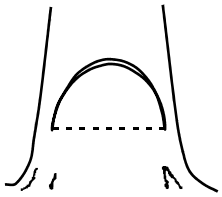
- Therefore, the depth of the notch should be at least 20% of the tree's diameter.



Long lever: Large turning moment

Width of the notch will then be about 80% of the tree's diameter

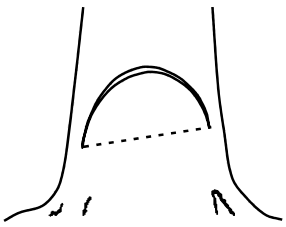
The deeper the notch, the shorter will be the distance between the hinge and the point at which a wedge is applied, thereby reducing the total leverage.



Right: top cut level

The directional notch is done in two steps: Top cut and bottom cut.

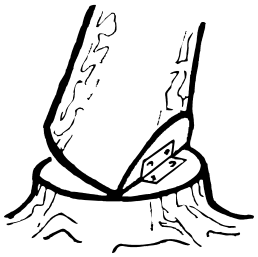
- The top cut is made first; the angle should be between 45° and 70°, the cut should end level (horizontal)
- Align the bottom cut carefully so that the top and bottom cuts meet exactly.
- The line where top and bottoms cuts meet should be horizontal
- If the line of intersection is not horizontal, then holding wood on higher corner will break first, thus pulling tree off line of fall



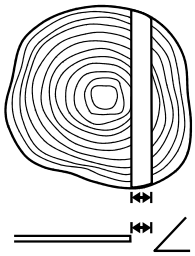
Wrong: top cut slant:

1. Difficult to align bottom cut
2. Uneven height of hinge will pull tree off line
3. Tree may split up

Hinge



Acts as a hinge controlling the tree's fall.

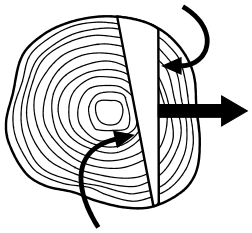


Hinge at least
3 cm thick

Should be approximately 10% of a solid tree's diameter - but at least 3 cm (just over 1 inch).

Trees with defects: holding wood needs to be slightly thicker.

Direction always determined by this line

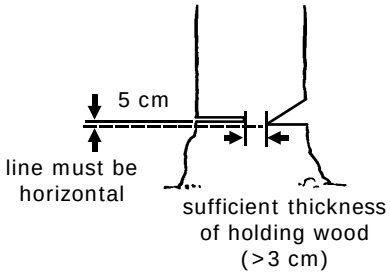


Never determined by this line

The direction of fall of the tree is determined by the front edge of the key or, in other words, by the way in which the notch is cut.

Consequently, if the notch is oriented incorrectly, this cannot be compensated for by leaving one end of the key thicker than the other end.

Back cut

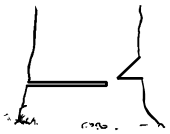


Back cut should be 2.5 cm to 5.0 cm (1-2 inches) above level of vertex of the notch (level of bottom cut if horizontal):

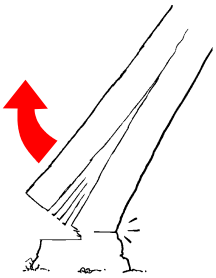
Provides a step, which prevents tree slipping backwards over stump (especially uphill felling).

Prevents butt log being damaged through splinters being torn out of log. (Splinters pulled out of stump.)

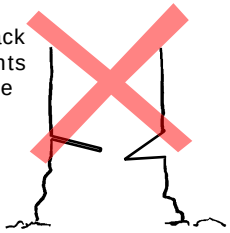
Trees are harder to fall with high back cuts. This creates more holding wood to be broken. (Particularly dangerous when wedging a slightly backwards leaning tree.)



back cut not above bottom of notch



tree may split up



sloping back cut prevents use of the wedge

saw may jam if tree starts splitting or starts to settle back

Back cut should be horizontal:

Sideways sloping back cut will give uneven thickness in the holding wood; may result in trunk splitting up.

An up- or downward sloping back cut prevents efficient use of wedge.

Should leave sufficient thickness of holding wood to guide the tree through intended fall.

Practical felling

Step 1: Before starting

- Make sure there is enough fuel in the tank before you start felling

Step 2: Starting

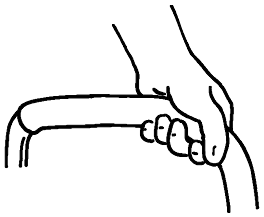
- Place your right foot firmly on the rear handle
- Grab the front handle with the left hand
- Pull the starting handle with your right hand

Step 3: Final checks

- Once the saw is running, check the chain brake function by pushing forward on the front hand guard.
- The chain lubrication should be checked by holding the guide bar over a stump and revving the engine.

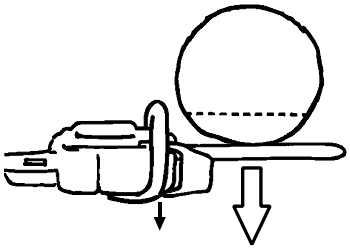
Step 4: Position yourself

- Stand facing the desired felling direction to aim properly.
- Position yourself firmly with your left shoulder resting against the tree.
- Support your right arm on your right knee, or support your right knee against the tree to take the strain off your back and enable you the guide the saw better



Step 4: Align the saw

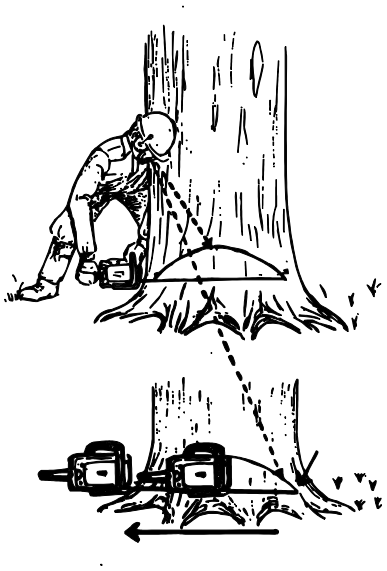
- Grip the top edge of the front handle, since this will tilt the saw at the right angle for sawing the top cut.



- Align the saw at right angles to the felling direction. Use a straight edge or a line painted on the saw for aiming.

Step 5: Make the top cut

- Always make the top cut first
- Complete the top cut by sawing horizontally. If the cut is not level, make the cut again properly



Step 6: Make the bottom cut

- Hold the side of the front handle.
- Align the cut carefully so that the top and bottom cuts meet exactly.
- Look through the top cut to check that the bottom cut is not made too deep.
- The angle between the top and bottom cuts should be as close to 70° as possible although never less than 45°.
- The bottom cut should have a depth of about 20-25% of the diameter

Step 7: Make the back cut

- Once the directional notch is complete, the back cut can be made.
- The technique used for making the back cut depends on the diameter of the tree, the length of the guide bar and the lean of the tree

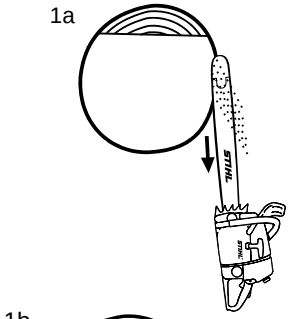
- Whenever possible, use the backward-running part of the chain. The reason for this is that the sawdust will be ejected from the cut, making it easier to insert a wedge.
- Use a felling wedge in order to prevent the tree from settling back and pinching the bar.
- Be careful if there are signs of internal rot. The wood fibres will be weakened when a tree has been attacked by rot, which may affect the direction of the fall.

Step 8: When the tree begins to fall

- Withdraw saw. Do not continue sawing when fibres start breaking
- Withdraw along intended escape route
- Continuously look back at tree's fall
- Look out for falling limbs
- Do not re-enter felling site until all movement has ceased
- When felling trees uphill, they may slide straight backwards over the stump
- Trees that have lodged into a neighbouring tree must be brought down immediately. If the hung-up tree cannot be brought down, its location should be clearly indicated with suitable signalisation; e.g. flagging tape.

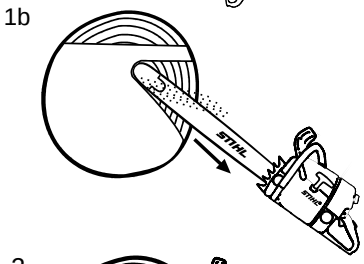
Techniques for making the back cut

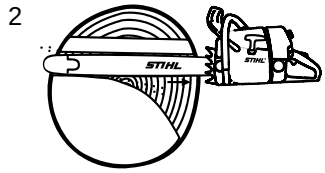
Small-diameter trees, where the guide bar can pass right through



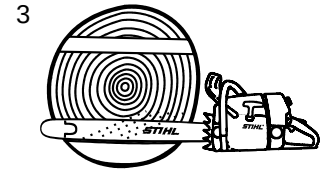
If you want to guard against the tree settling back, leave a small corner of the felling cut unsawn

1a/b. Cut a slot a short distance from the hinge. Use the saw at full throttle and the backward-running part of the chain.

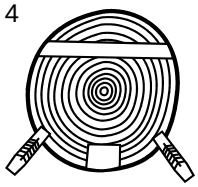




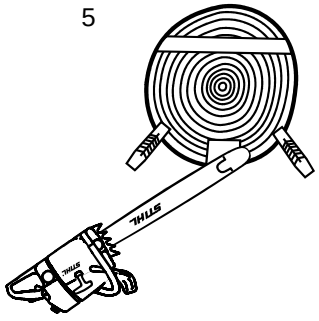
2. Cut the slot right through the tree. Straighten the hinge



3. Continue sawing towards the back of the tree but leave a "heel" as support for the tree. If you are uncertain how thick the bark is, cut through it at the corner support first.



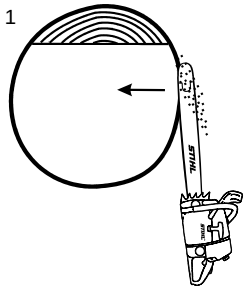
4. Now the tree cannot fall. Remove the saw from the cut and form the "heel". Insert wedges on either side of the "heel".



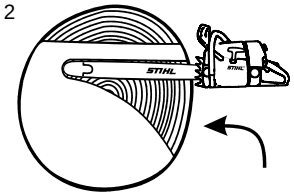
5. Supporting the saw against your right leg, cut through the corner support at a downward angle using the backward-running chain. Do not cut in or underneath any of the wedges

6. Drive wedges to force tee to fall

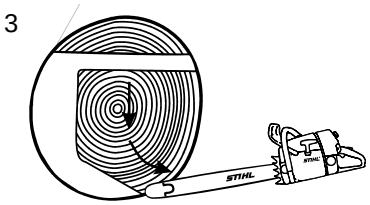
Trees bigger than the length of the guide bar



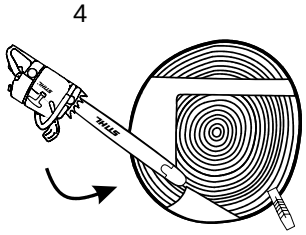
1. Cut a slot a short distance from where the hinge will be made. Use full throttle and the backward-running part of the chain.



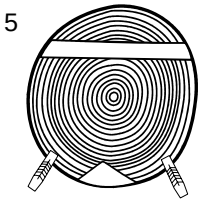
2. Make the cut parallel to the hinge as far in as the guide bar will reach.



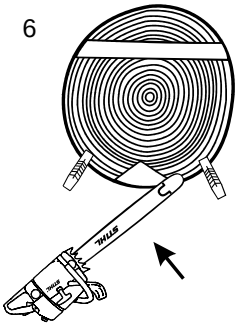
3. Keeping the guide-bar parallel to the hinge, saw towards the back of the tree. Do not cut through to the back but leave holding wood (”heel”) in the middle



4. Insert a wedge, aiming at the centre of the hinge. Cut a new slot on the opposite side. Finish cut by making the hinge straight.



5. Remove the saw from the cut and form the heel at the back of the tree. Insert a second wedge. The tree is still standing firmly on a large supporting base.



6. Cut the remaining corner (heel) a little below the felling cut. Do not cut in or underneath any of the wedges

7. Drive wedges to force tree to fall

Wedging

Types of wedges:

Steel

- Durable but heavy
- Will ruin chain if it contacts wedge

Aluminium

- Lighter than steel
- Generally won't ruin chain if chain contacts wedge
- Less durable

Plastic

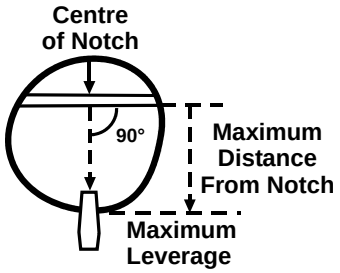
- Light
- Easy on chain (chain will cut through plastic)
- More prone to damage and wear from hammer blows
- Some types will "pop" out if struck hard.

Wedges are most often used when:

- slight backward leaning trees;
- side lean trees;
- cross cutting;
- preventing guide bar from pinching;
- removing pinched guide bar

Using Wedges:

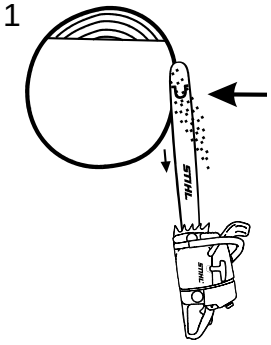
- Drive into back cut as soon as saw has cut deep enough for wedge not to come in contact with saw.
- Thick bark to be removed to allow wedge to work on solid timber.
- Whenever possible insert the wedge directly in line with the centre of the notch to obtain maximum leverage.
- If the tree does not move after three blows on the wedge, check the hinge (thickness) and back cut (cut through)



Special felling situations

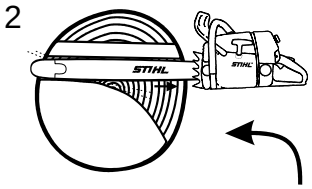
- Trees leaning backwards
- Trees with forward lean
- Trees with side lean
- Defective trees

Trees with forward lean

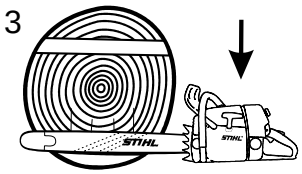


If felled in the conventional way, a tree with a forward lean is likely to split

1. Bore in behind where the hinge is to remain



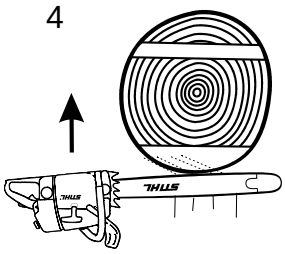
2. Cut the slot right through the tree and make sure that the hinge is straight.



3. Saw backwards in a straight line to complete the cut. Watch out for the butt kicking up.

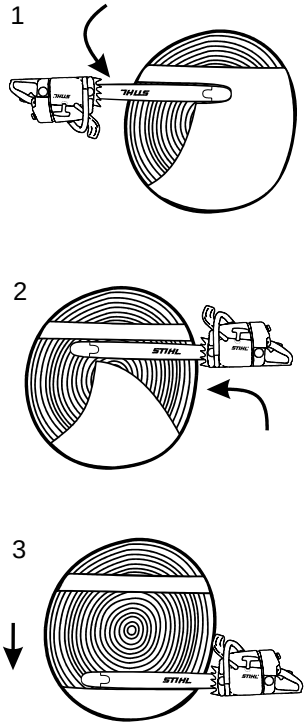
or

3. Withdraw the saw leaving a wide "heel" at the back of the felling cut.



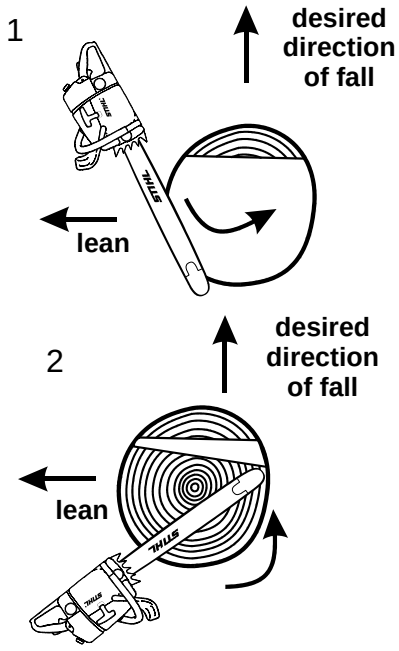
4. Cut the "heel" from the back. Watch out for the butt kicking up.

If the tree is bigger than the length of the guide bar



1. Bore in behind where the hinge is to remain
2. Bore in from the other side
3. Saw backwards in a straight line
4. Make sure the remaining "heel" is in the middle of the tree; withdraw the saw
5. Cut the "heel" from the back .Watch out for the butt kicking up

Trees with side lean

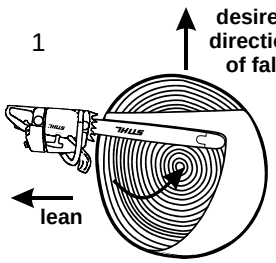


1. Start the felling cut on the side of the lean, to prevent the guide bar from pinching
2. Leave thicker holding wood on the opposite side of the lean (tapered hinge). The thicker holding wood will break last, thus swinging the tree towards the desired direction of fall

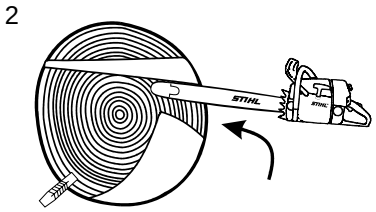
Note with this method the tree may split or the guide bar may get pinched.

Trees with side lean

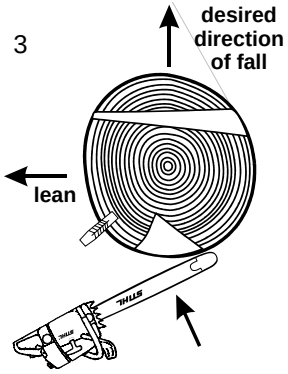
Safer method



1. Start the felling cut on the side towards which the tree is leaning, to prevent the guide bar from pinching but do not cut all the way through the bole.

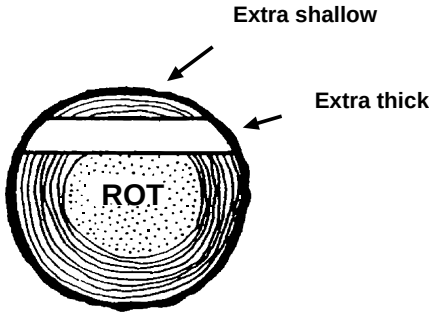


2. Insert wedge on the side of the lean. Bore on the opposite side; a bit further away from the notch, leaving a tapered hinge. Saw backwards



3. Withdraw the saw and cut the heel from the back.

Trees with internal rot



If you suspect that a tree may have butt rot., make a vertical plunge cut before making the notch.

If you discover the tree is afflicted with butt rot, but the hole appears not be that large:

1. Fell the tree in the easiest direction
2. Saw a shallow notch to leave a hinge with as much healthy wood in it as possible
3. Leave an extra thick hinge to avoid the tree falling in the wrong direction (one side of the hinge may have rotten fibres in it)

Trees that split easily on the sapwood

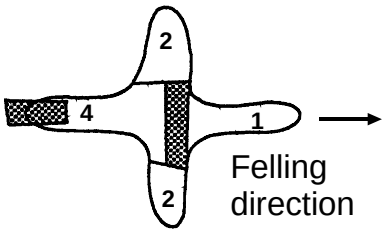
1. Cut a wide notch (approx. 70°) to guide the tree throughout its fall and break the hinge as quickly as possible

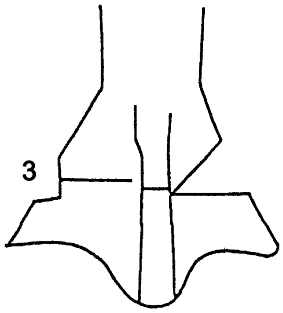
2. Make two side cuts ("dog ears") to prevent splintering
3. Make the felling cut according to guidelines

Trees that split easily on the heartwood

1. Cut a wide notch (approx. 70°) to guide the tree throughout its fall and break the hinge as quickly as possible
2. Make a boring cut into the centre of the scarf at the height of the intended back-cut ("heart-cut"). Because the hinge doesn't run all the way across the stump, it must be wider than normal
3. Make the felling cut according to guidelines

Trees with buttresses, no lean: alternative 1



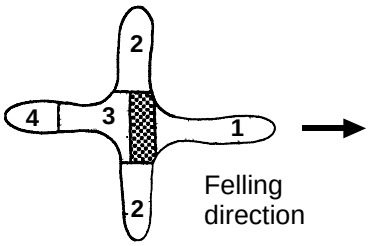


1. Make an open directional cut. The depth of this cut should be at least as deep as the buttress, and preferably go a bit into the actual stem.
2. Cut off buttresses perpendicular to the desired felling direction. Cut horizontally, at the same level as the directional cut. Pay attention to possible tensions in the tree that may squeeze the guide bar
3. Cut a wedge at the back-buttress. This is to achieve maximum lifting power with the wedges.

4 Begin the felling cut at the back. Secure the tree with a wedge. Work with care and keep pushing the wedge further into the tree as you progress.

5. Leave a hinge of at least 10 cm. If necessary, use a wedge to push the tree over.

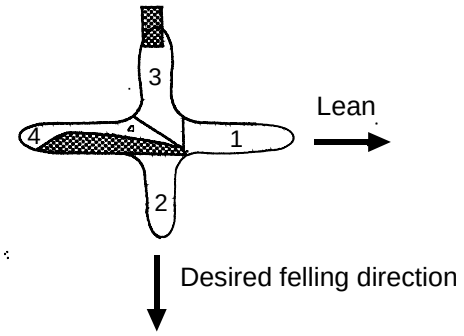
Trees with buttresses: alternative 2 (imperative with forward lean)



1. Directional cut as in Alternative 1
2. Cut off buttresses perpendicular to the intended felling direction
3. Make an incision, work your way towards the directional cut. Leave a hinge of at least 15 cm.

   Cut backwards, but leave at least 1/3 of the backside of the buttress to hold the tree, "holding buttress"
4. Cut off the holding buttress. Cut somewhat below the felling cut (3).

Trees with buttresses, felling 90° against the lean



1. Start by cutting off the buttress in the leaning direction of the tree
2. Make the directional cut.
3. Cut off the buttress opposite to the directional cut. Insert wedges tightly. Angle the felling cut to the hinge according to the figure.
4 Finalise by cutting the last buttress. Work with care until the tree falls. It is important to retain a solid hinge.

MODULE 15: WHEEL SKIDDER

Definition

Wheel skidders are four-wheel drive, rubber-tyre tractor with articulated steering and a cable-arch or grapple on the rear frame

Purpose

The main purpose of the wheel skidder is to extract logs from the felling site to the log landing cheaply, quickly, and efficiently, with minimal environmental damage to the forest; skidders are specifically designed for hauling logs in forest harvesting operations.

Types of skidders

- Grapple skidder; mainly suited for use on flat to undulating terrain.
- Cable-arch skidder; can be used on flat, undulating or hilly terrain.
- A bulldozer or crawler tractor (or the specially designed track-skidder) is recommended for stumping/ramping logs near the stump in steep terrain or poor underfoot conditions.

Skidder manufacturers and models

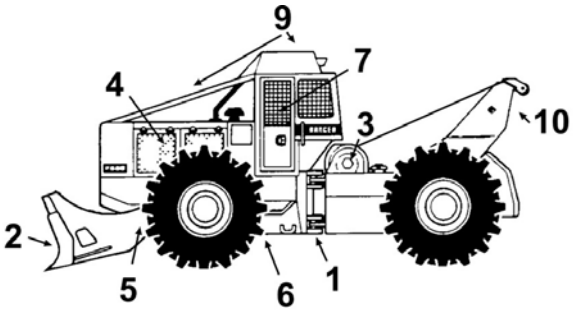
Different skidder models give forest enterprises options to match the volume to be extracted, the size of trees harvested, the skidding distance, and the nature of the terrain to the pulling power needed: some examples of skidders in use in Guyana

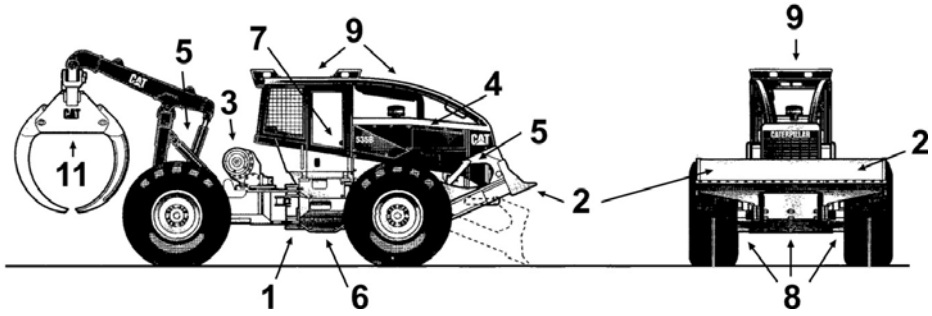
Manufacturer	Light (140 hp)	Medium (160 hp)	Heavy (180 hp)	Very Heavy (200 hp)
Caterpillar	518, 515	525, 525B	528, 528B, 530, 535B	545
(Clark) Ranger	666, F66, H66	H66D	667, F67, H67	F68
Timberjack		460D	660D	
John Deere	640G/648G	748G	848G	

Key start-up checks

- Visual inspection all around, in and under the machine.
- Lubrication checks

Key components



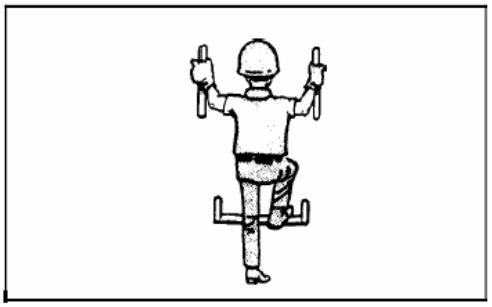


1. Steering Frame
2. Decking Blade
3. Winch
4. Engine
5. Hydraulics
6. Transmission
7. Cab, controls, instruments and seat
8. Drive train, drive shafts, differentials, wheels, and tyres.
9. Canopy ROPS, FOPS
10. Arch or
11. Grapple

Mounting and Dismounting

Mount and dismount the machine only where steps and/or handholds are provided.

Inspect, and when necessary, clean and have repairs made to steps and handholds before mounting and dismounting



Face the machine when mounting and dismounting.

Maintain a three-point contact (two feet and one hand or one foot and two hands contact) with the steps and handholds.

Never get on or off a moving machine

Never jump off the machine.

Do not try to climb on or off the machine when carrying tools or supplies. Use a hand line to pull equipment up onto the platform.

Do not use any controls as handholds when entering or leaving the operator's station.

Engine Starting

1. Engage the parking brake.
2. Move the transmission directional control lever into NEUTRAL.
3. Move the transmission neutral lock lever up, to engage the transmission neutral lock.
4. Move the attachment control levers to the HOLD position.
5. Turn the start switch to start the engine. Release the switch when engine starts.

Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again.

Turbocharger (if equipped) damage can result, if the engine rpm is not kept low until the engine oil gauge verifies the oil pressure is sufficient.

After Starting the Engine

Keep engine speed low until the engine oil pressure registers on the gauge. If it does not register within ten seconds, stop the engine and investigate the cause before starting again. Failure to do so, can cause engine damage.

Allow a cold engine to warm up at LOW IDLE for at least five minutes. Engage and disengage the attachment controls to help speed warm up of hydraulic components.

Cycle all controls to allow warm oil to circulate through all cylinders and lines.

Machine Operation

Be sure no one is working on or near the machine to prevent injury. Keep the machine under control at all times to prevent injury.

Reduce engine speed when manoeuvring in tight quarters or when breaking over a rise.

Select the gear speed necessary before starting downgrade. Do not change gears while going downhill.

A good practice is to use the same gear speed going downgrade that would be used to go up the grade

Do not allow the engine to overspeed downhill. Use the service brake pedal to reduce engine overspeed going downhill.

When the load will be pushing the machine, put the transmission selector lever in FIRST speed before starting downhill.

1. Adjust the operator's seat.
2. Fasten the seat belt.
3. Raise the dozer blade high enough to clear obstructions and to protect the radiator.
4. Be sure front ends of logs are high enough to clear obstructions. Watch for personnel in the area of the machine.
5. Push the knob down to release the parking brake lever
6. Push the lever down to release the transmission neutral lock.
7. Move the transmission control lever to the desired travel direction. Rotate the control to the desired speed.
8. Depress the accelerator pedal.
9. Drive the machine forward for best visibility and control.

For operator comfort and maximum service life of power train components, deceleration and/or braking is recommended before any directional shifts are made.

Moving the machine with the parking brake engaged can cause excessive wear or damage to the brake. If necessary, have the brake repaired before operating the machine.

Operating Precautions

Operate the machine only while seated and with the seat belt fastened.

Operate the controls only with the engine running.

Check for proper operation of all controls and protective devices while moving slowly in an open area.

The operator must be satisfied that no one will be endangered before moving the machine.

Do not allow riders on the machine unless additional seat, seat belt and Rollover Protective Structure (ROPS) are provided.

Report any needed repairs noted during operation.

Carry attachments close to the ground, approximately 40 cm (15 in) above ground level.

Stay an adequate distance from the edge of cliffs, overhangs and slide areas.

If the machine begins to sideslip on a grade, immediately dispose of the load and turn the machine downhill.

Be careful to avoid the condition which could lead to tipping when working on hills, banks or slopes, and when crossing ditches, ridges or other obstructions.

Work up and down slopes, rather than sideways, whenever possible.

Keep the machine under control and do not work it over its capacity.

Watch out for any obstructions such as rocks and stumps

- These may damage tyres and chassis components
- These may cause the machine to overturn.

Avoid excessive wheel spin.

- This will damage tyres and transmission components.

Avoid lifting the front of machine off the ground when skidding or winching.

Know the purpose of and monitor all gauges and indicators on instrument panel.

Check all gauges to ensure that the various components and systems are functioning correctly.

Shut down procedures

1. Park on a level surface. If necessary to park on a grade, block the machine
2. Apply the service brake to stop the machine
3. Apply the service brakes to stop the machine.
4. Move the transmission control lever into NEUTRAL.
5. Pull the lever up to engage the transmission neutral lock.
6. Engage the parking brake.
7. Lower the dozer blade and grapple to the ground and apply a slight down pressure.
8. If the engine is inoperable, the dozer blade can be lowered to the ground with the control lever.
9. With the machine stopped, run the engine for five minutes at LOW IDLE. Stopping the engine immediately after it has been working under load, can result in overheating and accelerated wear of the engine components.
10. Pull the accelerator pedal back past the detent to stop the engine.
11. Turn the disconnect switch key to OFF and remove.

Leaving the Machine

1. Use the steps and handholds, use both hands and face the machine, when dismounting.
2. Inspect the engine compartment for debris. Clean out any debris and paper to avoid a fire.
3. Remove all flammable debris from front bottom guard through the access doors to reduce fire hazard.
4. Turn the battery disconnect switch key to OFF and remove the key when leaving the machine for an extended period of a month or longer. This will prevent battery drain by short circuits or current draw made by some of the components, or by vandalism.

Maintenance

The most important care a machine receives is the preventative maintenance that you perform, which comprises of lubrication, various checks, and adjustments.

Most of the maintenance procedures are simple to perform.

Always use instructions provided in the operators' manual.

Daily inspection

Service the air filter elements

Service the primary air filter element

Check oil level of the winch

Check the crankcase oil level

Check the transmission system oil level

Check the hydraulic tank oil level

Drain moisture and sediment from air reservoir

Check radiator coolant level

Walk-Around Inspection

Accumulated grease and oil on a machine is a fire hazard. Remove this debris with steam cleaning or high pressure water, at least every 1000 hours or each time any significant quantity of oil is spilled on a machine.

Keep a close watch for leaks. If leaking is observed, find the source and correct the leak. Check the fluid levels more frequently than the recommended periods if leaking is suspected or observed.

Inspect the engine precleaner bowl for dirt build-up. Remove dirt from bowl when any dirt has accumulated close to the full line on the bowl.

Inspect and remove any trash build-up in the engine compartment.

Inspect the cooling system for leaks, faulty hoses and trash build-up. Correct any leaks and remove any trash from the radiator.

Inspect all engine attachment belts for worn cracked or frayed edges. Replace if worn, cracked, frayed or broken.

Inspect the hydraulic system for leaks. Inspect the tank, cylinder rod seals, hoses, tubes, plugs, joints and fittings. Correct any leaks.

Inspect the differentials and final drives (front and rear) under the machine for leaks.

Inspect tires (front and rear) for damage and proper inflation. Replace any missing valve caps.

Inspect transmission for leaks.

Inspect the wheel brakes for oil leaks.

Be sure the covers and guards are firmly in place. Inspect for damage.

Inspect the steps, walkways and hand-holds for their condition and cleanliness.

Inspect the Rollover Protective Structure (ROPS) for damage. Tighten any loose ROPS bolts.

Inspect the operator's compartment for cleanliness. Keep it clean.

Test brakes, indicators and gauges for proper function

Test back-up alarm.

For weekly (50 hrs) service consult your operation and maintenance manual

Closing remarks

The skidder is an expensive piece of capital equipment, with high hourly operating cost and as such should be used efficiently and optimally. This means that:

- Operators should be trained for the job they are assigned to do;
- Proper job conditions and working procedures must be maintained. Pay particular attention to conditions that may be hazardous or near the limits of the machine: e.g. side slopes, steep grades, potential overloads, etc.
- Make sure the machine is properly maintained. At the beginning of each shift, the operator should inspect it carefully. If this inspection reveals any defects, the machine should not be operated until these defects are corrected.
- Check the job for unusually demanding conditions that could cause premature failure or excessive wear of machine components

MODULE 16: SKIDDING

Definition

All log movement is divided into two categories—primary and secondary transportation. Primary transportation involves all movement of logs, after cutting, from the stump to the landing. Primary transportation may be performed by tracked machines (crawler tractors), four-wheeled tractors (wheeled skidders), any one of several cable systems, or aerial logging systems. *Skidding* generally refers to the use of either crawler tractors or wheeled skidders for moving forest products out of the forest.

Skidding is generally considered to be a major cost in logging, if not *the* major cost. Because of the cost relationships between components of the logging system, a small incremental cost increase in the planning and felling components can be afforded since it will decrease the skidding cost.

Objective

Extraction of logs from felling sites in an organised and efficient manner to minimise the impact on the environment.

Team

1 skidder operator
1 assistant (choker man)

Equipment & Materials

- Wheel skidder - cable-arch
- 45-m length of 19-mm (3/4") or 22-mm (7/8") wire rope with a minimum of three sliding hooks.
- Six 16-mm (5/8") choker straps with Bardon® hooks in various lengths e.g. 2m, 2.5m, 3m, 4m.
- Tree location map with skid trail alignments.
- Pencil
- Mode of communication (whistle, short wave radio, hand signals)
- Safety gear
- First aid kit

Equipment choice

Crawler tractors (bulldozers) are widely used for ground skidding. Their use is discouraged however because of the adverse environmental impact resulting from soil damage and erosion. Even on gentle slopes with shallow soils tractors can cause severe soil compaction problems during wet weather. Crawler tractors are versatile machines that can be used for skidding and also for road building, landing construction, and skid trail construction. On the other hand, crawlers are heavy and slow. In sparse timber such as in Guyana, a crawler tractor is not the most economical machine.

The wheeled skidder, which appeared on the scene during the 1960s, works well in sparse timber and can skid a given quantity of wood twice as fast as a crawler tractor. Its speed allows logging operators to skid greater distances and to concentrate more logs on a single landing rather than on several smaller landings. Finally, wheeled skidders cost less than crawlers. Not only is the initial cost less for comparable machines, but maintenance costs are also lower.

The wheeled skidder is a versatile vehicle, but it does not replace the crawler tractor. Each has its place. Which machine should be used depends on a number of conditions and variables, such as stand density, volume per stem or per log, thickness of brush and general terrain characteristics. In most cases these variables will interact in a logging operation. Under wet ground conditions skidder logging can cause the same soil damage as was described earlier with crawler tractors. The critical variables are stand density, slope, soil, volume per stem/log and skidding distance.

Stand density

Stand density is considered critical in both tractor and skidder operations. In low-density stands, travel time increases, production becomes lower than average, and unit cost increases. The positive relationship between density and cost reflects the time required to gather a full payload. Bunching, the gathering of stems for a load, takes a greater proportion of available productive time. The greater the distance between the trees, the longer the time required for bunching a load.

Slope

Slope is another variable which has considerable effect on skidding productivity. At the extreme, steep slopes may preclude the use of either tractors or skidders. Even though crawler tractors may be operated on some of the steeper slopes, environmental damage resulting from building skid trails on steep ground dictates that crawlers not be used. The damage results from erosion and soil compaction.

Operability and Slope

Operability class	Tractor slope	Skidder slope
Good	up to 30%	up to 15%
Poor	up to 50%	up to 25%
Impractical	50% plus	30% plus

Note: Even though slopes up to and exceeding 50 percent can be negotiated with tractors, the Guyana Code of Practice for Timber Harvesting does not allow skidding on slopes exceeding 40% because it is not desirable in terms of environmental damage.

Soil

Soil conditions affect operations, especially long skids. In soft, wet ground ruts are gouged out of the skid roads. As the condition worsens the operator must develop another road or suffer delays while attempting to negotiate mud holes. Also, the skidding cycle time will increase. Soil damage under these conditions must also be considered.

Rolling resistance, caused by tires penetrating the ground surface, increases as skidders negotiate wet, muddy ground. This increase in rolling resistance robs the skidder of traction power and reduces usable pounds of pull.

Hydraulics and articulated (hinged) frame construction permit a skidder to 'duck walk' through soft spots. Duck walking involves steering first left and then right in an attempt to

gain advantage by forcing one wheel and then the other onto firm ground. This is a good method for manoeuvring a machine out of a spot, but it is not very effective for pulling a load. It also churns the soil, an undesirable side effect.

Volume per stem/log

Another critical variable is volume per tree. The rule is simple, and pertains to nearly any logging system—the smaller the tree, the higher the variable operating cost per unit of production. The larger the tree, to a point, the lower the variable operating cost. The reason for this is also simple—in the forest, small logs are no more difficult to handle than large ones, but more pieces are required to make up a payload. As tree size increases beyond a certain point, depending on the machine used, some of the advantage is lost. Extremely large logs cause the equipment to be less manoeuvrable and to require more power.

Skidding distance

Skidding distance is perhaps the single most important variable affecting skidding costs and productivity. The cost of skidding almost any log size directly dependent on skidding distances. All other things being equal, the farther a machine has to travel from the stump area to the landing, the lower will the productivity and the higher the unit costs.

Skidding distances vary, depending on such variables as setting size, road location, terrain, and slope. In some cases, there is ample justification for long skidding distances. On rugged terrain, with steep slopes, an operator will have to travel farther to skid a given horizontal distance. Optimum skidding distances vary with terrain and other physical conditions, as well as with the type of machine being considered. Skidders can be used on longer distances because they are faster than track machines. Between 120 and 200 metres (400 and 600 feet) is a good skid for a crawler tractor. Wheeled skidders, because of their speed, can skid up to 400 metres (1300 feet) economically.

The relationship between road-building costs and skidding distances is important. Total cost is minimized when variable skidding costs and spur road construction costs are equal. As skidding distances are reduced, more road building and landing construction is required.

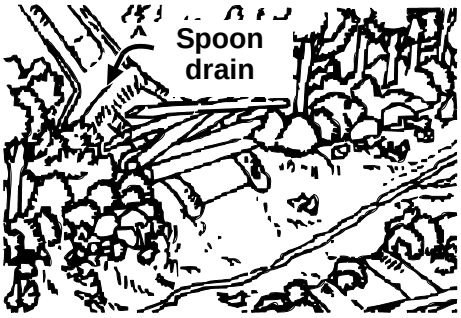
REDUCED IMPACT LOGGING REQUIREMENTS

Restricted areas

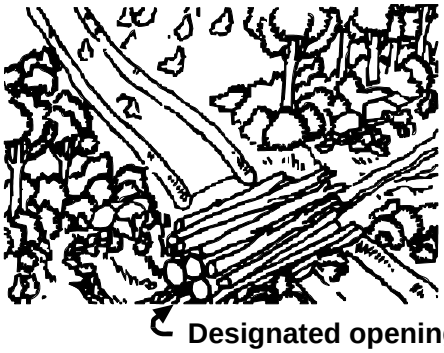
- Skidder cannot enter areas excluded from logging, such as buffer strips along creeks and steep slopes (>40%)
- Skidders are not allowed to cross watercourses, except at approved and properly constructed crossing points.
- Machine access is prohibited within 10 metres of roads with berms or side cuts more than one metre high.
- Avoid skidding along or across primary and secondary haulage roads.

Temporary watercourse crossings

Skid trail crossing watercourse causing damage to stream banks and channel



Crossing should be removed once skidding is completed to allow unrestricted water flow along the original course



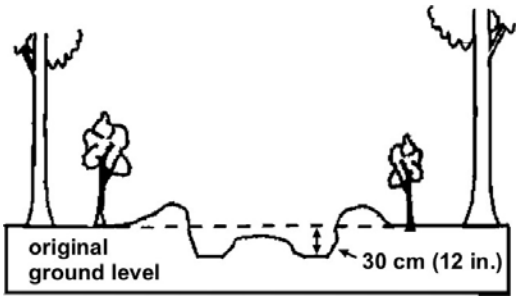
Temporary crossing using logs and poles or a culvert

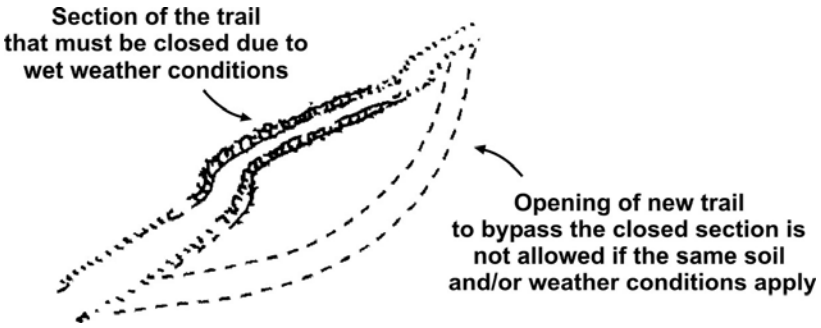
Operation

- Logs should be winched the maximum distance possible, to reduce soil disturbance associated with skidding.
- Winches with a minimum length of wire rope of 45 m and a diameter of 19-22 mm (3/4-7/8 in.) shall be fitted to the machine.
- Skidder and tractor blades shall be raised when travelling and skidding
- Pushing soil on skid trails < 20% slope should be avoided.
- Retain vegetation litter on skid trails.
- Reverse along skid tracks towards the log.
- Head or butt haul to reduce travel distance.
- Machines used for ground-based skidding operations should be equipped with an integral arch to lift one end of the log off the ground to avoid soil damage and to reduce skidding resistance.
- Avoid unnecessary damage to soil and standing trees and regeneration along skid trails.
- Skidding should commence at the rear end of the block and proceed along the main skid trails towards the log market.
- Crosscut long logs (>15 m) to reduce skidding damage consistent with highest value of saleable logs.

Wet weather restrictions for skidding

- Skidding should cease when:
  - soils are saturated and turbid water or mud is flowing down a skid trail for 10 metres or farther; or
  - soils are rutted to a depth of more than 30 cm below the original ground level over a section of 20 metres or longer; or
  - puddles, sludge or slurry are formed along a skid trail to a depth of more than 20 cm over a 20 m section or longer; or
  - turbid water or mud is flowing from a skid trail into a watercourse; or
  - blading of mud or soil is necessary to maintain trafficability of a skid trail or road.
- The affected section of the trail should not be by-passed by opening up a new trail/road alongside or close by if on similar saturated ground.





Operating Techniques

Safety First

- Improper skidder operation can cause personal injury or death.
- Do not winch in logs at a very sharp angle to avoid tipping the skidder.
- Do not attempt to turn the skidder around on a steep grade. Reduce travel speed and steering angle on steep grades.
- Injury to persons nearby can result from persons too close to skidder.
- Be sure all persons are clear of cable and logs before winching in logs or moving the skidder.
- The tail end of tree length logs can throw objects at the choker-person or bystanders.
- Always wear gloves when handling the cable or chokers.

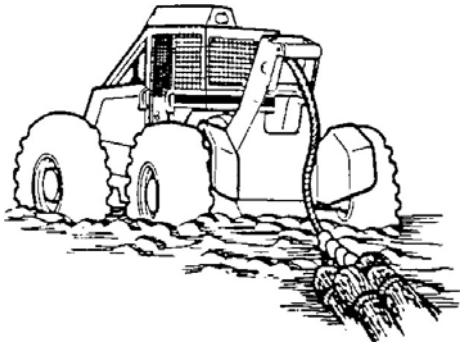
General operating techniques

1. If at all possible, always line up the rear end of the skidder with the logs, so that the logs can be winched in straight. This will avoid unnecessary strain and wear on the side rollers. It will also help to wind the cable onto the winch drum in level layers - neatly just as thread is laid on its reel, to prevent damage to the cable.

2. Pull out cable and attach to the log. If more than one log is to be loaded, attach the end of the main cable to the farthest log.
3. Attach logs so there will be clearance between the skidder and the logs when turning.
4. Reel in logs to raise the forward end of all logs clear of the ground.
5. Raise the dozer blade high enough to clear obstacles and to protect the radiator.

6. When turning, make sure that the cable has enough slack to prevent logs from striking the skidder.
7. Travel up and down hills. Avoid travelling at an angle to the slope, or the machine may tip.
8. When travelling downhill, keep the cable taut so the logs will not bump the rear of the machine.
9. Match your travel speed to condition of the terrain and the log load

10. If the machine loses traction in soft or muddy ground causing the wheels to spin, lower the logs and let out cable as the skidder moves through the soft spot.

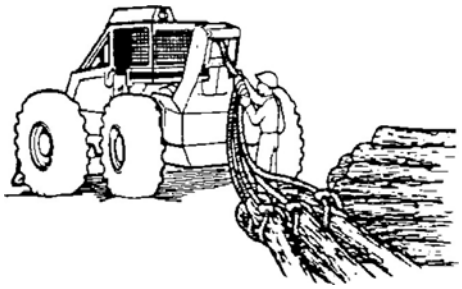


11. Let the winch run out free while driving forward until the machine reaches firmer ground, then winch in the load and proceed.
12. When moving up a steep grade, lower the logs and let out cable as the skidder climbs.
13. When the skidder reaches the top or a level spot, reel in the logs. Repeat until a level travel surface is reached.

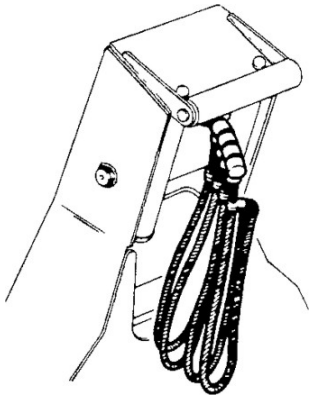
Unhooking Logs

1. Approach the storage or loading area so that the logs will be parallel to the logs in the deck.
2. Stop the machine when the logs are in position to load or deck.

3. Before leaving the operator's seat, put the transmission in neutral and engage the neutral lock mechanism, lower the blade and apply the parking brake
4. Pull the main cable from the winch drum so that the choker straps are loose enough to be removed easily
5. Unfasten the chokers. If some chokers are inaccessible, stop unhooking and move the machine forward.



6. Remount the machine, fasten your seat belt and slowly reel in the cable until the cable is free of logs and is in the travel position



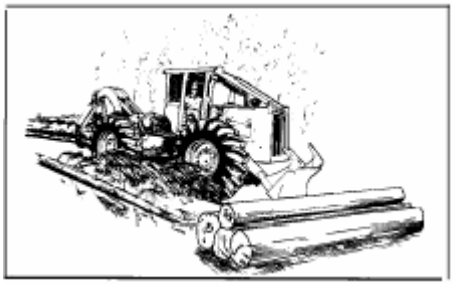
7. Make sure you collect all the choker straps

When reeling in cable, make sure that all persons are far enough away from the logs so they are not in the way of rolling logs or cable whiplash.

Decking Logs

1. Approach the logs near midpoint of their length

2. The dozer blade should be slightly above ground level when contacting the logs.



3. Push the logs against the deck and raise the logs with the dozer blade, while moving slowly forward.

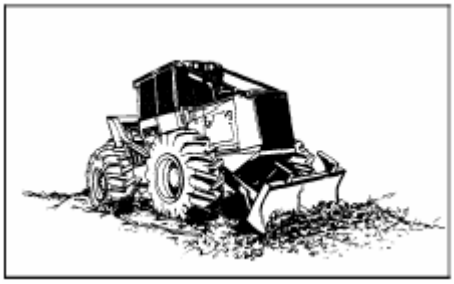
4. Make sure all logs are secure on the deck, then back away.

5. When the dozer blade is clear of the deck, move it to the travel height.

Dozing

The dozer blade is designed for work such as smoothing haul road, clearing debris, decking logs, etc. Do not attempt to dig out rocks, large stumps or do pioneer work with it.

The dozer blade is narrower than the overall width of the machine. When dozing, watch for obstacles that may strike the outer edges of the tires.



1. Move forward while lowering the dozer blade. Lower the dozer blade only enough to engage a load it can easily handle.
2. The haul road can usually be maintained by occasionally travelling at moderate speed with the dozer blade skimming high spots.
3. Doze with the machine in a straight line if at all possible.
4. Work areas can be kept level by smoothing high spots with the dozer blade.

RIL Skidding & Winching Practices

The winch

The winch is a powered drum located at the rear of either a skidder or a tractor. The power is applied to pull in logs. The drum can "free-spool" so that the line can be pulled off the drum by hand. Maximum efficiency is achieved in a straight-line pull. As the vertical or horizontal angle between the line and the skidder increases, efficiency drops. If winching at an angle is necessary, extra care should be taken so the skidder will not overturn, especially when winching on a slope. The angle also causes the line to spool unevenly and results in line damage.

Logging arches

The use of logging arches reduces ploughing and site destruction and, in general, improves the efficiency of the machine. Skidders are usually equipped with integral arches welded or bolted to the skidder frame over the winch. Skidding with only the winch drum and no arch results in reduction of the payload and skidding resistance is also higher. But probably more important is the damage to the ground that occurs when the log is dragged with both ends on the ground rather than with one end elevated.

Choker man is the key man

The skidder assistant or choker man is a key man. He chooses the logs that will make up a load, directs skid track location, and selects the path the logs will travel as they are accumulated for a load. Obstacles such as stumps, rocks, or root wads must be avoided. At all times the hooker should attempt to choose routes that will minimize skid trail construction and damage to the residual timber. The time required to bunch a load is a function of the expertise of the choker man. A slow choker man who does a poor job of selecting loads or directing the skidder will increase bunching time and create skidding delays. It takes experience to minimize delays and hang-ups in making loads.

Chokers

A conventional choker used in skidding is a single length of cable between 16 and 19 mm (⅝ and ¾ inch) in diameter between 2 and 4 metres (6 and 12 feet) long. The choker passes around one end of the log and is secured by the use of a *Bardon* or *bell* hook, which forms a noose that tightens as the choker is pulled. The Bardon hook is moulded with an eye that slips up and down the choker cable. Ferrules are pressed on both ends of the choker, one ferrule to prevent the hook from falling off. This ferrule is also the means by which the noose is made, as the ferrule fits into the ferrule eye in the hook. The ferrule on the other end is hooked to a *Bardon* hook or a *sleeve-type* hook attached to the winch line that slides up or down the winch line as required.

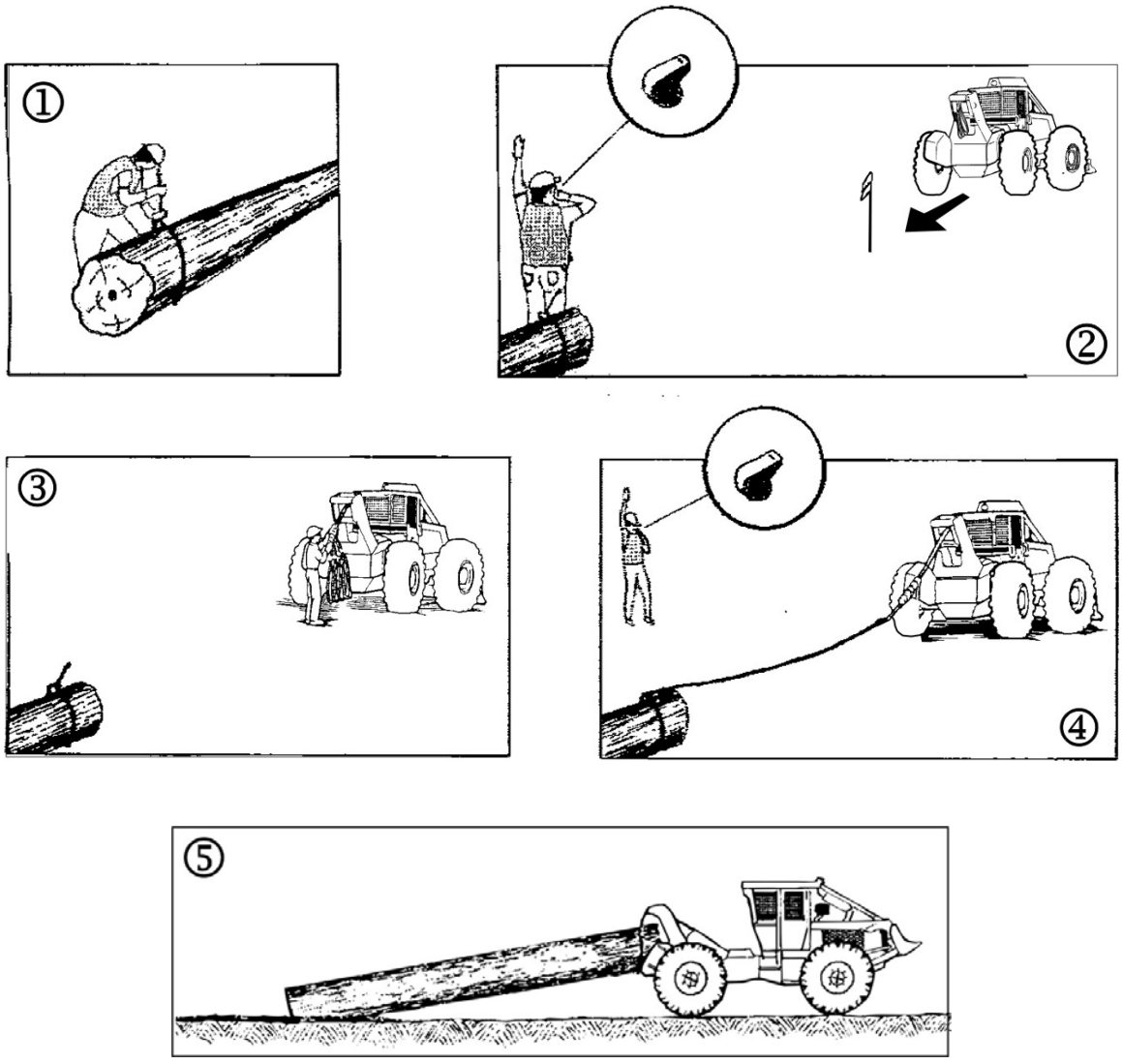
Choker setting appears, to the casual observer, to be a simple task. After all, all that needs to be done is place a steel noose about a log. It is not extremely difficult in terms of mental requirements, but it does take a good deal of common sense. A good, experienced choker setter is worth his weight in gold. There is a right and wrong way to set a choker. The choker should be hooked as close to the end of the log as possible without risking the loss of the log during skidding.

The sequence in which logs are hooked depends on the orientation of the large end. Large ends should be leading when an arch is used. When attaching the chokers to the winch line hooks, the tightest choker should be attached last. With the tightest choker on top, the other chokers on the hook will not drop off. The tightest choker is the choker with the least amount of slack. When the final log is hooked to the winch line, making up a full load, the skidder should always be pointed in the direction of the skid trail, if possible. This will reduce the amount of manoeuvring necessary and will result in less trouble getting the load started.

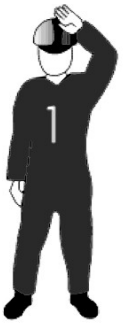
Setting a choker: (1) the Bardon or bell hook. (2) Choker setter has the ferrule in one hand and the bell in the other (3) the ferrule is placed in the bell and the cable is laid in the slot. (4) Choker is set and ready to go. The choker was placed over the log so that it will not become unhooked while the log is being skidded.

Accumulating a load

1. Skidding should commence at the point farthest from the log market (rear end of the block) and proceed along the main skid trails towards the log market.
2. The skidder assistant (choker man), using the harvest map, directs the skidder operator.
3. He locates the logs that will make up the load. Then he sets the chokers (1);
4. When the skidder returns from the landing, the assistant signals the operator to position the skidder in an appropriate way so that the choker can be attached to the winch line (2);
5. The assistant unreels the main cable (3) and attaches the choker to it (4).
6. Finally, the main cable is winched in until the log reaches the butt plate of the skidder (5).

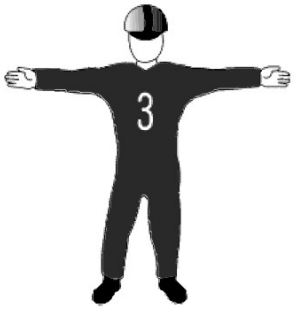


Recommended hand signals for directing the skidder operator

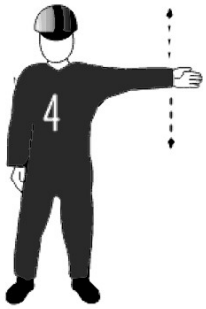


1. Tractor forward

2. Tractor reverse

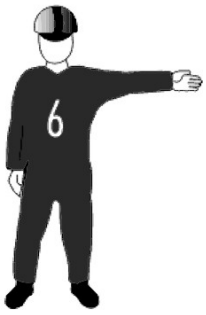


3. Tractor stop



4. Release cable

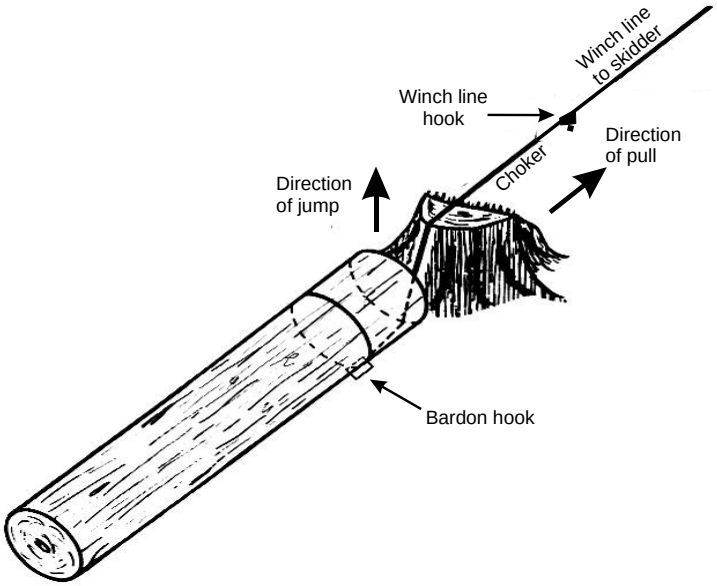
5. Retract cable



6. Stop cable

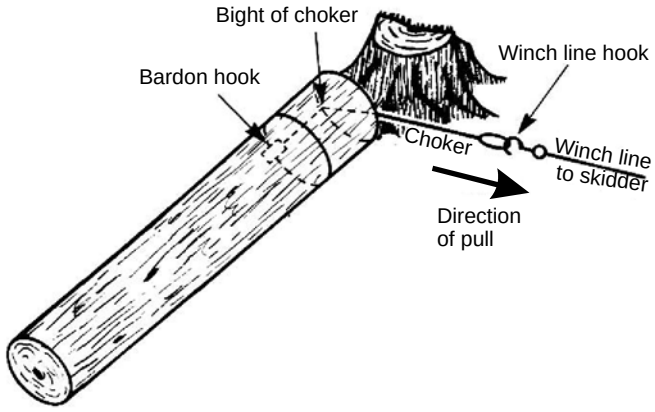
Obstacles or hang-ups

If an obstacle can be avoided by moving the skidder into a better position, this is desirable. It is always better to lead a log around an obstacle or to use a high-angle pull rather than fight a hang-up. However, there are times when hang-ups cannot be avoided. At these times the choker setter earns his keep. Three basic maneuvers can be used to work around a hang-up - the jump, the kick, and the roll.



The jump method of working around a hang-up

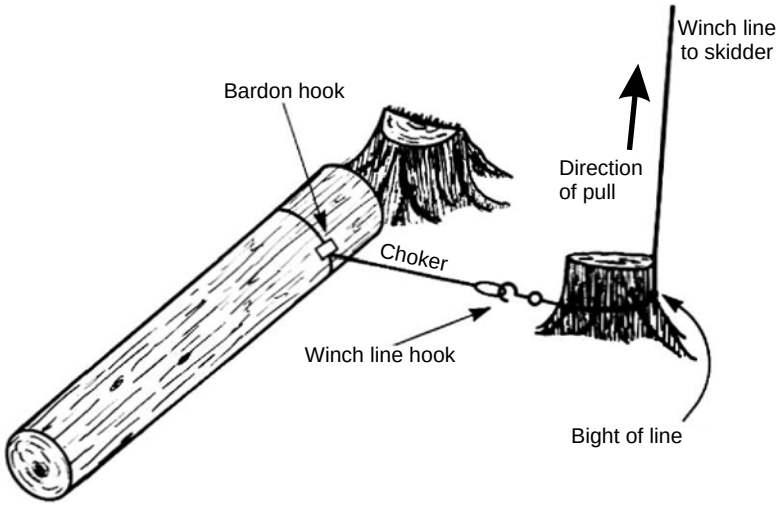
A *jump* could be used to apply the right-angle pull up over the stump. This is achieved by setting the choker in the usual fashion and then slipping the choker bell under the log. The leading end of the choker is forced under the log as close to the center as possible and is laid over the top of the stump. When the skidder winch is engaged, the bight of the line over the stump will pull straight up on the end of the log. The stump is used to change the direction of pull upward.



The kick method of working around a hang-up

A *kick* utilizes the same principle as the jump except that the force is made to apply from the side of the stump rather than up and over. The choker bell is placed opposite the direction of pull and the leading end of the choker is again led around the end of the log, but around the stump instead of over it. When the winch is engaged the log will be pulled sideways away from the stump.

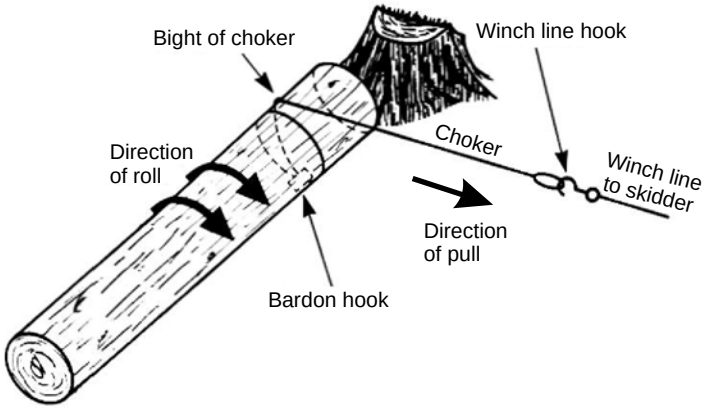
A variation of the *kick* is used when a second stump to the side of the hang-up is burned by throwing the bight of the winch line over it to change the direction of pull.



A variation of the kick

The *roll* is also effective in helping to free a hang-up. It is simple to apply, providing there is a little daylight or space between the log and the ground. The choker is set in the normal fashion. Once set, the noose is slid around the log, counter to the desired direction of pull and in screw fashion. As the noose is screwed onto the log, the leading end of the choker is automatically wrapped around it. The same effect results from setting the Bardon hook low on the log against the ground and wrapping the leading end of the choker around the log.

Once the roll is set, the choker eye is slipped on the winch line hook and tension is applied rolling the log in the direction of pull. The roll is often used with a kick when the kick alone will not free the hang-up.

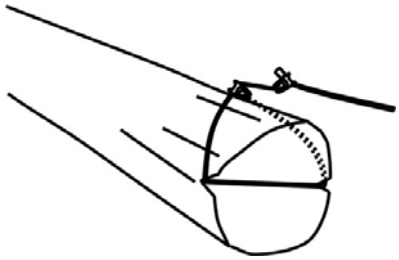


The roll method of working around a hang-up

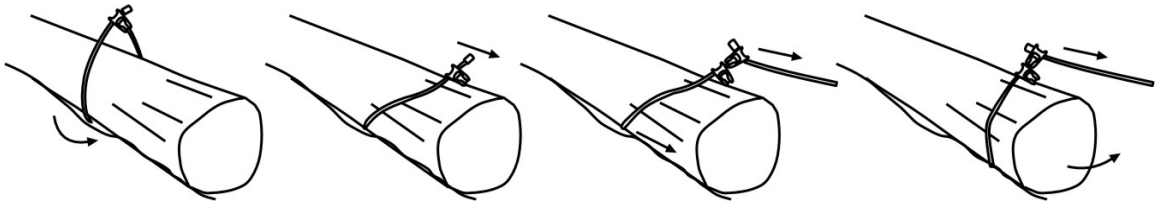
It is always better to think about a hang-up before it happens. If it looks as if a log will hang up on an obstacle, use one of the methods described before the skidder tries to pull on the log. This will save time in the long run since some of the logs will not hang up at all.

The correct way to winch a load is to ease into it. Ten percent more force is required to start a load than to sustain movement at skidding speed. Finally, winching should not be done at an angle. It is always better to pull straight into the load since in this position less force is dissipated.

It is best to use two sets of chokers. One set is hooked on the logs while the other is being used to skid a load.



Large logs can be attached by placing the choker in a "D Cut".



A log lying on the ground may require that the cable be passed under it well back from the final lifting point.

Advantages

- ☺ All logs that have been felled will be extracted.
- ☺ Lower operating costs.
- ☺ Less wear and tear; less downtime
- ☺ Improved use of machinery
- ☺ Less damage to the logs

Disadvantages

- ☹ Requires a trained team

Variation

- Using a wheel skidder in tandem with a track skidder (Caterpillar 527 or D5TSK) or bulldozer (not larger than D6), whereby the track machine forwards logs in steep terrain. When one machine accumulates and bunches a load for another to skid, it is called *shuttle logging*.

MODULE 17: WHEEL LOADER

Objectives

- To introduce participants to a safe working environment in the operation of the wheel loader;
- To provide operators knowledge and skills that will make them effective and efficient in using the wheel loader in loading the bucket, loading log forks, in truck loading and in load and carry operations.

Definition

- A wheel or front-end loader is a four-wheel drive, rubber-tired tractor with articulated steering with a hydraulically controlled bucket or log forks attached to the front of the machine.
- A wheel loader is designed for moving loads (such as earth, logs, etc.) over a short distance and for loading trucks with these loads;
- Log loading by means of a wheel loader is more efficient, less damaging to the environment and much safer than loading trucks with a tractor or a skidder, or manually (using a ramp);
- Another advantage of the wheel loader is its versatility: the same machine with just a simple change of accessory may be used for loading logs, earth or other tools.

Purpose

- Road construction
- Earth works
- Loading from stockpiles
- Loading hauling units (trucks or barges)
- Sorting logs and loading log loads onto hauling units

Safety

Personal Protection

Wear all the protective clothing and personal safety devices issued to you or called for by job conditions.

- Safety helmet
- Safety boots
- Safety glasses, goggles, or face shield
- Heavy gloves
- Hearing protection
- Reflective clothing
- Wet weather gear
- Respirator or filter mask

WARNING: Do NOT wear loose fitting clothing, flopping cuffs, dangling neckties or scarves, or rings and wrist watches that can get caught in moving parts

Machine safety

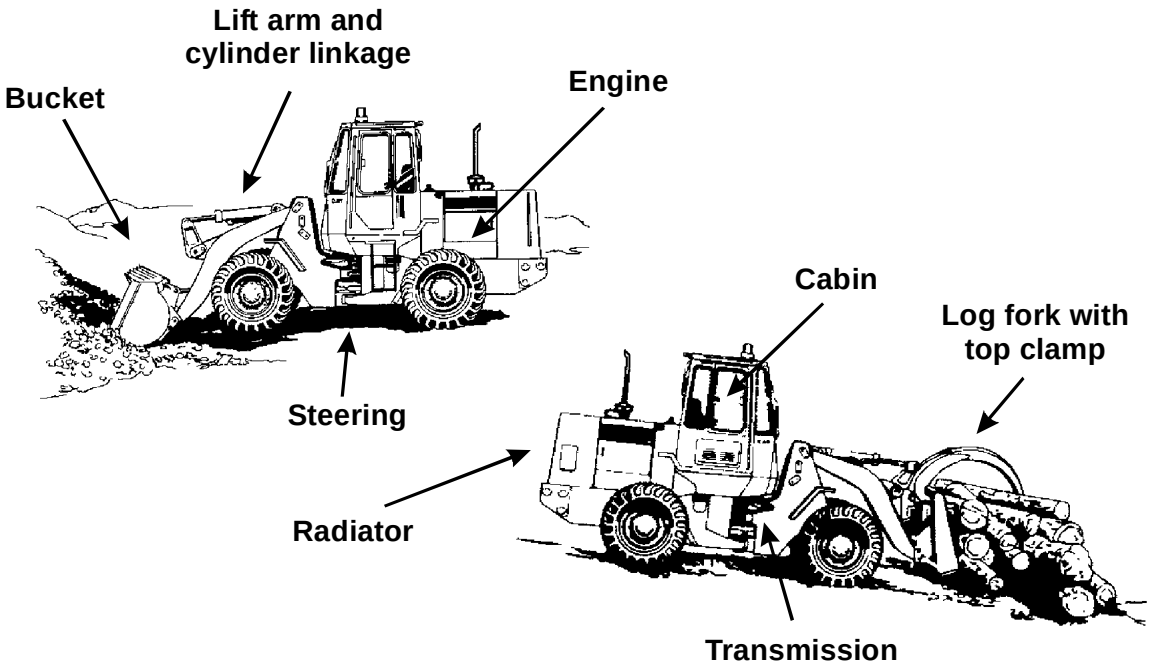
To protect you and others around you, your machine may be equipped with the following safety equipment. See that each item is securely in place and in operating condition (where applicable).

- Falling Object Protective Structure (FOPS)
- Roll-Over Protective Structure (ROPS)
- Seat Belts/Operator Restraints
- Lights, Horn, Mirrors
- Safety Signs
- Guards, Shields
- Back-Up Alarm
- Fire Extinguisher
- First Aid Kit
- Windshield Washers & Wipers
- Operation Manual

Work area safety

- Know the width of your attachments so proper clearance can be maintained.
- Know the working area
  - Location of slopes.
  - Conditions of haul roads.
  - Direction of travel on haul roads.
  - Holes, obstructions, mud.
  - Heavy traffic.
  - Thick dust, smoke, fog.
  - Utility line locations
- Know the appropriate work site signals and who gives them. Accept signals from one person only
- Do not allow unauthorised personnel on the machine
- Know the rules that should be observed at the work site

Key components



- Cabin ROPS
- Engine
- Transmission system
- Cooling system
- Hydraulic system
- Articulated steering
- Lift arm and cylinder linkage
- Bucket attachment
- Log fork with top clamp attachment

Before starting the engine

Before you begin your workday, you should inspect your machine and have all systems in good operational condition. Do not operate the machine until all deficiencies are corrected.

- Check for broken, missing or damaged parts.
- Check the tires for cuts, bulges and correct pressure. .
- Check service and parking brakes for proper operation.
- Check the hydraulic system for leaks. Inspect the tank, cylinder rod seals, hoses, tubes, plugs, joints and fittings..
- Check the cooling system for leaks, faulty hoses and trash build-up.
- Check that the steering frame lock on an articulated machine has been removed and properly stored.
- Check all of the oil, coolant and fuel levels. Allow the radiator to cool before checking the coolant level

- Inspect the engine pre-cleaner screen for accumulation of dirt and debris
- Inspect and remove any trash build-up in the engine compartment
- Inspect all engine attachment belts for worn, cracked or frayed edges
- Inspect the front and rear axles and the transmission for leaks.
- Inspect the steps, walkways and handholds for their condition and cleanliness
- Inspect the condition of the bucket or log fork and linkage for damage or excessive wear
- Clean windshields, mirrors and all lights
- Wipe steering controls, foot pedals, hand levers and knobs clean of oil and grease.
- Clean your boots of excess mud before getting on the machine
- Remove unauthorized tools, supplies, and other materials from the cab
- Secure all loose items such as lunch boxes, tools and other items in the tool box

Mounting the machine

Maintain a three point contact with the steps and hand holds

Face the machine when either mounting or dismounting.

Never jump on or off the machine. Never attempt to mount or dismount a moving machine.

Do not use the steering wheel or any control lever as a hand hold when you enter or leave the machine.

Pre-start checks

- Before starting, walk completely around the equipment and make sure no one is under the machine, on it, or close to it
- Sound the horn and let other workers and bystanders know you are starting up
- Don't start until everyone is clear of the machine
- Make sure the steering frame lock link is in the unlocked position
- Start the engine only from the operator's seat. Never attempt to start the engine by shorting across starter terminals or across the battery
- Adjust the seat so you can operate all the controls properly
- Fasten the seat belt
- Move the transmission control lever to neutral
- Unlock the steering column. Move the steering column to the desired position and lock
- Engage the parking brake

- Turn the start switch key to start the engine. Release the key when the engine starts.
- Do not crank the engine for more than 30 seconds
- Keep the engine RPM low until the engine oil gauge verifies the oil pressure is sufficient. High engine RPM at start up can result in turbocharger damage
- Cycle all controls to allow warm oil to circulate through all cylinders and lines
- Engage and disengage the attachment controls to help speed hydraulic oil warm up
- Allow the engine to warm up at low idle for at least five minutes

Machine Operation

- Be sure no one is working on or near the machine to prevent injury. Keep the machine under control at all times to prevent injury.
- Raise all lowered attachments enough to clear any obstructions.
- Push down on the service brake pedal to keep the machine from moving
- Push the parking brake knob in to release the parking brake
- Move the transmission control lever to the desired direction and gear speed
- Release the service brake pedal.
- Push down on the accelerator pedal to the desired engine speed.
- Drive the machine forward for best visibility and control.
- Reduce engine speed when manoeuvring in tight quarters or when breaking over a rise.
- Select the gear speed necessary before starting downgrade. Do not change gears while going downhill.
- A good practice is to use the same gear speed going downgrade that would be used to go up the grade.
- Do not allow the engine to over-speed downhill. Use the service brake pedal to reduce engine over-speed going downhill.
- When the load will be pushing the machine, put the transmission selector lever in first speed before starting downhill.
- For operator comfort and maximum service life of power train components, deceleration and/or braking is recommended before any directional shifts are made

Operating techniques

Bucket loader

General

- For good operator vision and loader stability, carry the loaded bucket low, approximately 40cm (15 in) above the ground
- Utilize wait time to clean and level the work area
- Maintain traction by avoiding excessive down pressure on the bucket
- When working with hard material use bucket teeth, or bolt-on cutting edges.
- Be certain that the bucket used is appropriate for the work performed. Exceeding the machine limits will reduce the service life of the machine.

Dozing

- Keep the bucket bottom parallel to the ground when dozing.
- Do not doze with the bucket in the tilt forward position or bucket damage can result.

Bucket Loading from a Stockpile

- Position the bucket parallel to, and just skimming, the ground. Drive the bucket straight into the pile.
- Move the control to the raise detent position as forward movement slows. Return to the hold position for additional crowding power.
- To "pump" in a heaped load, work the tilt control lever back and forth.
- When the bucket is loaded, move the tilt control to the tilt back position.
- When the tilt control lever is released to the hold position, the bucket will rise.
- Raise the bucket high enough to clear the material being loaded. Move the transmission control to reverse.

- Carry the loaded bucket approximately 40cm (15 in) above the ground level.
- When reaching the dump area, move the lift control to the raise detent. The lift kick out will automatically return the lift control to hold.

Bucket Loading Hauling Units

- To reduce the loader turning and travel, position the hauling unit at an angle to the material being loaded.
- The travel distance should be long enough for the bucket to reach the lift height without slowing loader movement.
- Position the loader to dump the lead in the centre of the hauler body. If the hauler body is two bucket widths or more in length, dump from the front to the rear.
- Push the tilt lever forward to dump the bucket.

- Shake the bucket to loosen sticky material. Move the tilt lever back and forth quickly, allowing the tilt arms to strike the stops.

- NOTICE: Striking the stops unnecessarily and repetitively can result in accelerated wear and high maintenance cost of the loader linkage.
- Put the tilt lever in the tilt back detent.
- Before lowering the bucket, make sure the hauling unit is out from under the bucket.
- Lower the bucket while positioning the loader for the next load.

Bucket loading from a bank

- Start to load at the base of the bank and follow up the face
- Raise the bucket slightly and move away from the bank
- When working at the base of a bank, overhang, or stockpile, avoid dangers such as rock or earth slides, overhanging trees or a cave-in, by proper job operation.

Backfilling

Extreme caution is required when backfilling as the weight of the fill material plus the weight of the machine could cause new construction to collapse

Log loader

Road rules

- Do not turn a machine on a wet road.
- Avoid using a road to load or unload trucks on; trucks should be loaded and unloaded away from the road - e.g. on a log market or yard.
- Do not carry logs in the forks along the road with vision restricted.
- Keep the forks low and crowded back whilst travelling.
- Do not let forks penetrate the road surface if parking on the roadway.

Methodology

- Position the fork in the centre of the load, with the top clamp open.

- Close the top clamp and tilt the fork back to hold the load against the fork uprights.
- For best operator vision and loader stability, carry the load as low as possible.
- Position the load over the stacking area. Tilt the fork down and raise the clamp to release the load.

- Always work to a systematic plan.
- Ensure personnel with you, know your plan.

- Do not lift logs over personnel
- Lifting, loading and unloading by forks should not be done over truck cabins.
- The upper clamp should hold the log securely at all times.
- Do not drop the log onto the stack or load as this may cause loss of control of where the log is stacked.

Log market operations

- Remove logs from skidding area so skidding is not slowed down.
- Stack logs according to species, sizes and grades, e.g. peeler logs, sawmill logs, large, small, long, short
- Ensure cross cutters can cut logs without danger to themselves from logs, log stacks or machine.
- Organise a system which allows skidder to skid logs to landing without obstruction and return to felling site immediately.
- Allow chainsaw operators to crosscut logs as necessary, quickly and without injury.
- Sort, segregate and stack logs without moving machine long distances.
- Load trucks without moving machine long distances
- All log stacks must be neat and segregated according to sizes, species, grades as per company specification, and ready for loading onto trucks.
- If trucks are not available for immediate loading, a series of landings alongside road or loading point will be necessary. In this case the stacking system may need to be changed

Loading and unloading trucks

- Check that area is clear.
- Position machine and truck correctly.
- Work with optimum load.
- Fork points placed under logs and tilt used to gather logs onto forks.
- Clamp log securely.
- Do not spear logs from clamp.
- Lift logs clear of truck pins and stanchions.
- Place logs on truck smoothly.
- Ensure log being moved will not force other logs to dislodge causing danger to others.
- When unloading short wood mixed with long logs, ensure that the logs being lifted are securely held, and will not damage equipment.
- Do not damage logs when trying to get the fork points under them, especially those high on the load.
- Do not throw logs around as this causes damage to logs and danger to personnel.
- Care must be taken when placing multiple pieces on truck.
- Watch for small, slippery logs that may slip out of the forks onto cabin.
- Place fork load of logs onto truck smoothly, sliding from the tilted fork points, without dropping.
- Load a level floor first. (of long logs if loading a trailer)
- Build up furthest side first (long logs if loading a trailer)
- Finish loading furthest point first.
- Ensure load is secure when truck is loaded so that when truck leaves landing, logs will not slip off
- Observe and maintain all loading specifications, load height above stanchions, do no exceed load limits.
- Insist that loads are securely chained before the truck leaves the loading area.