TVET CERTIFICATE III in FORESTRY

FOREST TOOLS, EQUIPMENT AND MEASUREMENT

FORTE301

Operate forest tools, equipment and Measurement

Competence

Credits: 8

Learning hours: 80

Sector: Agriculture

Sub-sector: Forestry

Module Note Issue date: June, 2020

Purpose statement

This module describes the skills and knowledge required to operate a variety of tools and equipment throughout the forestry activities. These tools and equipment are those used to establish, manage and harvest forests.

The module will allow the learner to:

- Compare Standard Measurements
- Select forest tools and equipment;
- Use forest tools and equipment;
- Maintain forest tools and equipment

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LU & PC is linked in LO inside the content

Total Number of Pages: 44

LO 1.1 – Perform Standard measurement of length

- Topic 1: Identification of standard measurement of length

✓ Inch

✓ Foot

✓ Yard

✓ Mile

✓ Meter

✓ Kilometer

- Topic 2: Comparison of standard measurement of length

✓ 1 centimeter = 0.39 inch

✓ 1 inch = 2.54 centimeters

✓ 1 meter = 39.37 inches

✓ 1 foot = 0.305 meter

✓ 1 meter = 3.28 feet

✓ 1 yard = 0.914 meter

✓ 1 meter = 1.094 yards

✓ 1 kilometer = 0.62 mile

✓ 1 mile = 1.609 kilometers

LO 1.2 – Calculate Area metric system

- Topic 1: Identification of area metric system

✓ Square meter (basic unit of area)

✓ Square inch

✓ Square foot

✓ Square yard (basic unit of area)

✓ Square rod

✓ Acre

✓ Square mile

- Topic 2: Comparison of area metric systems

✓ 1 square centimeter = 0.155 square inch

✓ 1 square inch = 6.45 square centimeters

✓ 1 acre = 0.405 hectare

✓ 1 hectare = 2.47 acres

✓ 1 square kilometer = 0.386 square mile

✓ 1 square mile = 2.59 square kilometers

LO 1.3 – Estimate standards volume and capacity (liquid and dry measurement)

- Topic 1: Identification of standard volume and capacity measurement

✓ 1 cubic centimeter = 1/1,000,000 cubic meter

✓ 1 cubic decimeter = 1/1,000 cubic meter

✓ 1 cubic meter = 1 stere (basic unit of volume)

✓ 1 milliliter = 1/1,000 liter = 1 cubic centimeter

✓ 1 centiliter = 1/100 liter

✓ 1 deciliter = 1/10 liter

✓ 1 liter = 1 cubic decimeter (basic unit of capacity)

✓ 1 dekaliter = 10 liters

✓ 1 hectoliter = 100 liters = 1/10 cubic meter

American and British units

✓ 1 cubic inch = 1/46,656 cubic yard = 1/1,728 cubic foot

✓ 1 cubic foot = 1/27 cubic yard

✓ 1 cubic yard (basic unit of volume)

✓ 1 U.S. fluid ounce = 1/128 U.S. gallon = 1/16 U.S. pint

✓ 1 British imperial fluid ounce = 1/160 imperial gallon = 1/20 imperial pint

✓ 1 pint = 1/8 gallon = 1/2 quart

✓ 1 quart = 1/4 gallon

✓ 1 U.S. gallon (basic unit of liquid capacity in the United States) = 231 cubic inches

✓ 1 imperial gallon (basic unit of liquid capacity in some Commonwealth nations) = 277.4 cubic inches

✓ 1 dry pint = 1/64 bushel = 1/2 dry quart

✓ 1 dry quart = 1/32 bushel = 1/8 peck

✓ 1 peck = 1/4 bushel

- Topic 2 Comparison of standard volume and capacity measurement

- ✓ 1 cubic centimeter = 0.06 cubic inch
- ✓ 1 cubic inch = 16.4 cubic centimeters
- ✓ 1 cubic yard = 0.765 cubic meter
- ✓ 1 cubic meter = 1.3 cubic yards
- ✓ 1 milliliter = 0.034 fluid ounce
- ✓ 1 fluid ounce = 29.6 milliliters
- ✓ 1 U.S. quart = 0.946 liter
- ✓ 1 liter = 1.06 U.S. quarts
- ✓ 1 U.S. gallon = 3.8 liters
- ✓ 1 imperial gallon = 1.2 U.S. gallons = 4.5 liters
- ✓ 1 liter = 0.9 dry quart
- ✓ 1 dry quart = 1.1 liters
- ✓ 1 dekaliter = 0.28 U.S. bushel
- ✓ 1 U.S. bushel = 0.97 imperial bushel = 3.5 dekaliters

LO 1.4 – Calculate Weight (mass) metric system measurement

- Topic 1: Identification of weight (mass) metric system measurement

- ✓ 1 milligram = 1/1,000,000 kilogram = 1/1,000 gram
- ✓ 1 centigram = 1/100,000 kilogram = 1/100 gram
- ✓ 1 decigram = 1/10,000 kilogram = 1/10 gram
- ✓ 1 gram = 1/1,000 kilogram
- ✓ 1 dekagram = 1/100 kilogram = 10 grams
- ✓ 1 hectogram = 1/10 kilogram = 100 grams
- ✓ 1 kilogram (basic unit of weight or mass)
- ✓ 1 metric ton = 1,000 kilograms

American and British Units:

- ✓ 1 grain = 1/7,000 pound = 1/437.5 ounce
- ✓ 1 dram = 1/256 pound = 1/16 ounce
- ✓ 1 ounce = 1/16 pound
- ✓ 1 pound (basic unit of weight or mass)
- ✓ 1 short hundredweight = 100 pounds
- ✓ 1 long hundredweight = 112 pounds

- ✓ 1 short ton = 2,000 pounds
- ✓ 1 long ton = 2,240 pounds
- ✓ American and British Units: Troy and Apothecaries'
- ✓ 1 grain = 1/7,000 avoirdupois pound = 1/5,760 troy or apothecaries' pound

- Topic 2: Comparison of weight (mass) metric system measurement

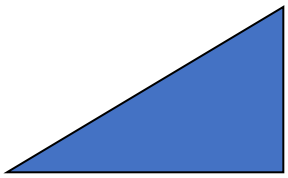
- ✓ 1 milligram = 0.015 grain
- ✓ 1 grain = 64.8 milligrams
- ✓ 1 gram = 0.035 avoirdupois ounce
- ✓ 1 avoirdupois ounce = 28.35 grams
- ✓ 1 troy or apothecaries' pound = 0.82 avoirdupois pound = 0.37 kilogram
- ✓ 1 avoirdupois pound = 1.2 troy or apothecaries' pounds = 0.45 kilogram
- ✓ 1 kilogram = 2.205 avoirdupois pounds
- ✓ 1 short ton = 0.9 metric ton
- ✓ 1 metric ton = 1.1 short tons

LO 1.5 – Compare general conversion

- Topic 1: Comparison of general units' conversion

There are three ways to indicate the slope of a surface relative to the horizontal plane:

- ✓ Degrees
- ✓ Gradient and
- ✓ Percentage



3"

3 feet or 36"

- ✓ **Calculating a slope gradient**

Slope gradients are written as Y:X, where Y is a single unit in rise and X is the run. Both numbers must use the same units. For example, if you travel 3 inches vertically and 3 feet (36 inches) horizontally, the slope would be 3:36 or 1:12. This is read as a **"one in twelve slope".**

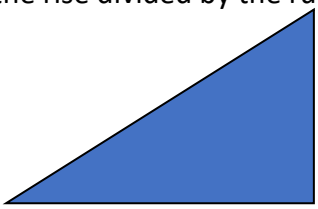
Slope=$\frac{3"}{36"}$=0.083x100=8.3%

✓ **Calculating a slope percentage**

Slope percentage is calculated in much the same way as the gradient. Convert the rise and run to the same units and then divide the rise by the run. Multiply this number by 100 and you have the percentage slope. For example, 3" rise divided by 36" run=0.083x100=8.3% slope.

✓ **Calculating a slope in degrees**

The most complicated way to calculate slope is in degrees and it requires a bit of high-school math. The tangent of a given angle (in degrees) is equal to the rise divided by the run. Therefore, the inverse tangent of the rise divided by the run will give the angle.



3feet or 36"

Tanα=$\frac{3"}{36"}$ ===== $\alpha\ tan^{-1}\frac{3"}{36"} = \alpha = 4.76^{o}$

Slope of 15% will give $\frac{15}{100} = 0.15;\ tan^{-1}0.15 = 8.5^{o}$

Tangent of 42^{o}= 0.900404044x100=90%

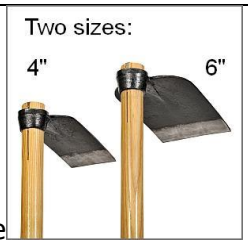
Tangent of 18 grades=0.290526856x100=29%

Normally, 400 grades correspond to 360^{o}

LO 2.1 – Select nursery forest tools and equipment

- Topic 1: Selection of forest nursery tools and equipment (identification, description and functions)

For carrying out day-to-day routine cultural operations in the nursery, various tools, implements and accessories are required. Some tools are simple and are used for simple operations, whereas for carrying out specific operations, special types of equipment are required. These are listed and briefly described hereunder:

Tool identification	**Description**	**Function (use)**
Hand hoe 	-It has a metal (iron) blade attached to a wooden handle. It is operated manually.	- It is used for digging of soil, pits or any basic digging work prior to preparation of nursery beds.
Garden fork 	- It has a flat blade like the common hoe and metal part has 3 pointed structures called prongs. - It has a wooden handle	-Garden fork is used for breaking of soil clods and separation of medium size soil during preparation of nursery bed or fields.
Weeding fork 	- It consists of a long handle with a blade of handle teeth.	- It loosens the soil and helps in weeding and collect the weeds and cops of plants also
Shovel 	- It has iron blade of spoon shape and wooden handle	- It is used for within field transport of dug out soil required for leveling of field for preparation of nursery beds

 Pick-Axe	- It is made of carbon steel. Pick axe has two edges with provision of axial hole for attachment with handle. One edge of pick –axe is pointed and another is broadened.	- It is used for digging hard, compact and stony soils
Spade 	-It has an iron blade adapted for pressing into the ground having an iron blade adapted for pressing into the ground with the foot and a long handle commonly with a grip or crosspiece at the top, and with the blade usually narrower and flatter than that of a shovel.	-It is used for lifting and turning the soil. Also used for digging the pit, preparing channel for irrigation and drainage lines
 Hoe-cum-Rake	-It is of rectangular shape metal blade with fork like fore edge	- It is used for digging, hoeing, leveling and collecting weeds
 Furrow opener	-It has a share point or sweep attached to the handle and is operated by pulling action in standing posture	-It is a hand tool to open the furrow and divide the soil into two sides for placing the seeds in nurseries
Hand leveler	-It consists of narrow rectangular metal blade attached to long wooden handle.	-Seeds are sown in the furrow and covered by a hand leveler

 Dibbler tool	-It is a pointed wooden stick	-Is useful for creating holes and furrows for planting.
Garden Trowel 	-It is of shovel shape but small in size with iron blade and wooden handle. It can be made in many shapes as per local designs and requirements	- It is used for hoeing, weeding and nursery plants and also for transplanting seedlings
 Axe	-Iron blade, fastened to wooden handle	- It is used for felling trees and cutting stump roots
 Sickle	- It has a curved metal with a wooden handle	-It is used for cutting grass and leafy vegetation to use in mulching of seed beds.
 Wheel-Barrow	-It can be designed into different shapes according to requirement -It has a container, frame, wheel	-It is manually operated, used for carrying nursery plants, compost, fertilizes, leaf litter, etc. from one place to another place.
 Cultivator	-It has tyres of quality carbon comprising of different sizes depending upon the plough depth.	-It is a tractor drawn implement used for tilling the soil efficiently. These days, hand driven small cultivator is more popular. It can plough up to ½ to 1 feet depth.

 Disc harrow	Frame, Disc; circular concave cutting blade made of steel. Arbor bolt; also called gang bolt, is a long heavy steel shaft on which discs are mounted.	It is used for pulverizing the soil. It is used for deep ploughing and turning of soil
 Knife	-Knives having combined blade for grafting and budding purposes. A grafting/budding knife has a straight 7.5cm long blade and strong long handle. It has a spatula at the end of a handle.	- It is used for lifting the bark during budding operation. Sometimes knife has two parallel double blades, used especially for lifting or removing the patch of a bud from the bud wood.
 Secateurs	- The blades of secateurs should be of high quality carbon blade for giving smooth cuts to the stock and scions	- It is used for removing scions, lopping off the rootstock, preparation of scion sticks, removal of undesirable shoots/sprouts from the stock and training and pruning operations.
Tying and wrapping materials 	-Polyethylene tapes/strips, waxed string and cloth, raffia fibro and rubber strips are used for this purpose. adhesive tapes similar to surgical adhesive tapes but lighter in weight are also used by commercial nursery men.	- It is essential to hold scion and stock firmly together to have successful graft/bud union. For this purpose, a suitable tying or wrapping material is required

Grafting wax 	- is a composition of rosin, beeswax, tallow, and similar materials, used in gluing and sealing the wounds of newly grafted trees or shrubs to protect them from infection	-Wax is used by propagator to seal the graft union for preventing moisture loss and desiccation of cells at cut surface and to prevent the decay of wood by way of checking the entry of pathogens.
Label 	-Labels may be made of paper, card board, wooden, celluloid, aluminum and plastic	-Labels are used for proper labeling of seedlings for their identification
Pots 	-Pots may be of clay, organic, metal or plastic usually 10cm, 15cm or 20cm for single specimen. -Pots are of different types, tube pots, ¼ size,1/2 size,3/4 size and full size.	-Pots are used in place of seedbed during seed sowing, pricking out -These are used for potting ornamental plants, fruit plants, saplings.
Spray-pumps 	-Pumps are of different shapes, size and types.	-To spray protective material i.e. insecticides/pesticides/fungicides to eliminate the infection of pathogens or insects, spray pumps are very important tools
Watering can 	-It is a portable container, usually with a handle and a funnel	-It is used to water seed beds and seedlings by hand.

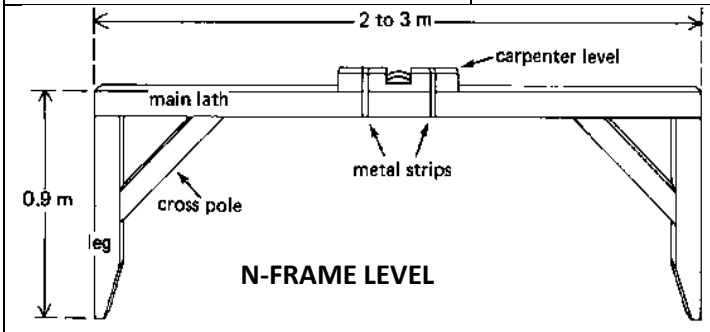
Hose pipe 	-Flexible irrigation pipes available in convenient length	-Irrigation to nursery plants is made possible to any extent.
Rakes 	-Finger like called prongs -Wooden handle	-Gathering cut grass in the field -Collecting dug out weeds -Removing big soil particles so as to ensure a leveled bed and a fine bed -Mixing manure in nursery beds.

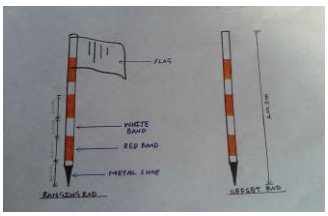
LO 2.2 – Select forest plantation tools and equipment

- Topic 1: Selection of forest plantation tools and equipment (identification, description and function)

Tools/Equipment identification	**Brief description**	**Function (use)**
Hand hoe 	-It has flat metal blade fitted with a wooden handle. The handle may vary in length but often a handle is about $1^{1/2}$meters and less.	-Digging while preparing seed beds -making holes during planting of trees -weeding trees -digging holes for the preparation of compost manure or proper disposal of plant residues
	-The metal part has 3 pointed structures called prongs. -It has a wooden handle.	-Remove weeds with underground stems like couch grass. -It is used in stony soils
Pick axes 	-both ends of metal piece are pointed, or only one. In the middle it has a hole where a handle is fitted.	-Dig manure pits -Removing tree stumps -Breaking up hard ground

Spades 	-Flat ended metal piece -Wooden handle	-Heaping dug out soil and manure so that it is transferred to another point in the field -Can be used in soil sampling
Shovels 	-Curved metallic piece -Pointed front part -Wooden handle	-Turning manure in manure pits -Removal of soil in the hole -Can be used in soil sampling
Rakes 	-Finger like called prongs -Wooden handle	-Gathering cut grass in the field -Collecting dug out weeds -Removing big soil particles so as to ensure a leveled bed and a fine bed -Mixing manure in nursery beds.
Garden forks 	-Toothed frame fitted on wooden handle	-Softening soil around seedlings -Weeding in a nursery bed -Used for transplanting
Machete or panga 	-A long flat or curved blade metal -Either plastic or wooden handle.	-Clearing bush before cultivation -Cutting woods
	-Thick metal piece with a hole where a handle is fitted -Wooden or metallic handles are fixed or welded on the axe	-Cutting down trees -Removing tree stump during land preparation

Tape measure  	-Steel or nylon -Sometimes with handle	-Determine spacing of plants during planting -Determine the area to plant
Wheelbarrow 	-Container -Frame -Wheel	-Transportation of manure or fertilizers to the field -Transportation of seedlings
Watering can 	-Handle -Perforated rose -Tank	-Watering young plants after transplanting
	Tank: -Pressure chamber -Hose pipe -Trigger -Nozzle -Handle -Lance	-Application of chemicals to plants or holes
	-Metal piece which is bent at the end to form a blade -The metal piece is fitted on a small wooden handle.	-Cutting down grass in the forest
 **N-FRAME LEVEL**		-used to set out contour lines -slopes

Meridian and suunto clinometers 	Meridian: it has two vertical glassed eye pieces -Swinging pendulum ended with the ring on its top. Suunto: it has one glassed eye pieces -Circular graduated scale -Rope handle	-Used to measure the slope of land -Used to measure contour line -Used to measure the tree height
Dumpy level 	A dumpy level consists of three main parts: -Telescope -Tripod -E-meter staff/staff reading	-used to establish or check points in the same horizontal plane -used in surveying (topography) -measure, or set horizontal levels
 GPS	-screen -keypad -sometimes with antenna	-used in measuring land surface -used in drawing maps
A-frame level 	-A-shape -Swinging plumb bob -Wooden or metal	-Measure contour lines -Measure land slope
 Theodolite		-used to establish or check points in the same horizontal plane -used in surveying (topography) measure, or set horizontal levels measures vertical and horizontal bearings
Ranging rods 		-used for marking the position of stations and -for sightings of those stations as well as for ranging the straight lines

- Topic 2: Selection criteria for forest plantation tools and equipment

The selection of forest plantation tools and equipment will be often basing on:

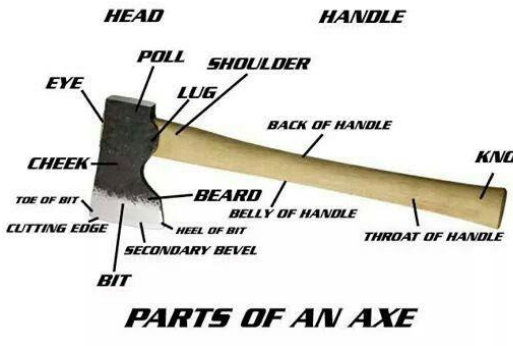
- ✓ ***The nature of the soil***: this will influence the choice of tools and equipment to use while planting because if the soil is covered by vegetation, it will ask forester to clear the land. Tools to use are different from tools and equipment to use on bare soil. The same, stony soil will demand different tools and equipment from silt permeable soils.
- ✓ ***The type of task (work) to perform***: tools and equipment are selected according to the specific activity to perform. Example transportation tools are not similar with digging tools and so on
- ✓ ***The size of the land to plant:*** as the land is large as the quickest tools and equipment will be selected.
- ✓ ***Seedlings to plant:*** the seedling condition influences foresters to select tools and equipment according to the health of seedlings.
- ✓ ***Topography of the land***: for steep slope lands, heavy implements like machines will not be chosen because their movement seems to be impossible.
- ✓ ***Climate****:* some tools and equipment are not used if the climate is rainy.

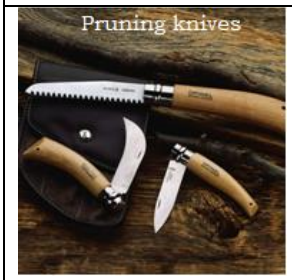
LO 2.3 – Select forest management tools and equipment

- Topic 1 Selection of forest management tools and equipment (identification, description and functions)

Forest management is a branch of forestry concerned with the overall administrative, economic, legal and social aspects as well as scientific and technical aspects, such as Silviculture, protection and forest regulation

Tools identification	**Brief description**	**Function (uses)**
Hand hoe	-It has a metal (iron) blade attached to a wooden handle. It is operated manually.	-Hoeing in young plants -weeding of plantations -Digging anti-erosive structures
Forked hoe	- It has a flat blade like the common hoe and metal part has 3 pointed structures called prongs. - It has a wooden handle	-Remove weeds with underground stems like couch grass.
Spade	-It has a flat metallic piece fitted with wooden handle	-used in forest road creation & maintenance -Used in cleaning anti-erosion structures
Shovel	- It has iron blade of spoon shape and wooden handle	-used in maintenance and creation of forest roads

Machete	-It may be curved or straight blade with wooden or plastic handle	-Clearing bush in the forest -Sometimes used in cutting big branches and tops of trees in agroforestry management -Cut trees in thinning and coppicing
An axe		-Cutting down trees while thinning
Pruning saw 	It has a blade frame which is toothed -Fixed or folding blade style	-Toothed blade is used for cutting during pruning
	-Has short handles and are operated with one hand. -A spring between handles	-To prune hard branches of trees and shrubs, sometimes up to two centimeters thick.
	-Type of scissors -Double curved blade -Very long handles than secateurs -Operated with two hands	-used for pruning twigs and small branches, like secateurs with very long handles -Loppers are mainly used for the pruning of tree branches with diameters less than 5 centimeters
	-It consists of a cloth or steel tape -It has regular length measurements on one side and diameter conversions on the other -It has a hook is on the end of the tape for easy attachment to a tree	-The D-tape is used primarily to measure tree diameter 

Caliper 	-Outside large jaws -Graduated scale	-For measuring tree and log diameters. Serves the same purpose as a diameter tape. 
Wheelbarrow 		-Used in forest road creation and maintenance -Transport of forest management tools like pesticides, pruning shears, hoes, shovels, spades, sticks etc. -Transport of fertilizers to the forest site
Ladder 	-Vertical or inclined set of rungs or steps	-used for climbing trees while pruning the upper branches
Tractor 	-It has engine -Wheels and other many devices connected to it allowing it to perform different works	-Best for thinning -Pesticides application, -Fire control road creation and maintenance
	-Tank -Delivery hose -Trigger type cut-off Device -Extension rod -Gooseneck bent and Nozzle	-Spraying on trees pests and/or diseases
Harvester 	Refer to the SOPs from Manufacturer	-For plantation thinning and final-fell applications
	-A knife with a curved or hooked blade -Edge tool used as a cutting instrument; has a pointed blade with a sharp edge and a handle	-For thinning delicate branches, removing coppices, and shaping rose bushes

- Topic 2 Selection criteria for forest management tools and equipment

Forest management tools and equipment are selected basing on:

- ✓ **The type of task to perform**: basically, tools and equipment are selected depending on the specific task to execute. For example, required tools for pruning are different from tools for pest and disease control.
- ✓ **The topography (slope):** on steep terrain, heavy forest management implements are limited because tractor wheels cannot move easily.
- ✓ **Age (stage of growth):** Tools and equipment used to manage mature forest are not the same as for young forests.
- ✓ **Skills of workers:** very often, tools and equipment are selected depending on the users' skills. Foresters tend to choose tools and equipment which they are familiar with.
- ✓ **Timing**: for a specific task needed to be accomplished in a given time, foresters will choose quick and faster tools and equipment.
- ✓ **Tree condition**: this criterion describes whether the tree is decayed, lean, diseased etc. so, tools and equipment are selected accordingly.
- ✓ **Forest area:** for large forest area, quick equipment will be adapted.

LO 2.4 – Select forest harvesting tools and equipment

- Topic 1 Selection of forest tools and equipment (identification, description and functions)

Tools identification	Brief description	Function
Axe 	-It consists of a thick metal piece with a hole where a handle is fixed. Wooden handle is preferred. Metallic handles are fixed or welded on the axe.	-Used in felling medium sized trees, delimbing, splitting, and bucking activities.
Machete 	- It has a curved or straight blade -It has wooden or plastic handle	-Used in small sized trees feeling, delimbing, and bucking activities

<table>
<tr>
<td>Two-man saw/cross cut saw
  </td>
<td>-Designed for use by two sawyers
-Typically, be 4 to 12 feet long (approximately 1.2 to 3.6metres and
-Sometimes up to 16 feet (4.9metres)
-With a handle at each end</td>
<td>-Two-man saw were designed to cut in both directions. Careful tooth design was necessary to clear the sawdust during the cut</td>
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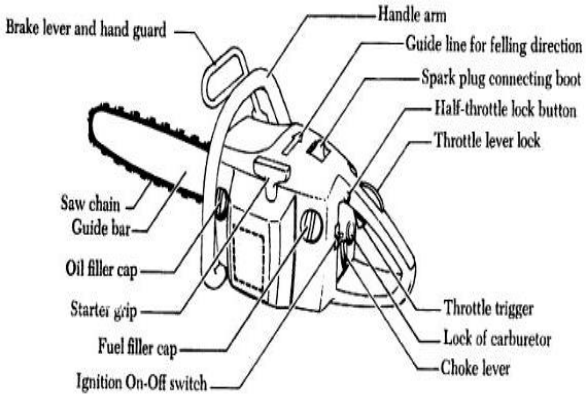
<td> 
</td>
<td>-It is used in activities such as tree felling, limbing, bucking and Splitting
  </td>
</tr>
<tr>
<td colspan="2">Tigercat 720E feller buncher
  </td>
<td>-For plantation thinning and final-fell applications.</td>
</tr>
<tr>
<td colspan="2">Tigercat 234 loader
  </td>
<td>-Loading logs into a forwarder which transport to the mill saw.</td>
</tr>
<tr>
<td colspan="2">Tigercat 630C skidder
  </td>
<td>-Super high production skidder suited to the toughest jobs: demanding terrain, extreme temperatures and heavy loads</td>
</tr>
</table>

Forwarder 		Transport of timber either by a tractor or trailer unit pulled by a tractor.
Harvester 		-For thinning, tree felling, delimbing, bucking operations
Metal file 	-It consists of roughed metal part and a handle	-It is used to sharpen all tools and equipment like axe, saws, panga, etc.
Tackle 	-It consists of pulling cables	-It is used in tree felling
		-A cant hook or cant dog is a traditional logging tool consisting of a wooden lever handle with a movable metal hook called a dog at one end, used for handling and turning logs and cants, especially in sawmills.

- Topic 2 Selection criteria for forest harvesting tools and equipment

Forest harvesting tools and equipment are selected mainly basing on:

- ✓ **The type of task to perform**: basically, tools and equipment are selected depending on the specific task to execute. For example, required tools and equipment for cutting are different from tools and equipment for extraction.
- ✓ **The topography (slope):** on steep terrain, heavy forest harvesting implements are limited because tractor wheels cannot move easily. Also felled trees tend to roll on such terrain and special tools and equipment may be used to stop tree rolling.
- ✓ **Age of stand:** Tools and equipment used to harvest mature forest are not the same as for young forests.
- ✓ **Skills of workers**: very often, tools and equipment are selected depending on the users' skills. Foresters tend to choose tools and equipment which they are familiar with.
- ✓ **Timing**: for a specific task needed to be accomplished in a given time, foresters will choose quick and faster tools and equipment.
- ✓ **Tree condition**: this criterion describes whether the tree is decayed, lean, diseased etc. so, tools and equipment are selected according to the health of trees to harvest.
- ✓ **Forest area**: for large forest area, quick and faster equipment will be prior adopted.
- ✓ **Current obstacles around the forest**: where the forest is surrounded by buildings, lakes, over headlines (electric cables), more safety tools and equipment must be taken into account.

LO 2.5 – Identify forest tools and equipment

- Topic 1: Estimation of the number of forest tools and equipment

A man-hour is the amount of work performed by the average worker in one hour. It is used in written "**estimates**" for estimation of the total amount of uninterrupted labour required to perform a task. For example, felling a big tree in normal conditions might require two man-hours if hand tools like an axe is used.

Man-hours do not take account of the breaks that people generally require from work, e.g. for rest, eating, and other bodily functions. They only count pure labour. Managers count the man-hours and add break time to estimate the amount of time a task will actually take to complete.

A simple formula: Total man-hours ÷ actual work days ÷ 8 hours/day = No. of forestry workers

Example: Your estimate says the project will require 4,000 man-hours to establish forests. The contract is six months, which, by the way, is not really 180 working days—unless your forestry workers work seven days

per week. On average, there are only 20 working days each month. So, six working months is only about 120 working days. Now apply the formula: 4,000 hours ÷ 120 days ÷ 8 hours = 4.17 forestry workers (call it 5).

Keep in mind, your estimate's 4,000 hours does not include any time for lost productivity. The 4,000 hours is only a figure from your extended takeoff and is strictly based on what it will take to build the job. You'll be lucky to get six fully productive labour hours per day, per forestry worker, so you need to factor for the lost time.

A better formula: Total man-hours ÷ actual working days ÷ 6 hours/day = No. of forestry workers

Now your Forestry workers count is up to 5.5, Might as well make it six. Guess what. You gained another two forestry workers per day.

Lost time formula: No. of actual working days × No. of lost hours/day × No. of forestry workers = No. of hours needed to add to your estimate (really)

But wait, there's more! Even though you are going to get only about six productive hours per day from each forestry worker, you still need to pay them for eight. So, unless you like giving away money, you need to add back in the lost unproductive labour. **120 days × 2 hours × 6 forestry workers = 1,440 hours of lost time.**

Therefore, the number of tools and equipment will depend on the number of workers for specific tasks.

LO 3.1 – Check forest tools and equipment

- Topic 1: Checking procedures of forest tools and equipment

When not in use all tools and equipment will be securely locked away in the tool shed. Tools and equipment should be checked and cleaned before they are put away. Half termly the forester will ensure that each tool and equipment is thoroughly cleaned and oiled. Wear and tear will be monitored daily. Before each tool is to be used it will be checked for damage and working order as follows:

- ✓ Take the guard off and twist to check for security if normally the tool is kept in the guard (cover).
- ✓ Examine the integrity of the wooden handle for cracks and do not use tool with a painted handle.
- ✓ Look for signs of the head shifting
- ✓ Examine the fitness of all parts of the tool and equipment.
- ✓ Examine the blade for chips, fractures and carefully check the sharpness of the blade by running your thumb over it, just as you would with a knife.
- ✓ Check that there are no cracks in the sheath.
- ✓ Visually look for any signs of denting, rust etc.
- ✓ Check for sharpness
- ✓ Make sure there are no signs of replacement, cracking or rusting
- ✓ Open up the secateurs and place over knee to make sure they cannot close as you check the blade.
- ✓ Examine the functions of buttons and the fixing screws if any.
- ✓ Examine the battery power if the tool really uses the batteries.
- ✓ Examine if the tool or equipment is easily readable.
- ✓ For saws, examine if there are no broken teeth.
- ✓ Examine the feedback from command of indicators (buttons, screws...)

LO 3.2 – Adjust forest tools and equipment

- Topic 1: Adjustment techniques of forest tools and equipment

Adjustment means a small alteration or movement made to achieve a desired fit, appearance, or result.

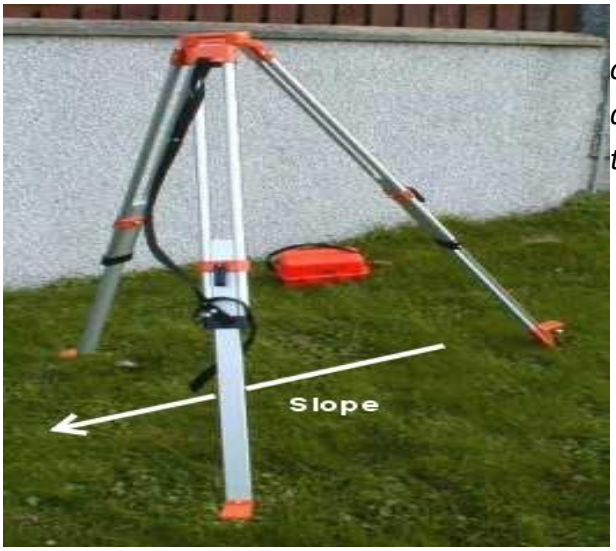
Forest tools and equipment should be adjusted for their proper use.

Example: the way loose tools and equipment (hoes, axes, shovels, rakes, dumpy level....) are well fixed or firmed for perfect use is referred to as adjustment. Adjustment techniques differ from one tool or equipment to another depending on the shape, size, function and its components. Adjustment techniques of a dumpy level serve as an example.

A **dumpy level** is an instrument used to measure, transfer or set horizontal lines. It is an instrument that is often used in surveying buildings. A dumpy level is used to establish relative height, distance and bearings from different parts of a site. Using this instrument requires a certain amount of skills.

Step 1: Setting the Instrument

It is important to make the dumpy level completely horizontal for it to work properly. Adjust the height of the tripod until it is eye level. Move the legs of the tripod so it is balanced and can hold the level properly. Once you are satisfied, secure the legs of the tripod by pressing it to the ground.



Set tripod in position if the ground is sloping place two legs on the downhill side. Firmly press the two tripod feet on the down hillside into the ground using your own foot on the tripod's foot plate

Step 2: Attaching the Instrument to the Tripod

The level is a very sensitive instrument so take special care when you handle it. Set the instrument on top of the tripod. At the center of the tripod is a large screw that you will use to screw in the instrument. On the side of the level is the bubble, adjust the screws at the bottom of the level until the bubble is at the center of the marker. This is to ensure that the instrument is leveled.

Step 3: Using the E Meter Staff

Once the dumpy level is set, ask your assistant to stand a distance away while holding the E meter staff.

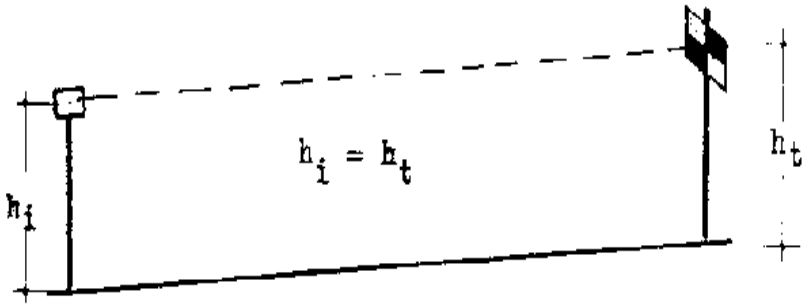
LO 3.3 – Use of forest tools and equipment

- Topic 1 Manipulation of forest hand tools and equipment

✓ **CLINOMETER**

First, hang the instrument from your thumb. Then place the instrument close to your eye and keep it plumbed. You cannot see through the instrument, but you see the bright, translucent scale. The percent scales are seen on both edges of the ocular lenses. The left lens is for uphill (+) (see scale as shown in Figure 13); the right lens is for downhill (-) reading. By simultaneously looking through the lens and alongside the

clinometer you can align the objective. You must keep both eyes open. Be sure to read the correct number on the scale and remember + (elevation) or - (depression).



Use two poles (or rods) with flat bases so that the poles do not penetrate the round and so that their height will be constant. The clinometer (zero point) and target (middle line) are adjusted to the same height with the two poles on level ground. The height of the instrument pole is adapted to the comfortable eye height of the instrument.

✓ **HAGA ALTIMETER**

- **Distance measurement**

❖ Place the reference tape at the tree,
❖ Determine an optimal distance to the tree by checking the view field to tree bottom and top within the forest stand - preferably 15, 20, 25 or 30m,

- **Height measurement**

❖ Select the corresponding height scale by turning the adjustment disk,
❖ Sight tree bottom, lock the pointer needle and remember the value,
❖ Sight tree crown, lock the pointer needle and remember the value,
❖ The difference between the measurements will be tree height

Note: *When measuring with Haga, take care that the pendulum has stopped oscillating before locking the button. Be careful of choosing the scale corresponding to your actual distance!*

✓ **BLUME-LEIS**

- **Distance measurement**

- Determine an optimal distance to the tree by checking the visibility of the tree bottom and tree top within the forest stand,
- Place the vertical base measure at the tree,
- Find the correct fixed distance using the optical range finder by focusing the distance leveling board and move closer or farther to the tree, until the top of the mirrored picture of the base is coincident with the corresponding mark on the original picture - in this example, the mid mark of the leveling corresponds to a distance of 15m (alternatively a tape measure can be used to find the correct fixed distance).

- **Height measurement**

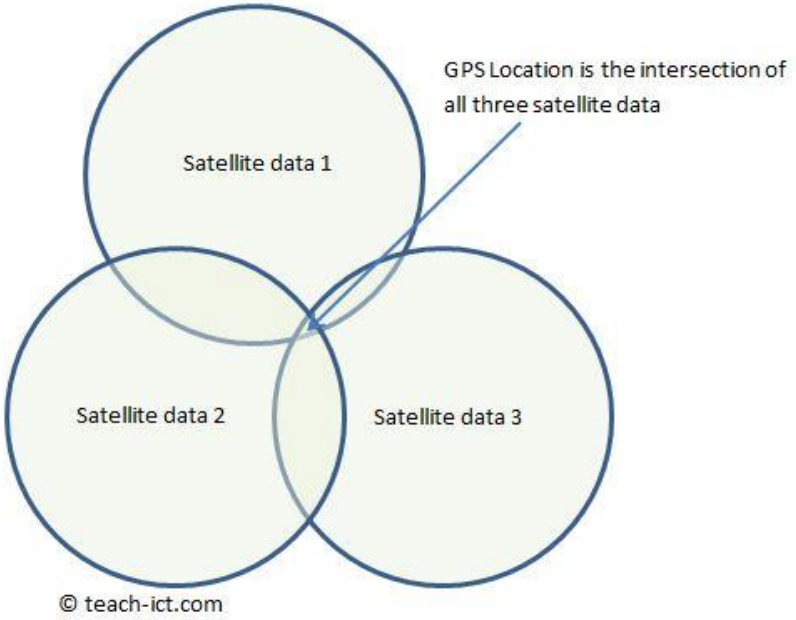
- Focus the bottom of the tree and lock the pendulum,
- Focus the top of the tree and lock the second pendulum,
- The front side of the device shows two height values - the height can directly be derived by the formulas described above, depending on the slope
- Correct the derived height if necessary

- **Slope measurement**

- Sight at the zero mark of the levelling board and lock the needle
- The slope in ° can directly be read from the scale

✓ **GPS**

There is a constellation of 24 low earth orbit satellites covering the entire earth called NAVSTAR. This gives enough coverage to have 3 or 4 satellites visible from anywhere. Accuracy is good to about a foot or even better with more sophisticated equipment.



Here's how GPS works in six steps:

- GPS works by using a method called "triangulation" or "trilateration".
- It needs to get a message from at least three, preferably four satellites
- To "triangulate", a GPS **receiver** measures the distance between itself and each satellite. It can measure distance because it works out exactly **how long** it took for each satellite's message to arrive. (distance = time of arrival * speed of light)
- To measure travel time, GPS needs very accurate timing which it achieves with **atomic clocks** on board each satellite.
- Along with distance, the device needs to know exactly **where** the satellites are in space at any given time. This information is held inside the GPS receiver itself.
- Finally, because it knows exactly where the satellites are at that instant, by using some very clever mathematics, it can work out where it is on the ground.

Triangulation, is the key idea behind GPS. It makes use of satellites in space as reference points for locations here on earth. By very, very accurately measuring our distance from at least three satellites we can "triangulate" our position anywhere on earth.

✓ **CALIPER**

- Press the beam of the caliper firmly against the tree stem perpendicular to the axis of it to minimize maladjustment of the moveable arm
- Read the diameter directly from the scale

Note: It is important that all types of calipers be held perpendicular to the axis of the tree stem at the point of measurement (breast height, usually). If the stem cross sections are irregular, sometimes two caliper readings are recommended at right angles; then, the mean value of the two readings is taken as diameter.

✓ **CHAINSAW**

Step 1: Stabilize the Chainsaw

- The chainsaw should always be started on level ground; never up in the air or on a high surface.
- Place your right foot inside the rear handle and press it down firmly to secure the chainsaw.
- Place your left hand on the top handlebar.
- Make sure that nothing is touching or near the chainsaw guide bar or chain.

Step 2: Engage the Chain Brake

- With your left hand on the top handlebar, lean your wrist forward to push the chain brake handle forward. This will engage the chain brake, which prevents the chain from spinning during the starting process.

Step 3: Turn the Chainsaw On and Open Up the Choke

- Turn the chainsaw on/off switch to the on position.
- Open up the choke by moving the knob/lever to the cold start (or fully open) position. The choke regulates the air/fuel mixture that goes to the engine.

Step 4: Prime the Fuel

- Press the fuel primer bulb three to five times or until the bulb stiffens and you can see fuel in it. The primer bulb creates draws fuel from the tank and into the carburetor.

Step 5: Pull the Starting Cord a Few Times

- With your left hand on the top handlebar, the chain brake engaged, and your right foot in the rear handle, pull up on the starting cord with your right hand in a smooth, quick motion. (Not too fast or too hard).
- Pull up on the starting cord a few times until you hear the engine trying to turn over and failing.

Step 6: Close the Choke

- When you hear the engine failing to turn over, move the choke lever to the halfway position.
- Pull up on the starting cord again. The engine should start and idle. If not, pull up several more times.

Step 7: Let the Chainsaw Idle

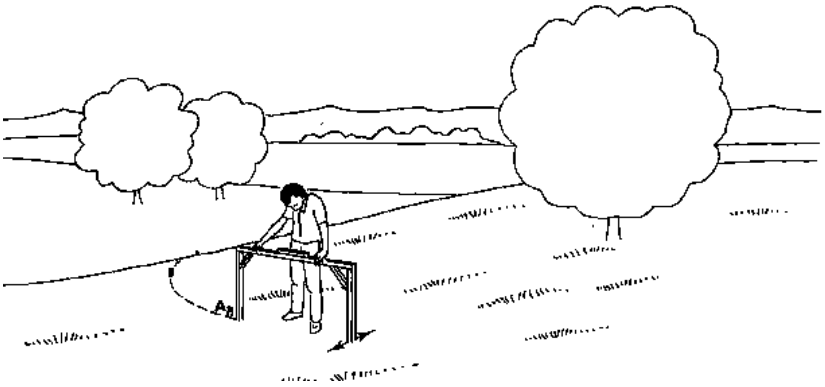
- Allow the chainsaw to idle for 30 seconds. If you don't, the chainsaw could stall out.

- **Step 8: Close the Choke**
  - After 30 seconds of idling time, move the choke lever to the closed position.
  - The chainsaw should still be running.
- **Step 9: Disengage the Chain Brake**
  - Pull back on the chain brake handle with your right hand to disengage it. Otherwise, the chain will not spin after starting.
- **Step 10: Lift Up the Chainsaw**
  - With the chainsaw still firmly in both hands, raise your body into the upward position.
  - To start sawing, pull the throttle with the index and middle fingers of your right hand.

✓ **N-FRAME LEVEL**

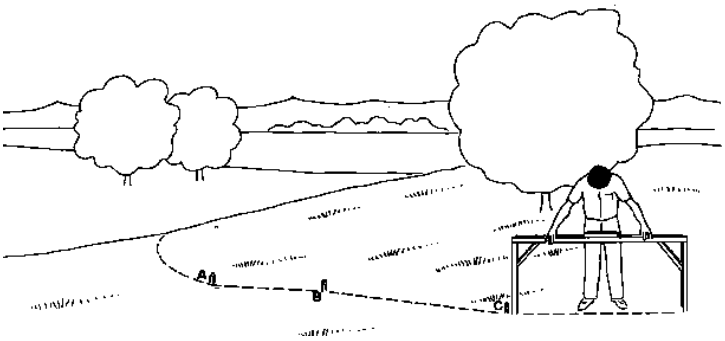
- **Step 1**

One leg of the instrument is placed close to peg (A). By turning the frame around this leg, a position of the frame is found such that the second leg is on the ground and the bubble of the carpenter level is in between the marks. This means that the spot thus found by the second leg of the frame is at the same elevation as the starting point. Both points belong to the same contour line. A new peg (peg B) is driven in close to the second leg to mark the place.



- **Step 2**

The N-frame is moved to the newly-placed peg and the procedure is repeated until the end of the field is reached. All the pegs, thus driven in the ground, form a contour line.



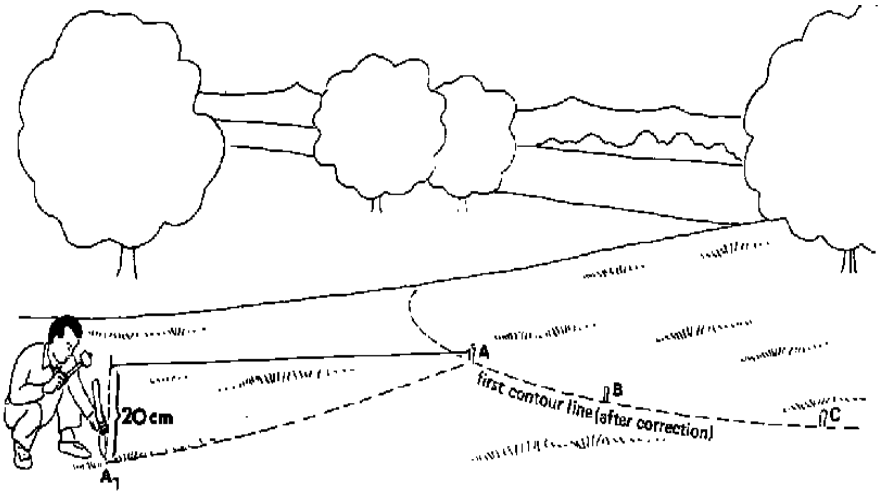
Step 3

When the first contour line has been pegged out it might be necessary to make minor adjustments by moving some of the pegs to the left or to the right to find a smooth line. Most of the pegs will remain in the same place. The smooth line thus formed by the pegs represents the first contour line.

Step 4

The next step is to determine the second contour line. A choice has to be made on how many centimetres lower (or higher) the next contour line should be. This choice should be based on the required accuracy (a little difference in height means it is more accurate), the general slope of the area and the regularity of the general slope of the area. In practice, the height difference will vary between 10 and 50 cm.

In this example, a height difference of 20 cm was chosen. This means that the ground level near peg A should be 20 cm higher than the ground level near peg A. The position of peg A. is found by trial and error, using e.g. the method described in section 3.4 to measure the vertical distance between the ground levels near A and A1. peg (A1) represents the starting point of the second contour line. Now follow the procedure described above to determine the second contour line.



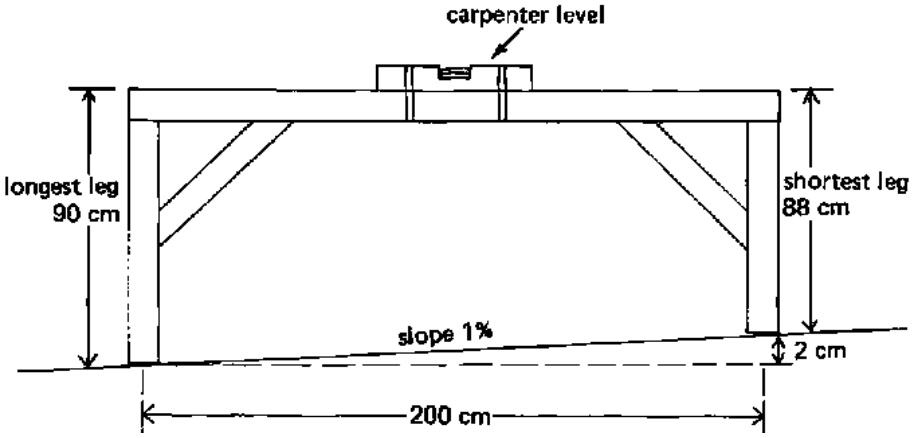
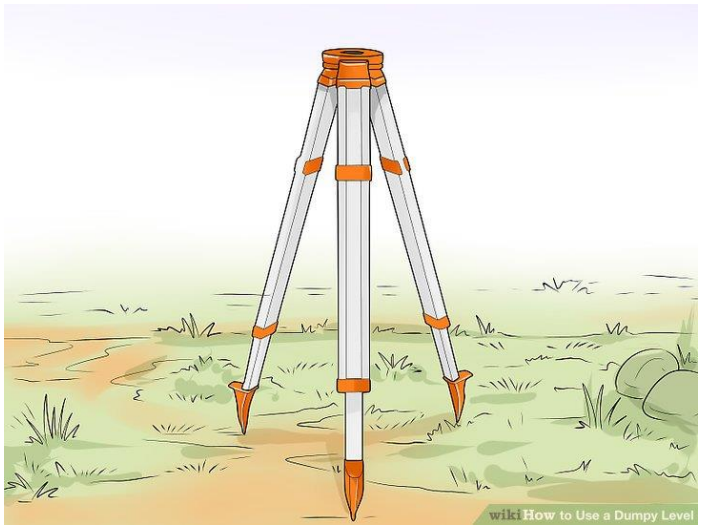


Figure 1: N-frame level in measuring slope

✓ **DUMPY LEVEL**

- **Find a benchmark location near the spot you want to measure.** A benchmark location is a spot that you already know the height of thanks to previous land surveys.
- **Set your tripod up near the spot you want to measure.** Place your tripod on a patch of flat, clear ground that sits between your benchmark location and the spot you want to measure. Then, undo the latches on your tripod's legs and extend each leg out. Adjust the legs until your tripod is completely level, then close each latch.

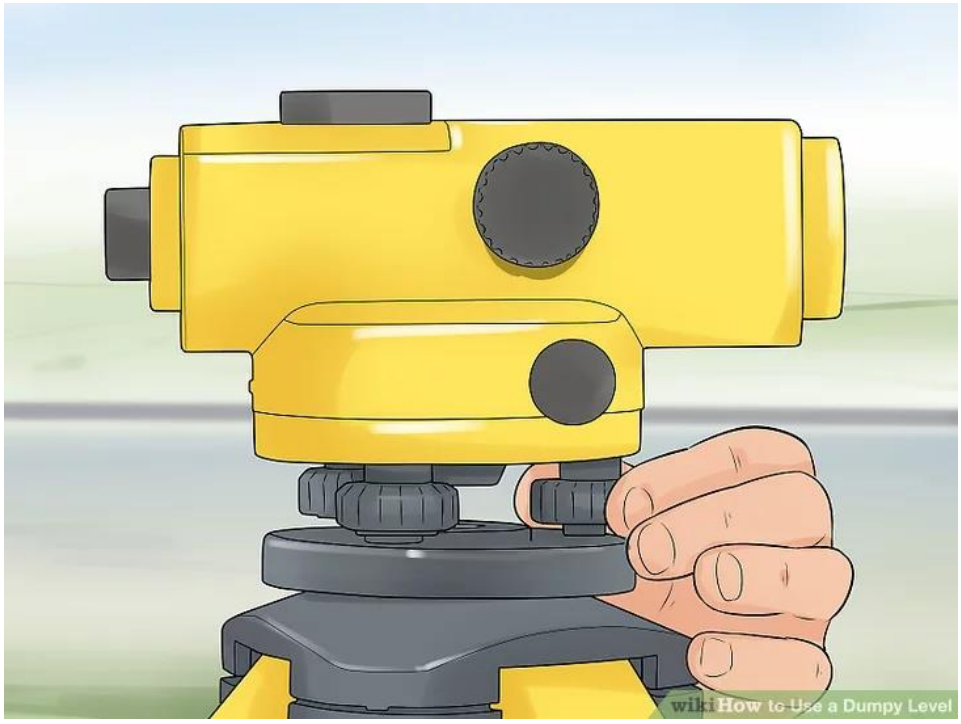
- Almost all tripods come with a built-in bubble level. You can use this to assess whether or not the tripod is level.
- To measure the area properly, make sure you set up in a spot that's slightly higher than your benchmark location.



- **Connect your device to the tripod and position it over 2 leveling screws.** Screw your dumpy level onto the tripod's base plate, then connect the base plate to the main tripod body. Once the instrument is securely attached, turn the dumpy level's telescope so that it sits parallel with 2 of the device's leveling screws.
    - If the dumpy level wobbles when tapped, tighten the leveling screws to better secure the device.

- **Level the device by adjusting the 2 leveling screws.** Look for a traditional bubble level located somewhere on your device. When you find it, grab the 2 leveling screws that are parallel to the device's telescope and twist them in opposite directions. Do this until the bubble sits in the exact center of the level.
    - For the best results, turn the screws with an even amount of force and pressure.
    - You'll typically find the bubble level either on top of or below the device's telescope.

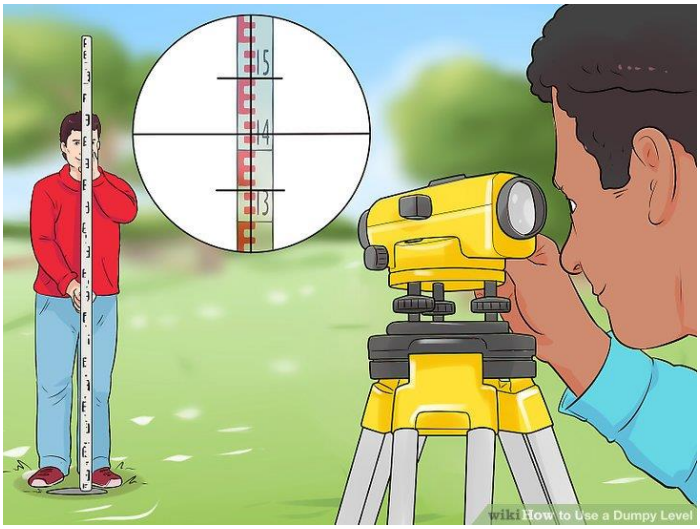
- **Turn your telescope 90 degrees and adjust the third leveling screw.** After adjusting your first 2 leveling screws, turn your telescope approximately 90 degrees so that it sits parallel to the device's third leveling screw. Then, adjust this screw until the bubble once again sits in the center of the level.
    - Vintage dumpy levels often have 4 leveling screws instead of 3. If this is the case for your device, adjust the second pair of screws just like you adjusted the first pair.



- **Check your level's calibration by turning it 180 degrees.** After making your initial leveling adjustments, return your telescope to its starting position and check that the bubble still sits in the center of the level. If it does, turn the telescope 180 degrees and check the level again. You can focus the device once all 3 positions show the bubble in the center of the level.
    - If the bubble is not centered in any of the 3 positions, repeat the leveling process until it is.

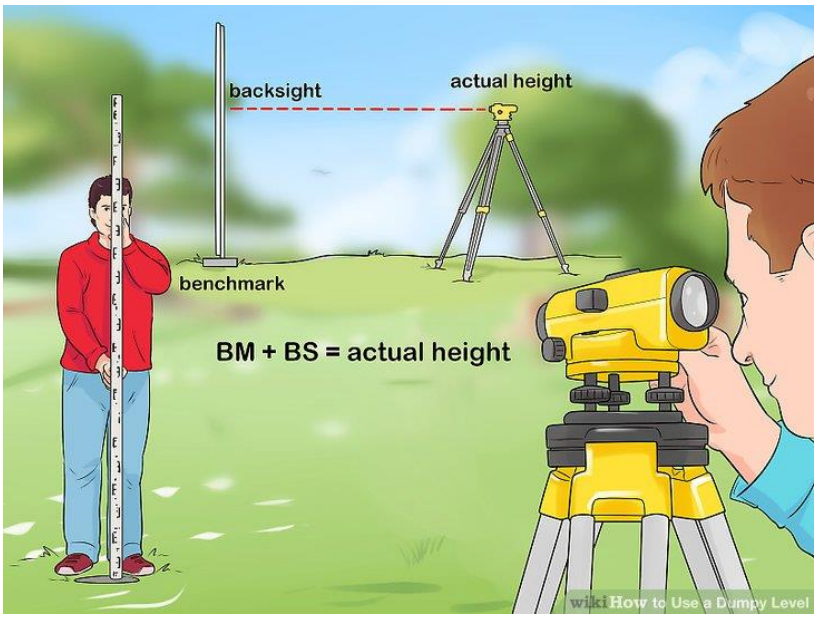
- **Position an E staff on top of your benchmark spot.** If necessary, purchase an E staff online or from a survey equipment shop. Then, have a friend or colleague hold the staff on top of your benchmark spot.
  - For the most accurate measurements, have your friend rock the staff forwards and backwards and record the lowest number you read.
  - Most E staffs collapse to save space, so make sure you extend your staff before taking any measurements.
  - Use a fiberglass staff instead of a metal version if you're taking measurements in an area beneath power lines.

- **Find the height difference between your level and the benchmark spot.** Look through your dumpy level's telescope and locate the E staff. Then, record the measurement indicated by your device's center, horizontal crosshair.
  - This measurement is known as your backsight.
  - Each numbered section of your staff represents 10 cm (3.9 in). Within these sections, every block indicates 1 cm (0.39 in) and every E indicates 5 cm (2.0 in).

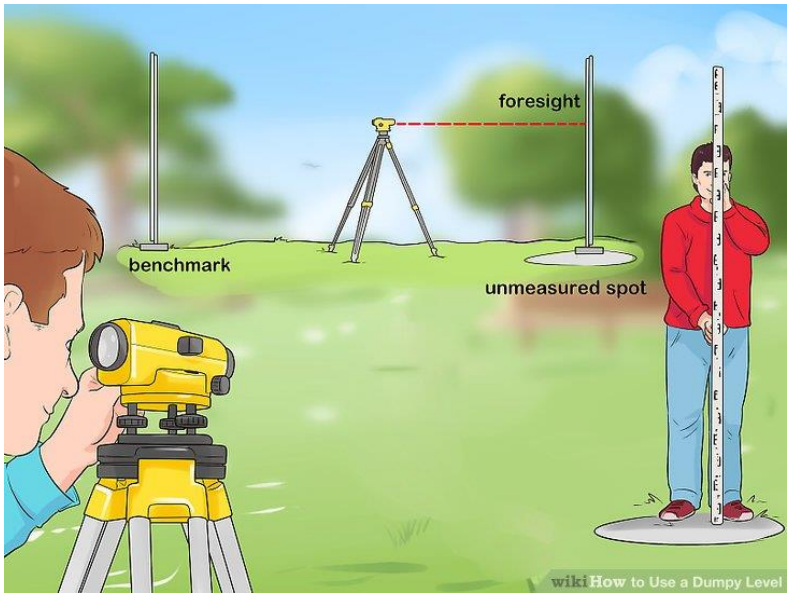


- **Calculate your level's actual height using the benchmark height.** Once you have your backsight measurement, add it to your benchmark location's actual height. This will give you the current height of your dumpy level's telescope.

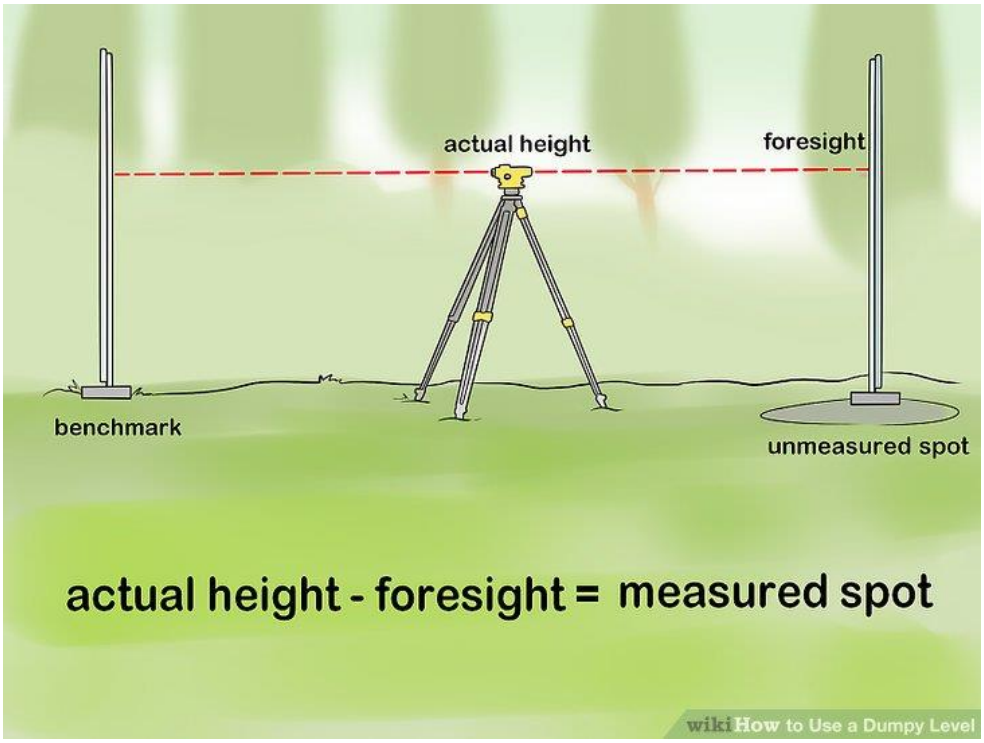
  - Record this measurement so you can use it to find the height of your next spot.



- **Find the height difference between your level and the unmeasured spot.** Move your E staff so it sits directly on top of the spot you want to measure. Use your device's telescope to find the staff, then record whatever number the device's center, horizontal cross hair sits over.
  - This measurement is known as your foresight.
  - If necessary, adjust your eyepiece's focusing knob until you can see the staff.
  - If the spot is too high or far away for you to measure, move your staff to a lower, closer spot first. Find the height of this new spot, then move your dumpy level to it and restart the measuring process.



- **Calculate the spot's actual height using your level's height.** Unlike with your previous calculation, you'll need to subtract your foresight measurement from your dumpy level's actual height. This will give you the height of the spot you measured.
    - When your record this height, make sure to include a thorough description or diagram of the spot you measured. That way, if you return to the area, you'll be able to find the measured spot easily.



- Topic 2: Environmental impact on using forest tools and equipment

When operating forest tools and equipment environmental features often challenge the data collected. Climate, ground cover and slope of the land have direct impact on the manipulation of forest tools and equipment. For example, using a GPS when the sky is cloudy seems to be impossible because GPS does not receive satellites well hence the GPS accuracy is reduced.

Another example is of operating N-frame level on the irregular ground which makes the movement of its legs difficult in determining contour lines. Dumpy level also faces some problems of taking readings on staff when the ground is covered by tall vegetation and other natural hazards.

LO 3.4-Clean forest tools and equipment

- Topic1: Cleaning procedures of forest tools and equipment

Despite the amount of soap and cleaning agents used on cleaning tools, they still need to be cleaned on their own and properly taken care of to ensure safety and quality. Proper cleaning and maintenance begins with employee training and supervision and should be considered a significant part of the facility's overall hygiene and sanitation plan.

The cleaning regime of different tools is influenced by their purpose or use. To ensure tools have a longer utility and lifespan, they must be properly cared for. Cleaning your tools should be approached in the same manner that you clean any other equipment or surface in your facility.

The cleaning principles are:

- **Dry clean.** Remove visible and gross soils and debris.
- **Pre-rinse.** Rinse all areas and surfaces until they are visibly free of soil.
- **Wash (soap and scrub).** Use the right detergent in the right concentration with the right level of mechanical action in the right water temperature for the right contact time.
- **Post-rinse.** Rinse away all visible detergents and remaining soil.
- **Inspect.** Look again at crevices and other contamination traps to ensure they're free of soils and detergents. Determine whether steps 1-4 should be performed again.
- **Sanitize.** Foam, wipe or spray sanitizing chemicals onto surfaces as per the appropriate instructions.
- **Dry.** Ensure adequate time is allotted for equipment to thoroughly dry.

- **Verification.** Gather proof that the cleaning performed achieved the expected level by following facility verification protocols.

LO 3.5-Record the use of forest tools and equipment

- Topic1 Types of recording the use of forest tools and equipment

Record is a document that memorializes and provides objective evidence of activities performed, events occurred, results achieved, or statements made.

User names:.....

Check in date:.....

Check out date:.....

Tool and equipment	**Number of tools & equipment**	**Tools & equipment status**		**Duration of use**	**Observation**
		Check in	**Check out**		
e.g: chainsaw	*1*	*normal*	*Chain damage*	*30 min*	*Needs replacement*

LO 4.1 –Perform the maintenance of forest tools and equipment

- Topic 1: Types of maintenance

✓ **Breakdown maintenance**

It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

✓ **Preventive maintenance**

It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

✓ **Periodic maintenance (Time based maintenance - TBM)**

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

✓ **Predictive maintenance**

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analysing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

✓ **Corrective maintenance**

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability

LO 4.2 –Identify malfunctions, faults, wears and damages to forest tools and equipment

- Topic 1 Types of malfunctions, faults, wears and damages to forest tools and equipment

A wide range of forest tools and equipment have different faults, wears and damages depending on their components. Their summary is given in the below table.

- ✓ *Malfunctions: a failure to function normally.*
- ✓ *Wears*: damage, or destroy by friction or use
- ✓ *Types of damage*: Worn belts, loose bolts, handles, oil leaks, broken parts, handles, bent parts, worn parts, rusted areas, cracks of handles, broken teeth, distortion of blades.

LO 4.3 –Perform the basic repair of forest tools and equipment

- Topic 1 Basic repair procedures

Basic repair/adjustment, replace, tighten, plastering/covering, replace, weld, straighten, replace, touch-up paints, replace, discard, sharpen.

LO 4.4 –Store forest tools and equipment

- Topic 1: Storability conditions of forest tools and equipment

✓ **General maintenance and storage conditions of tools and equipment**

The following points should be strictly observed so as to keep any tool or equipment in good condition:

- Each tool should be used for its designed purpose. Due to hurry, negligence or lack of the right tool to use, tools are sometimes misused and spoilt, e.g it is not unusual to find someone using the handle of a machete for hammering nails.
- The tools should be handled correctly during the course of working and should not be thrown about.
- After use, each tool should be cleaned and serviced for the next day's work, i.e. the bolts and nuts tightened, the cutting edges sharpened, etc.
- Whenever tools are to lie unused for long periods they should be greased or oiled to reduce chances of rusting.
- During storage, they should be kept neatly in a dry place. They should preferably be kept in tool racks, cabinets (cupboard) or shelves of some sort. This helps to protect them until the time when they are needed and reduce chances of their damage and of injury to the workers during selection of tools.

LO 4.4 –Record information about forest tools and equipment maintenance

- Topic 1 Type of recording of forest tools and equipment

Operator's name	Date	Tool/equipment status	Spare parts used	Observation

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