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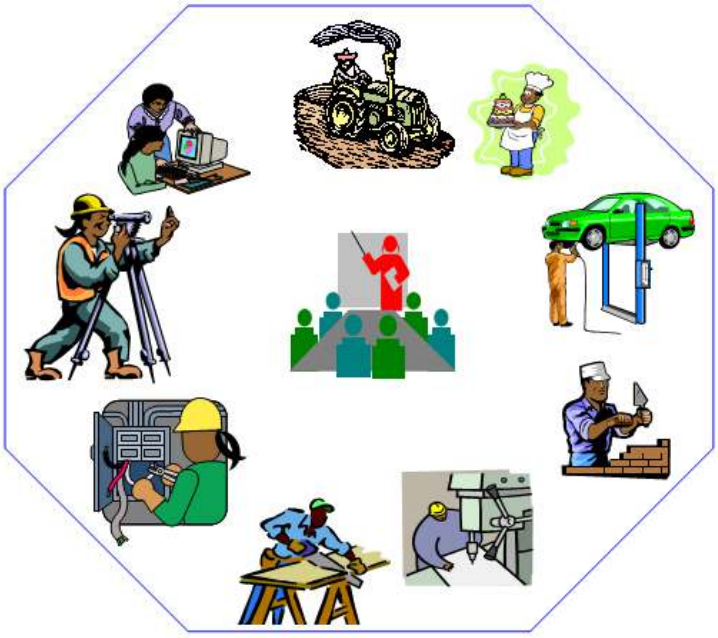
MINISTRY OF LABOR AND SKILLS

Bamboo Product Processing

Level-I

Based on November 2021, Version 1 Occupational standards



Module Title: - Harvesting Bamboo Culms

LG Code: IND MAC2 M01 LO (1-3) LG(1-3)

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November, 2021

Addis Abeba, Ethiopia

Table of Contents

LG #1	LO #1- Prepare for work

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Following work place procedure
- Following safety plan, policies, and requirements
- Selecting tools and equipment,
- Checking serviceability and rectifying /reporting faults
- Recognizing and adhering quality assurance requirement

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Follow safety requirements in accordance with safety plans and policies
- Select tools and equipment to carry out tasks
- Check serviceability and any faults rectified or reported prior to commencement
- Recognize and adhere quality assurance requirements to in accordance with enterprise operation

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1- Work requirements

1.1 Introduction

Work requirements means measures determined by the Administrator for the purpose of facilitating and enabling an individual.

1.2 Work instructions

Work Instructions are documents that clearly and precisely describe the correct way to perform certain tasks that may cause inconvenience or damage if not done in the established manner. That is, describe, dictate or stipulate the steps that must be followed to correctly perform any specific activity or work.

- Work instructions are keys to reducing variation, allowing manufacturers to improve quality and meet demand.
- When planning any work you must take into account your duty of care obligations and the policy and procedures of your workplace.
- You must make sure your conduct is safe and does not place others at risk.
- The requirements will be in your work instructions for the job.

Work instructions can be obtained from you're:

a. Supervisor
b. Manager
c. Team leader

In the form of:

a. Written documentation
b. Verbal instructions
c. Team meetings
d. Plans/specifications

Work instructions should provide employees with the following basic information:

- The purpose of the job
- The work activity to be done and sequence of tasks
- Hazard assessment
- Emergency requirements
- PPE requirements
- Time frames
- Priorities

1.3 The planning process

- Once you have your work instructions you must decide the best way to sequence or organize a job.
- Written instructions will include information on the procedures, hazard assessment, maintenance requirements, what to do in an emergency and so on.
- The more information you have about a job the more you will understand how to be safe and efficient and be able to plan your part in it.
- If you do not understand the instructions you receive then you must ask your supervisor to clarify them.
- Things can go wrong if you don't understand instructions properly.

1.4 Job plan

When you understand the task, you can create a plan. A job plan must cover all parts of the work and should:

- Break down the job into individual tasks
- Identify the equipment needed to perform each task
- Define the safety requirements for each task
- Set a timeframe for job completion
- By planning your job ahead you will make sure that all the resources you need to complete the job safely and on time are available.

1.5 Sequence of tasks

- How efficient your job is will depend on how well you sequence or order the tasks.
- Your aim when planning and preparing a sequence of steps is to create a logical and practical way of completing tasks to reduced time and other wastage.
- It also helps to remember other things you need to think about.

1.6 Delegation of tasks

- All materials and tools needed to complete a job must be located and ready to use at each stage of the job.
- There is no point starting a job if you do not have the correct equipment to complete it safely and effectively.
- You might have to delegate others to provide services to complete part of a job. If this is the case, this should be organized at the planning stage. If it is done later you risk interrupting the flow of work.
- Early planning also helps them to plan their time and gives you a better chance of a smooth operation.

Self-check 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 point)

1. ----------means measures determined by the administrator for the purpose of facilitating and enabling an individual?
   a. **Work requirements** c. Job plan
   b. Work instructions d. Planning process
2. ---------- all materials and tools needed to complete a job must be located and ready to use at each stage of the job?
   a. Work requirements c. Job plan
   b. Work instructions d. **Delegation of tasks**
3. A job plan must cover all parts of the work and should include ----------?
   a. Break down the job into individual tasks
   b. Identify the equipment needed to perform each task
   c. Define the safety requirements for each task
   d. Set a timeframe for job completion
   e. All
4. Work instructions can be obtained from ----------?
   a. Supervisor c. Team leader
   b. Manager d. **All**

Test II: Short Answer Questions

1. List basic information of work instructions should provide to employees (6 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Following safety plan, policies, and requirements

2.1 Following safety plan, policies, and requirements

- Before you start work, you need to be aware of any company policies, procedures or requirements that you must comply with when you're using tools, plant or equipment in a workshop or on a worksite.
- While these policies and procedures may vary from company to company,
  - ✓ They will commonly cover the quality of work required
  - ✓ The tools to be used
  - ✓ How they should be maintained and stored and
  - ✓ The safety procedures to be followed

2.2 Harvest plan

Before starts harvesting, the principal and contractor should agree on a plan for the area to be harvested. At this time, principals and contractors should share information on any potential hazards involved in the work or the site, as well as other health and safety management requirements. The harvest plan should include the principal's requirements for the bamboo felling operation.

The harvest plan should contain the following information:

- Maps showing road and landing locations, as well as key landmarks;
- Terrain;
- Mean culm height;

All known felling hazards including:

- Natural features like cliffs and tomes;
- Physical features like power lines and fences;
- Stand features like areas of wind-throw, dead trees (culm) and vines;
- Stand characteristics including piece size, species, pruned/ un pruned; and
- Resource consent conditions.

This harvest plan should be used by the contractor when developing a bamboo felling plan. This felling plan should include the identification of areas of wind-throw or steep terrain and other issues that should be communicated to their team before the harvest starts.

2.3 Planning

The person in charge of bamboo felling operations controls and supervises the work to ensure that safety precautions are being observed. That person should be fully experienced in the kind of work to be undertaken. The bamboo harvesters and the person in charge of the operation shall identify hazards specific to the site.

Five step culm felling plan

Any bamboo harvester should ensure that they follow the five step tree felling plan.

I. Site assessment

- Assess the stand for hazards relating to the trees, terrain, other operations, and power lines.
- Assess the strength and direction of the wind and whether it will affect safety.

II. Individual culm assessment

- Look for bamboo culm defects, decay, heavy lean, or any other characteristics of the bamboo that may affect the felling plan.
- Note the ground condition and soil moisture.
- Check the surrounding bamboo culm for interlocked branches, dead tops or branches that may fall into the work area.
- Select bamboo harvesting method for harvest
- Determine if you can fell it safely and plan the felling cuts.
- Decide on the felling direction. This will help determine which side of the bamboo culm will be the safest for the escape route.

III. Preparation of the work area and escape route

- Clear vegetation and obstacles from around the base of the culms.
- Always think about your escape route before you begin any felling cuts.
- Be sure your escape route is clear of obstacles or hazards before beginning.

IV. Fell the culm using safe felling techniques

- Good felling technique is critical to safe, accurate, consistent results.

- Appropriate felling of a bamboo culm for long term health of the clump, and maximum value of the culm.
- Culms should be cut between 15cm - 45 cm from the ground, directly on top of the first node above ground.
- Cutting too high above the ground is a waste of raw material.
- Culm felled using a scarf and back cut.

V. Retreat and observe

- Remember to finish the felling cut on the safe side of the culm and use your escape route as soon as the culm begins to fall.
- Watch for falling material and be far enough from the base of the culm to avoid a kick back, butt swing, or bounce.
- Avoid walking directly behind the culm.

2.4 Personal Protective Equipment (PPE)

- It is important to use personal protective equipment (PPE) to protect yourself against hazards, such as chemicals and heavy equipment, and ensure you are working safely.
- Depending on the job you are undertaking, you may need to use various types of protective equipment together, so you should read the job description to determine what is required.
- If you are unsure what equipment you will need, you should check with your supervisor to make sure you are fully prepared.
- Equipment must be provided in good condition to ensure it is fit for the purpose.

Personal protective equipment could include:

- **Eye protection:** - Protect the eyes. Provides protection when there is potential for particles to enter the eye from the front. Protective eyewear should be carefully selected, fitted and cleaned. Protective eyewear should be reasonably comfortable and fit snugly without interfering with the movements or vision of the wearer.
- **Gloves:** - Gloves provide protection for the hands and arms from chemicals, temperature extremes, and abrasion. Longer and thicker gloves are used to protect workers from cutting their hands on sharp objects such as needles.

- **Protective clothing: -** Protect the body from exposure to strong chemicals or wear high visibility clothing when working outside in the dark.
- **Safety shoes:** - Safety boots should be slip-resistant to prevent slips and falls. Rubber soled shoes can be used as protection against electrocution. Safety shoes should also have impact protection in work areas where heavy objects such as tools can be accidentally dropped on the feet.
- **Sun protection:** - Ultraviolet protection. When workers are outside for long periods, they should be provided with sun protection, such as sun lotion.

Figure 1: Personal protective equipment

2.5 Health and safety precautions

While working in the field you must observe certain health and safety precautions. Failing these precautions there are chances of accidents or health hazards. The important precautions are as follows:

- You should ensure availability of all the necessary first Aid for safety measures.
- During harvesting of bamboo ensure that the workers wear tight clothing and tie-up their hair to avoid entanglement.
- Proper procedure for felling should be followed to avoid crush type of accidents.
- You must effectively use all the necessary safety material and follow all the preventive measures to avoid any injury during usage/application of pesticide.

Self-check 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (3 point)

1. Policies and procedures of a company commonly cover ……?
   a. Quality of work required
   b. Tools to be used
   c. How they should be maintained and stored
   d. The safety procedures to be followed e. All
2. ---------- should include the principal's requirements for the bamboo felling operation?
   a. Maps b. Harvest plan c. Felling hazards d. All
3. What does the information harvest plan contain?
   a. Maps showing road and landing locations c. Terrain
   b. Mean culm height d. all

Test II: Short Answer Questions

1. List personal protective equipment ?(3 point)
2. What is the five-step culm felling plan? (4 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Selecting tools and equipment

3.1 Checking tools, and equipment

A very important part of planning for bamboo harvesting project is being able to identify the tools that are most appropriate for the task and making sure you have access to them where and when you need them. You'll be looking at the tools, materials and equipment used to bamboo harvesting operations in more detail later in this guide, but here are some key points you need to remember when planning and preparing for a work task.

- Check the condition of all tools before you start any work, and rectify or report any faults.
- Always read the manufacturers' instructions for any tools, equipment and materials you're not familiar with.
- Be aware of materials that may be hazardous. Look for warning labels and, if there's a safety data sheet (SDS), read it carefully.
- Never use a tool or piece of equipment for any purpose other than what it's designed for.
- When you're calculating material quantities, always double-check the plan and/or instructions you're working from, and also your calculations. This will help you to avoid situations where you can't complete a task because you have either too much or not enough of a material you need.

3.2 Selecting tools for cutting bamboo from field

- **Hatchets/axes** are perhaps the preferred tool for making the initial cut on a bamboo culm. This cut should ideally take place directly above the first node, but may be made above the 2nd or 3rd node if cutting is difficult (in a crowded clump).
- **Knife:-** use for slitting, sizing and shaving the bamboo
- **Machete: -** the machete is a cross between a knife and an axe. The machete blade is used for cutting, while the weighted upper blade provides force for chopping
  - ✓ **Bow saw**:- Bow saw or one man saw is used for felling of small trees and culms or cutting other small sized products

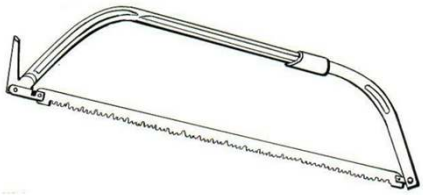


Figure 2: Bow saw

- **Crosscut saws:** - saws should be carefully selected for the work they are to do.
  - ✓ For crosscut work on green wood, a coarse saw (4 to 5 points per inch) is to be used.
  - ✓ A fine saw is better for smooth, accurate cutting when using dry wood.
  - ✓ Saws are to be kept sharp and well set to prevent binding.

Figure 3: Crosscut saws

- **Hacksaws** should be adjusted in the frame to prevent buckling and breaking, but should not be tight enough to break off the pins that support the blade.
  - ✓ Install blade with teeth pointing forward.
  - ✓ Pressure should be applied on the forward stroke not on the back stroke.
  - ✓ If the blade is twisted or too much pressure is applied, the blade may break and cause injury to the hands or arms of the user

Figure 4: Hacksaws

- **Files**
  - ✓ Selection of the right kind of file for the job will prevent injuries and lengthen the life of the file.

- ✓ The file should never be cleaned by being struck against a vise or other metal object due to file chips becoming possible flying debris.
- ✓ A file-cleaning card or brush should be used.
- ✓ A file is not to be hammered or used as a pry. Use of a file in this manner frequently results in the file chipping or breaking causing injury to the user.
- ✓ A file should not be made into a center punch, chisel, or any other type of tool because the hardened steel may fracture in use.

- A file is never to be used without a smooth, crack-free handle; if the file were to get hung up, the tang may puncture the palm of the hand, the wrist, or other part of the body.
  - ✓ Under some conditions, a clamp-on raised offset handle may be useful to give extra clearance for the hands.
  - ✓ Files are not to be used on lathe stock turning at high speed (faster than three turns per file stroke) because the end of the file may strike the chuck, dog, or face plate and throw the file (or metal chip) back at the operator hard enough to inflict serious injury.

Figure 5: Files

- **A power recipro saw** is a time-saving tool, enabling bamboo foresters to make quick, clean cuts. Use of a power recipro saw requires a portable generator.

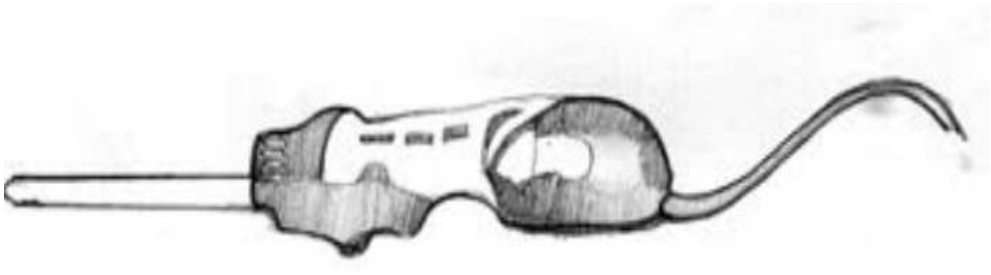


Figure 6: A power recipro saw

- **Diameter tape**
  - ✓ A diameter tape (D-tape) is used by foresters to measure the diameter of a tree (culm). Since trees are swelled at the base, measurements are made 1.37m (4.5 feet) above the ground in order to give an average diameter estimate.
  - ✓ The D-tape is wrapped around a tree and is specially designed to convert the tree (culm) circumference to tree (culm) diameter. Use the D-tape in case the bamboo diameter is larger than 3 cm; for smaller than 3-cm cases, the electronic calipers should be used to measure D accurately.

Figure 7: A power recipro saw

- **Caliper**
  - ✓ A caliper is a device used to measure the distance between two symmetrically opposing sides.
  - ✓ A caliper can be as simple as a compass with inward or outward-facing points. Used to measure the culm diameter and culm wall thickness

Figure 8 Digital caliper

- **Oil Stones**
  - ✓ An oilstone is a fine- grained stone and an abrasive surface used to sharpen some cutting tools.
  - ✓ These come in coarse, medium or fine grades, often as a combination with two of them on opposite sides.
  - ✓ These stones are made from one of three materials (Novaculite, Aluminum Oxide, or Silicon Carbide) and use oil for swarf (metal filing) removal.
- **Rope**
  - ✓ In regeneration areas and sloping grounds, it is sometimes required to use ropes or cable puller to make the culms (trees) fall in the desired direction.
  - ✓ Its material is long-lasting, and it can be exhausted without fracturing if kept within its maximum tensile strength.
- **Gasoline powered chainsaw**
  - ✓ This tool is perfect when you need to cut a large number of bamboo plants.
  - ✓ It can be used in all kinds of weather, and for people who regularly need to cut bamboo or have large areas with bamboo plants, this is ideal.

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (10 point)

1. ……. use for slitting, sizing and shaving the bamboo?
   a. Machete b. bow saw c. **Knife** d. Files
2. …….are perhaps the preferred tool for making the initial cut on a bamboo culm?
   a. Machete b. bow saw c. Knife d. **Hatchets/axes**
3. …… is a cross between a knife and an axe?
   a. **Machete** b. bow saw c. Knife d. Hatchets/axes
4. …… is a time-saving tool, enabling bamboo foresters to make quick, clean cuts.
   a. **A power recipro saw** b. Caliper c. Diameter tape d. Bow saw
5. ……. is used by foresters to measure the diameter of a tree (culm).
   a. Caliper b. **Diameter tape** c. File d Tape Measures

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Checking serviceability and rectifying /reporting faults

3.1 Faults and serviceability

Faults result from malfunctions or events that interfere with, degrade or obstruct service delivery. Machine fault diagnosis is a procedure used to determine the root cause of equipment failure. Fault diagnosis provides information about precisely what happened and how to address it, preventing similar failures in the future.

Serviceability is the measure of and the set of the features that support the ease and speed of which corrective maintenance and preventive maintenance can be conducted on a system. Servicing: Cleaning, lubricating, charging, preservation, etc., of items/materials periodically to prevent the occurrence of incipient failures

Before using any tool and equipment, you should take the time to check it thoroughly to make sure it is clean, undamaged and in safe working condition. Equipment should be inspected on a regular basis to look out for any faults and to check the cleanliness and safety of it. If you are unsure how to inspect equipment, you should read the manufacturer's instructions or ask your supervisor for advice. If you notice any faults with equipment, it should be reported straight away to your supervisor so they can arrange for it to be fixed or replaced, and to prevent anyone else from using it in the meantime.

Most organizations will provide you with tags that should be placed on equipment that is damaged or broken, so this should be done to make other people aware of it. You should not attempt to use or repair any faulty equipment unless you are qualified and authorized to do so, as it could be very dangerous.

When inspecting tool and equipment, it is important to check the following:

- Make sure it is clean, hygienic and safe to use
- Check that it is working fine
- If you are using electrical equipment, you should make sure it is fully charged so it won't run out when you're working
- Check that it has been serviced recently and is fit for the purpose
- Check that it is compliant with environmental regulations

- Make sure it is suitable for the task at hand.
- Any defective equipment and PPE is to be tagged and recorded and reported in accordance with organizational procedures.

3.2 Reporting and Record Keeping

Make sure you record any action you have taken, talk to your supervisor and officer about the control strategies in place. Reports and records include:

- Risk assessment reports
- Incident reports
- Job safety analysis (JSA)
- Safe work methods (SMWS)
- A workplace procedure keeping records is important as they can help ensure that any risk management activities are traceable.
- Records also provide a basis for improving methods and tools in the risk management process as well as improving the overall process.

Self-check 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (6 points)

1. What does a report and records include?
   a. Risk assessment reports
   b. Incident reports
   c. Job safety analysis
   d. Safe work methods
   e. All
2. …….. is the measure and set of features that support the ease and speed with which corrective and preventive maintenance on a system can be performed?
   a. Risk assessment reports b. **Serviceability** c. Fault diagnosis d. Faults
3. ……is is a procedure used to determine the root cause of equipment failure?
   a. Serviceability c. **Machine fault diagnosis**
   b. Faults d. Risk assessment reports

Test II: Short Answer Questions

1. What should be checked when inspecting tools and equipment? (4 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 4- Recognizing and adhering quality assurance requirement

4.1 Recognizing and adhering quality assurance requirement

Quality assurance is a process management activity that focuses on ensuring that the processes used to create a product produce as few defects as possible. Quality assurance activities are conducted with the goal of ensuring that processes are consistent and effective at producing their desired outcome.

All industry has the potential to affect the environment negatively. Although bamboo harvesting tasks are generally considered to have very little environmental impact as they don't use resources heavily, create a lot of waste or require much clean-up, environmental issues still need to be considered. However, environmental regulations have had enormous benefits in terms of lives saved and illnesses averted, especially through reductions in airborne particulates.

Most industry will have an environmental management plan (EMP) or policies and procedures for ensuring that projects have as little impact as possible. It's everyone's responsibility to work in a way that has as low an impact on the environment as possible. As part of your planning and preparation, make sure you:

- ✓ Check if there's an existing EMP for the company, worksite and project
- ✓ Comply with waste management and clean-up procedures as required.

Self-check 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (5 point)

1. …….is a process management activity that focuses on ensuring that the processes used to create a product produces as few defects as possible?
   a. Quality assurance c. Policies and procedures
   b. Waste management d. Environmental management
2. …….for ensuring that projects have as little impact as possible?
   a. Quality assurance c. Policies and procedures
   b. Waste management d. Environmental management

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

LG #2

LO #2- Harvest bamboo from field

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Bamboo terminology and morphology
- Identifying and marking bamboo culms
- Harvesting bamboo culms

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Identify bamboo terminology and morphology
- Identify and mark to harvest bamboo culm
- Harvest bamboo culms according to harvesting procedures and techniques.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Bamboo terminology and morphology

1.1. Introduction

The term bamboo comprises more than 1,500 species that are widely distributed in the tropical, subtropical and temperate regions of all continents except Antarctica and Europe, between 46° N and 47° S. Geographically bamboo distribution can be classified in to three zones: the Asian Pacific zone, the American zone and the African zone.

Bamboo is strong, flexible, durable and widely available. Bamboo plant used more than 1,000 known uses for bamboo, common uses include, post and beam construction, formwork, food, fodder, musical instruments, piping, walling, flooring, mats, baskets, roofing, cooking utensils, medicine, charcoal, etc. A bamboo pole is known as a culm.

In Ethiopia two indigenous bamboo species in the country are the highland (Arundinaria alpina) and lowland bamboo (Oxytenanthera abyssinica).

1.2. Bamboo plant

Bamboo is technically a form of grass, growing in clumps or forests of large tubular sections known as culms. Each culm is made up of jointed hollow sections, divided vertically by a series of solid nodes. The hollow internode section gives the culm flexibility, whilst the nodal diaphragm provides strength and prevents buckling under stress.

The bamboo plant (Figure 1) is made up of an underground axis and above ground axis. The underground axis is comprised of rhizomes, roots, and buds. The above ground axis is comprised of stems, branches, and foliage. Buds on the rhizomes may develop into shoots that emerge from the ground.

The new shoot elongates vertically into a main stem or culm until it attains its full height. The growth of a culm is completed in one growing season. In large bamboo species, new culms may grow to a height of more than 20 meters within 3 months.

“Morphology” refers to the outward appearance of the plant’s components. Bamboo growth can be divided into three phases: underground shoot growing, stem forming and stem maturing.

Clump: A clump is a cluster or group of bamboo culms originated from a single mother plant.

Culm: - This is really the above-ground stem of the plant. In botanical terms, this stem is really a branch. The culm grows to full height in 6-8 months.

Shoot: The bamboo shoot is an emerging stem or culm. It originates from buds on the underground rhizome. Shoot is the edible part of the bamboo plant.

Culm sheath: Culm sheaths are modified leaves, arranged alternately on opposite sides of the growing culms, providing protective cover for the young shoots / culms.

Branches: When a shoot / culm reaches its full height growth and culm sheaths fall off, branches grow out from the nodes of the culm.

Leaves: Bamboo leaves grow out from the top of the newly emerged culm when height growth ceases and proceeds downwards; quite the opposite of that observed for most plants.

Nodes and internodes: Each culm segment begins and ends with a solid joint known as a node. Nodes are key growth points in rhizomes, culms and branches from where new vegetative axes develop and grow. Buds on the culms are also placed on nodes. The segment between two successive nodes is known as an internode.

Rhizomes: The underground portion of the bamboo plant is the rhizome. The rhizome system constitutes the structural foundation of the plant.

Buds: Buds are meristematic organs in bamboo located at nodal portions on culms and branches. In the underground portion, buds are placed at the nodal region in the rhizomes.

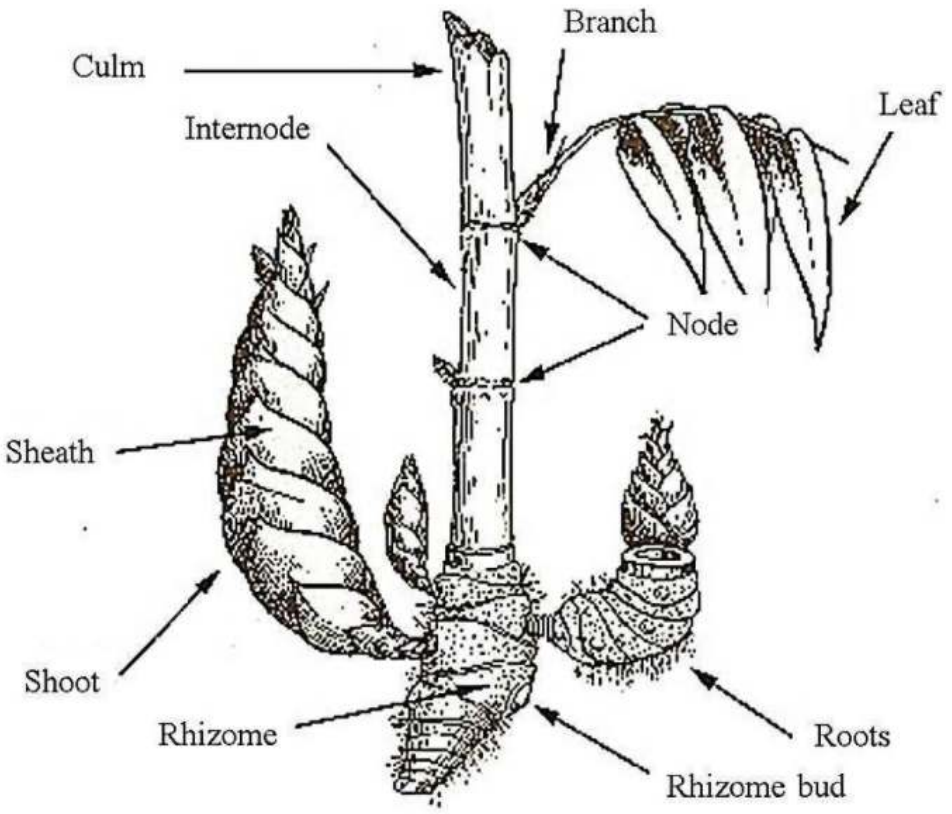


Figure 1: Parts of the Bamboo plant

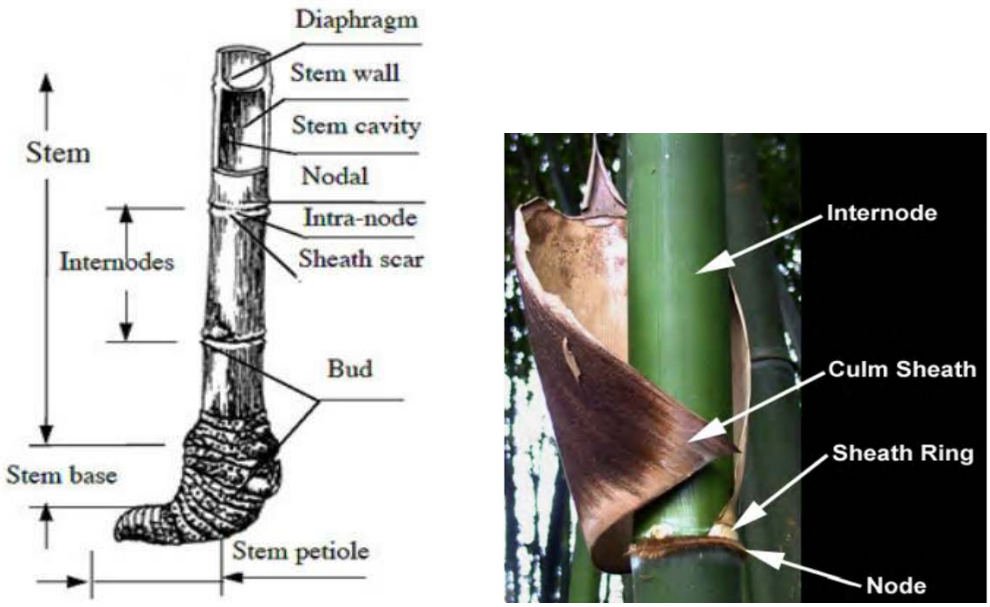


Figure 2: Parts of the bamboos stem (culm)

1.3. Growth pattern of bamboo

The growth pattern of bamboo can be divided broadly into two groups: running and clumping. Two main systems of rhizome formation are predominant in bamboos, namely clump forming rhizomes and running or creeping rhizomes.

- Clump forming bamboos have rhizomes that exhibit a sympodial branching pattern. Commonly found in tropical areas.
- Running bamboos, on the other hand, have rhizomes with a monopodial branching pattern. Commonly found in subtropical areas.
- In sympodial branching, each branch or axis becomes dominant. In the case of bamboos with sympodial rhizomes, each new rhizome turns upward and develops into a culm.
- On the other hand, bamboos with monopodial rhizomes have a single, dominant subterranean stem, or axis, that develops secondary stems that either extend laterally or turn upward to become culms. The lateral extension of the monopodial bamboos may exceed hundreds of meters.

Pachymorph, clumping bamboo (sympodial rhizome branching)

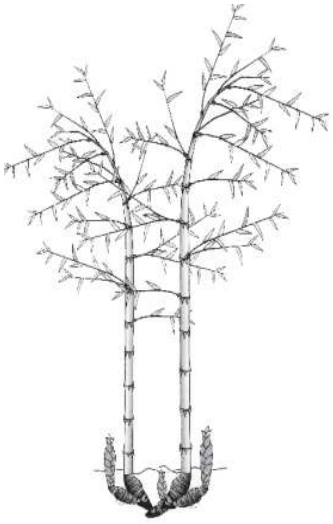


Figure 3: Pachymorph and Sympodial bamboo

Leptomorph, running bamboo (monopodial rhizome branching)

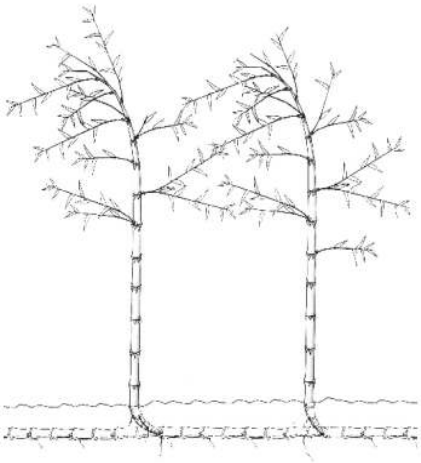


Figure 4: Leptomorph and monopodial bamboo

1.4. Strength and Other Properties of Culms

The culms have varied characters like mechanical strength, moisture content, starch content etc. at different ages. The main traits are discussed below:

- Culms below one year of age have very high moisture content and shrivel up after harvesting.
- Young bamboo culms have a high starch content that makes them exposed to borers and termites when harvested and used. The process of lignification is also incomplete in young culms, leading to poor strength and mechanical properties.
- As the culm grows older, the starch content reduces and the lignin content is enhanced which contributes to the hardness of the culm.
- Culms therefore increase in strength and other properties as they grow older.
- A bamboo culm is strongest in its three to fifth years.
- After 6-7 years, fungal attack appears, rot and age begin to set in. It becomes gradually brittle and weak, until it dies in its seventh or eighth year.

1.5. Properties for specific applications

Bamboo application requires materials with specific characteristics which are related to the age of the culm and to the part of the culm. Before harvesting, it is very important to select the culms suitable to the intended application. For instance:

- New culms (i.e., younger than 1 year old), which have very soft and flexible fibers, can be used as finishing strips for weaving and for making bamboo fiber for crochet weaving.
- Fibers from 1 year old culms, which are quite tender, are the best materials for plain woven products such as mats.
- For plain bamboo weaving, the base and middle portion of the culms are ideal materials, since they have more tender fibers than upper section of the culm.
- 3 to 4 year old culms are ideal for bamboo furniture making.
- It can take between 3 to 5 years for bamboo to be strong enough to be used for structural purposes.

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (3 point)

1. ……. are key growth points in rhizomes, culms and branches from where new vegetative axes develop and grow?

   a. **Nodes** b. Internodes **c.** Buds d. Clump

2. …… is a cluster or group of bamboo culms originated from a single mother plant?

   a. Nodes b. Internodes **c.** Buds d. **Clump**

3. The segment between two successive nodes is known as …….?

   a. Nodes b. **Internodes** **c.** Buds d. Clump

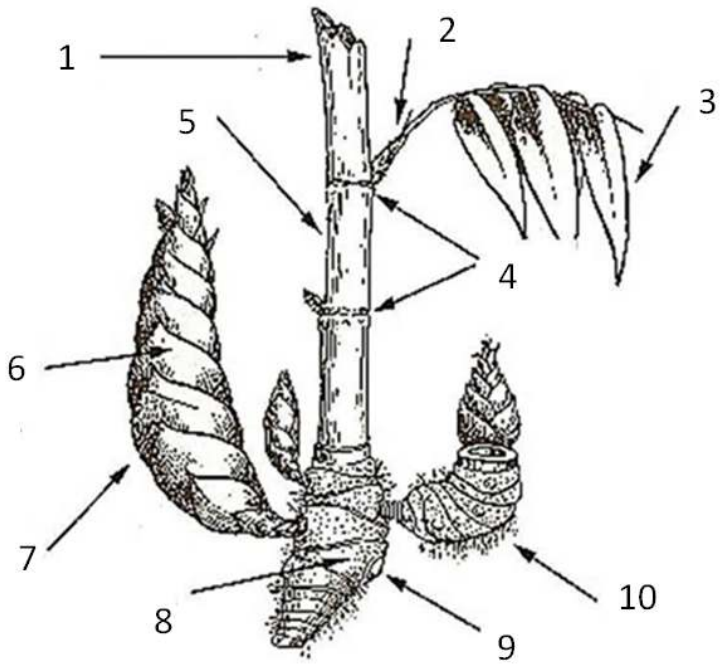
Test II: State whether True or False (7 point)

1. Rhizome is the edible part of the bamboo plant.
2. The internodes of bamboo are hollow but nodes are solid.
3. During the dry season, the starch content and moisture content of bamboo plant is high.
4. Areal roots and culm sheath attracts decaying organisms and insects
5. Monopodial bamboo produces more straight bamboo culms compared to sympodial bamboo.
6. Closed clump forming bamboo found in the low
7. Closed clump forming bamboo found in the low

Test II: Matching question questions (10 point)

1. Match the number of each bamboo part with the correct part name (7 point)

a. Rhizome	e. Sheath	i. Culm
b. Rhizome bud	f. Node	j. Leaf
c. Roots	g. Internode	
d. Shoot	h. Branch	



You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 20 points** **Unsatisfactory - below 20 points**

Information Sheet 2- Identifying and marking bamboo culms

2.1 Introduction

This section provides a basic overview of key characteristics of bamboo, identification culm maturity and maturity marking system.

- As you are now aware, bamboo culms vary in their strength and other properties with age. It is therefore important to know the age of the culm while harvesting.
- Only when they are harvested at the right time, will the culm have appropriate strength which is important for its use in products and applications. This can be done through a simple Maturity Marking System (MMS).

2.2 Harvesting lifecycle

- The life cycle of bamboo culms can be divided into four (4) periods: the growing period, the toughening period, the ripening period and the decaying period.
- The ripening (maturity) period is considered the most efficient time to harvest. Culms should be harvested between 3 and 5 years old, although this can depend on the species.

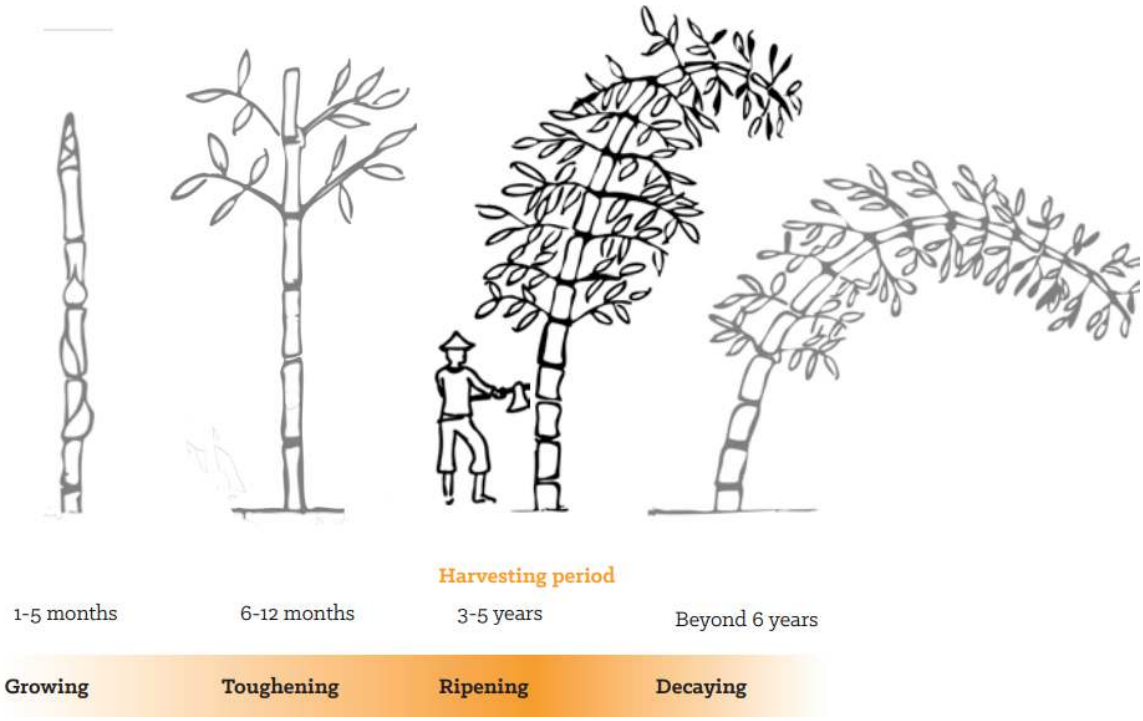


Figure 5: Harvesting Lifecycle. The life cycle of bamboo culms can be divided into four (4) periods.

- Stem maturing – a process of bamboo maturity. This is of vital importance to the quality of bamboo material. In processing and utilizing of bamboo material close attention should be paid to this problem
- The maturity process can be divided into three phases: improving, stabilizing and declining.

- ✓ In improving phase cell wall thickens and basic density increases, moisture content decreases and physical and mechanical properties increase.
- ✓ In the second phase (stabilizing) the quality of bamboo stem reaches the peak and becomes stable.
- ✓ The quality of stem material in the third phase is thought to have a declining tendency.
- ✓ Stem quality depends on the age and species of bamboo plants.

2.3 Identifying culm maturity

Identifying the age of bamboo culms is an essential skill in the raw material selection. There are two practical methods to identify the age of culms based on certain culm features and marking culms.

- Under field conditions, it is not easy to recognize the age of a bamboo culm, especially since culms in a mature clump tend to have similar girth, length and nodal structure.
- People familiar with bamboo cultivation can distinguish bamboo of different ages in a clump. However, the accuracy of such distinction is dependent on the skill and experience of the person. It is not always reliable. Therefore, there is a need to implement independent systems of maturity identification.
- These systems provide a basis for harvesting and help to ensure out-turn of good-quality and mature bamboo.
- The culm age can be identified based on certain features of the culm sheath, development of branches and leaves, external colour of the culm, position of new culms, etc.
- For example, in sympodial bamboos, younger/current year culms are usually on the outer side, while older culms are toward the inner side.
- Culm sheaths are usually absent on older culms.
- The accuracy of such a distinction is, however, dependent on the skill and experience of the person and is not always reliable.
- Therefore, other guaranteed methods have to be adopted to determine the age of bamboo.

Table 1: Methods to identify the age of culms based on certain morphological features

No	Morphological characters	Young culm	Mature culm

1.	Color	Dark Green	Dirty with scratches
2.	Knots	Alive	Dead
3.	Nodes	Close	Separated
4.	Culm sheath	Present	Absent
5.	Aerial roots	Alive	Dead

Figure 5: Bamboo features at different growth stages

2.4 Maturity Marking System (MMS)

The difficulty of determining the age of culms has led to the implementation of a very reliable method which involves marking each new culm. Maturity marking systems are used and encouraged in several parts of the world. Such systems ensure that bamboo of the desired maturity is harvested. This is an inexpensive and easy method.

Age can also be determined by marking the culms

(a) With different colour paints,

(b) Writing year and month of shoot emergence using colour/paint and

(c) Inscribing the year of shoot emergence.

Please note: Marking should be done after the culm attains its full height, that is, after it has stopped growing. The indication of the stoppage of further dimensional growth (length) is when branches begin to appear, normally first in the upper portion of the culm.

- Detach the culm sheath from the culm before beginning to paint.
- Mark the different-aged culms with the thick paint by making a two to three-inch band at breast height in the inter-nodal portion of the culm, taking care that paint should not drip down the culm.
- Use different colours (as given in Table) for marking different ages.
- Writing year and month of shoot emergence: Using single colour paint (black), write the year and month of shoot emergence. This method is widely adopted in China.

Table: Colour schemes for identifying the age of culms

Colour	Age (Year)	Rotation-2
Red	Current: 0-1 years (2018)	Current: 0-1 years (2021)
Yellow	1-2 years (2019)	1 – 2 years (2022)
Blue	2-3 years (2020)	2 – 3 years (2023

Figure 6: The photo shows marked culms that emerged in 2007, 2008, 2009 and 2010.

Self-Check – 2	Written test

Name…… ID…… Date…….

Test I: Choose the best answer (2 point)

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. In ……. phase cell wall thickens and basic density increases, moisture content decreases and physical and mechanical properties increase?
   a. Stabilizing c. Declining
   b. **Improving** d. Maturing
2. In …….the quality of bamboo stem reaches the peak and becomes stable?
   a. Stabilizing c. Declining
   b. **Improving** d. Maturing

Test II: Short Answer Questions

1. What is the use of marking culms? (5 points)
2. Fill the table below? (8 points)

No	Morphological characters	Young culm	Mature culm
1.	Color		
2.	Knots		
3.	Nodes		
4.	Culm sheath		
5.	Aerial roots		

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Harvesting bamboo culms

3.1 Sustainable management and harvesting practices (timber stands)

Sustainable management and harvesting of clumping bamboos are focused on measures to regulate the population structure of bamboo clumps and culms and improve the growing conditions.

- New culms are commonly produced on the periphery of the clump (young culms / rhizomes are the ones which produce new shoots (1-2 years old).
- So, the tendency of the bamboo collectors, harvesters to harvest the bamboo poles on the outside periphery of bamboo clump, which is young and immature affecting the sustainability of the clump as well as the durability of the bamboo products / poles used are low.
- Mature bamboo poles in sympodial bamboo clumps are commonly found on the inner core of the bamboo clump.
- In the case of sympodial bamboo with long rhizome neck such as Yushania alpina, penetrating inside the clump and harvesting mature bamboo poles are relatively easier due to its sparse nature of growth.
- In the case of unmanaged sympodial bamboo with short neck rhizome (genus such as Bambusa, Oxytenanthera, Dendrocalamus, Cephalostachyum and others) bamboo clump is congested prohibiting the entry into the clump.

Best time to harvest:

- Timber production post rainy season or early dry season is the best time to harvest bamboo poles.
- During the post rainy season, starch content is comparatively lower (since new shoots consumed most of the nutrient in the clump).
- With low starch content and relatively less moisture content, the bamboo poles are least susceptible to attacks by fungi, borers, termites and other pests.
- Harvesting or felling should not be done during shoot emergence and growing periods as harvesting operation will damage the tender growing shoots.

- Harvesting should not be done in end of dry season and early rainy season as the bamboo plant bodies have lot of accumulated starch and nutrients to feed the emerging shoots.
- Bamboo poles harvesting during this period will be susceptible to borer and insect attacks due to high starch concentration.

3.2 The goals of sustainable harvest

- Maintaining your social economic and social ecologic balance.
- Improving productivity of your bamboo
- Increasing shooting
- Maximizing the number of shoots that turn into culms,
- Improving the quality of your bamboo culms
- Maintaining the long-term health of your bamboo clump

Two techniques for managing congested or clustered bamboo are

(a) Tunnel technique

(b) Horse-shoe technique.

Tunnel technique

- Make 60 cm wide path from one end to other end of the clump.
- Make sure the tunnel created passes through the central part of the clump.
- As most of the mature bamboo poles are created in the center of the clump, tunnel is created so that one can enter, harvest and drag the bamboo poles.

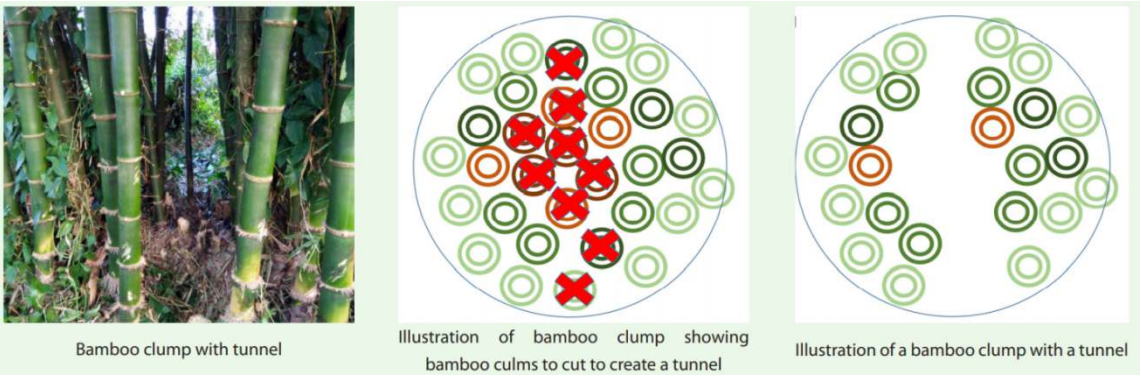


Figure 7: Tunnel technique.

Horse-shoe technique

- Make 60 -100 cm wide path from the periphery or outside of bamboo till the center of the clump.
- Select the location or side of the clump where there is minimum number of young bamboo poles, to avoid cutting of young poles
  - ✓ Year after year, the size of the tunnel and horse-shoe will expand and with right culm density, harvesting operation will be easier and cost effective.
  - ✓ ***Please note:*** Harvesting should be selective, only mature culms should be harvested using very sharp tools. It is advised to disinfect the harvesting tools to lower the risk of infection in plants.

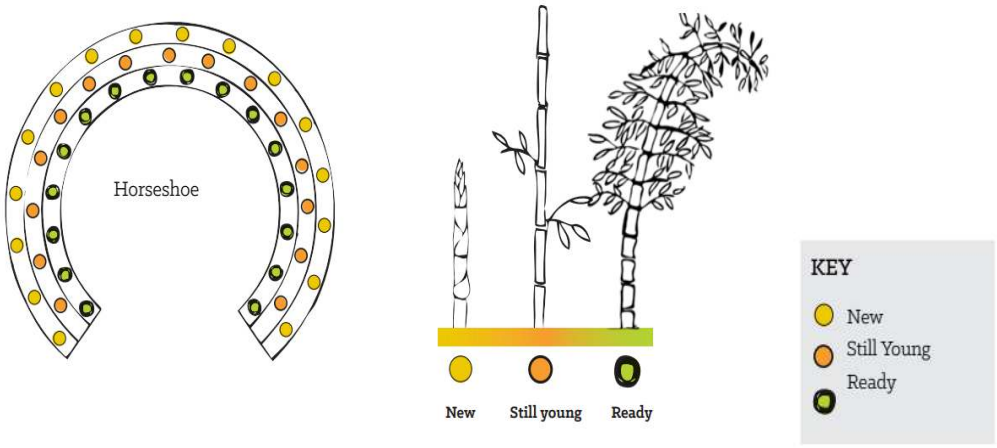


Figure 8: Horse-shoe technique.

3.3 Rotational harvesting in case of bamboo forest management

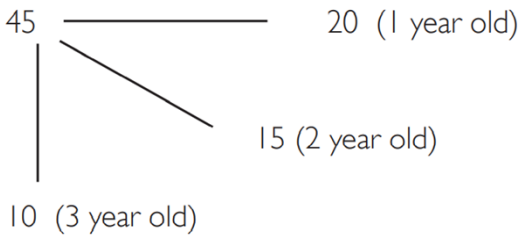
- Clear cutting should not be allowed.
- Three-year rotation cycle can be followed. Three blocks or compartments can be created in a bamboo forest, and cutting is permitted in only one block per year.
- Leave all the one-year-old culms and leave equal number of mature culms (2 & 3 years combine) and harvest the rest.
- In managed bamboo forests, regeneration (quantity) and quality of bamboo poles will be better.
- In locations of unregulated or over harvested bamboo forests for years, stopping harvesting for few years allows the bamboo forests to recoup.

3.4 Basic harvesting rules

- No clear felling should be allowed.
- All older or matured bamboo culms should be harvested (3 years +)
- Current year culms should be retained.
- At least a minimum of six culms over 1-year-old, spaced uniformly over the clump should be retained. When there are large clumps, proportionately more mature culms can be retained.
- Number of harvestable culms should not exceed the number of poles emerged in the last year.
- Digging of rhizomes is not permitted, except for propagation purpose.
- Culms should be felled / cut above first node from ground (about 10 cm from ground level).
- A sharp instrument (knife or saw) should be used when felling to avoid splitting and damage of culms.
- All dead and dry bamboo, all debris as a result of harvesting and high cuts (due to lopping) should be removed from the clump.
- Bamboo forests should be protected from fires.

3.5 Selecting bamboo for harvest using ratios

- To adhere to a simple ratio to assist in annual sustainable bamboo harvest.
- No matter what size your bamboo clump, a simple ratio of leaving 4 - one year old bamboos, 3 - two year old bamboos and 2 - three year old bamboos in the clump each year leads to optimum productivity.
- Leave 4-3-2 culms of 1-2-3 years of age
- The graphics below depict a clump with 45 culms being split into year classes based on the 4-3-2 ratio.



- Relationship of culm density within the clump to yield: when determining the appropriate ratio and spacing for your bamboo, refer to the following:
- Lower standing-culm densities promote increased diameter of each culm but reduce total yield.
- Higher standing-culm densities increase total yield but reduce diameter of shoots and culms.

3.6 Felling / Cutting Method

- Cut the culms in a slanting manner (45 degree) just above the lower most node (~ 10 -15 cm) to :-
  - ✓ Minimize wastage
  - ✓ Avoid sprouting and at the same time rainwater will not stagnate in cavity of stump portion.
  - ✓ When felling is done far above the ground, buds on the nodes of cut stump will get activated and produce branches and create bushy clumps hindering future harvesting and management operations.

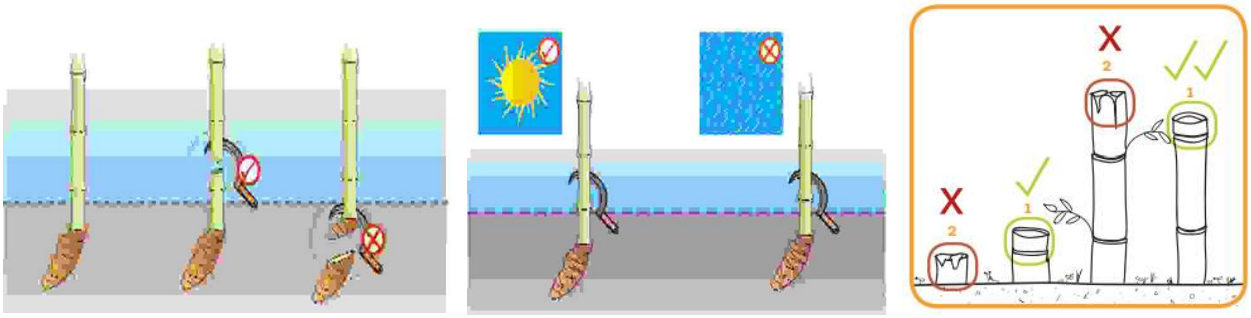


Figure 9: Examples of correct and incorrect cutting techniques for harvesting.

3.7 Care during felling / harvesting

- Branches and twigs from harvested poles need to clean from the mother culms.
- Dead, rotten and deformed culms and stumps should be cleaned.
- Remove old, damaged, diseased, pest infested or rotten bamboo from the clump.
- Harvesting and felling operations should not be undertaken in culm emergence period.

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (2 point)

1. Harvesting of bamboo for commercial purpose can begin from ..... year of growth.
2. .....is the best season for harvesting bamboo.
3. .....and.....systems of harvesting are used for harvesting culms in densely clumped bamboo.
4. Culms of more than 5 years are.....
5. .....is the system used for ensuring right age of bamboo while harvesting.

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Operation Sheet 1- Harvesting bamboo culm

1.1 Techniques of harvesting bamboo culm

1.1.1 Tools and equipments

I. Hatchets/axes
II. Hacksaws
III. Crosscut saws
IV. Knife
V. Hand saw
VI. Machete
VII. Diameter tape
VIII. Calipe
IX. A power recipro saw
X. Rope
XI. Oil Stones

1.1.2 Procedures/Steps/Techniques

I. Wear proper personal protective equipment's
II. Identify age structure of a bamboo clump
III. Identify and marking the age of a bamboo culm
IV. Determine bamboo for harvest using ratios from clump
V. Determine harvesting technique

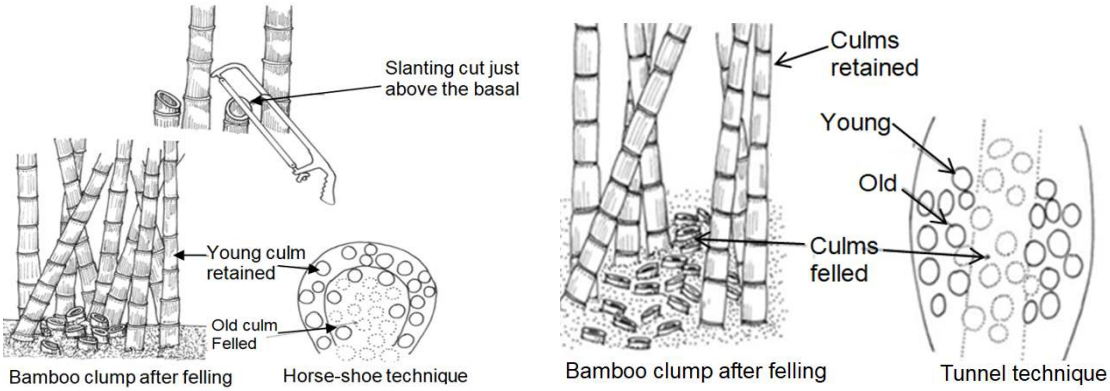


Figure 9: Technique and pattern of felling of bamboos from a clump

VI. Cut bamboo culm between 15 - 45 cm from the ground, directly on top of the first node above ground

VII. Cut with an axe higher off the ground in the middle of the second node.

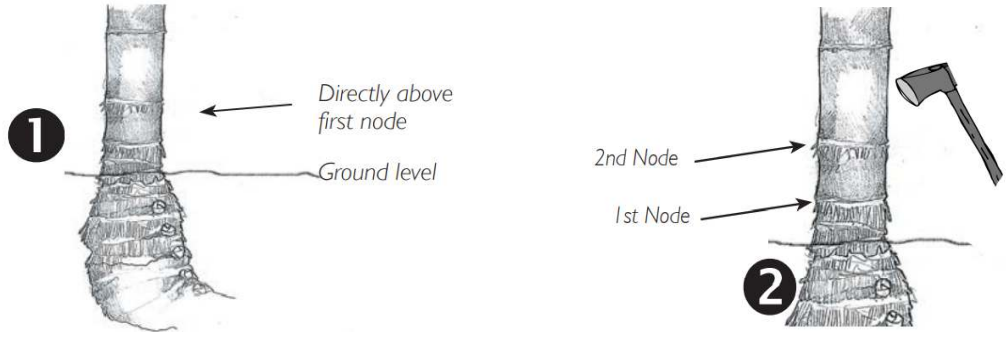


Figure 9: Cutting culm in the middle of the second node

VIII. Clean up the bamboo stump

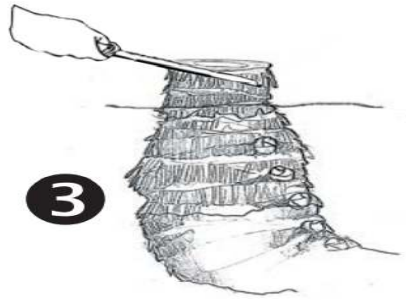


Figure 9: Clean up the bamboo stump

IX. Remove culm from the clump

https://www.youtube.com/watch?v=wXcmtHM-ueg&t=92s

Bamboo selection and harvesting

https://www.youtube.com/watch?v=Blf3jZ-vB3Q

How to cut bamboo the easy way

LAP TEST	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task: 1 Perform culm identification and marking

Task: 2 Perform harvesting (cutting) culm

LG #3 — LO #3- Crop and clean bamboo

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Cleaning bamboo culm
- Collecting harvested culms, stacking and storing according to specification
- Sorting and collecting cut-offs, branches and leaves
- Cleaning and maintaining hand and power tools and equipment

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Remove branches and knots without damaging the culm
- Collect harvested poles according to specification, stack and prepare for drying/storing
- Sort and collect cut-off, branches and leaves following workplace procedures
- Clean hand and/or power tools and equipment , maintain following workplace procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Cleaning bamboo culm

1.1 Cleaning bamboo culm

- Cleaning of bamboo clumps enhanced the growth and development of new shoots and culms. As a result, culms were bigger and longer, and better-quality culms were harvested.
- Cleaning reduced the cost of harvesting mature culms. Income obtained was higher in cleaned culms.
- Remove over mature and defective culms and branches from the ground level up to 2 m above the ground
- The first step after harvesting is to remove all branches of the culm. Branches should be cautiously removed in order to avoid damaging of the culm.
- The outer layer of skin of the culm should be protected very well to avoid scratching them.
- Once the culm is stripped of its branches and foliage, the culm should be cut into sections in order to facilitate transport to the area where processing will take place.
- Branches, culm sheath, aerial root should be remove.
- Branches interfere during stacking and piling
- Aerial roots and culm sheath can attract decaying organisms and insects.
- Remove branches and aerial root using machete or knife without damaging the skin of bamboo. Cut along the growth of bamboo.
- Knives are used to remove branches.
- The knife should be drawn upward to remove the branches so that no damage is done to the culm.
- The right way of doing it is shown in Figure 1, reproduced. Even though hacksaws or hand saws will do the work better, they are not popular because they take more time.

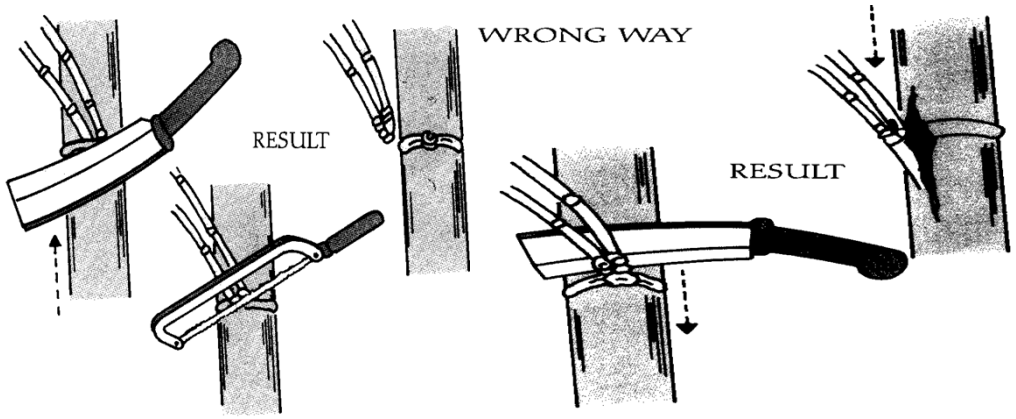


Figure 1: Remove branches

- The culms are cross-cut to required lengths. Use knives for this purpose results in material wastage and uneven cut ends.
- For certain end-products such as furniture, any bulging of material at the nodes needs to be removed.

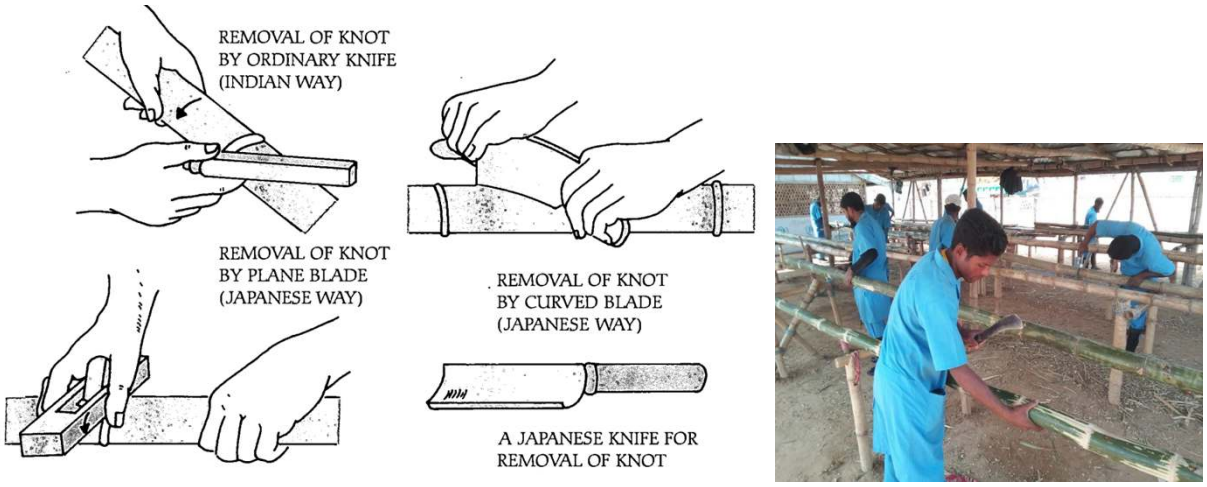


Figure 2: Removal of bulging node

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What is the use of cleaning bamboo clumps? (5 points)
2. List the tools for remove branches and clean knot and nodes**?** (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Collecting harvested culms, stacking and storing according to specification

2.1 Stacking harvested poles

- Stacking bamboo culms above the ground helps prevent molding and subsequent rotting.
- Storing after post-harvest treatment is done; bamboo culms should be stored in a ventilated shelter and not in a closed area.
- The poles should be piled in stacks of different diameters with distance splits to allow air flow.
- Sort and classify the preserved culms based on their size, diameter and quality.

2.2 Temporary bamboo storage

Stock-piling bamboo before it gets to a processor. Before the bamboo goes to a processor, it may be necessary to stock-pile the bamboo. This is the stage where most high quality bamboo culms losses its value due to improper storage. Improper storage has the following risks associated with it

- Time for bamboo to be attacked by termites and powder-post beetles.
- Direct placement in sun causes warping and cracking
- Direct placement in rain causes warping, cracking, and fungal damage
- Placement in a non-ventilated situation leads to fungal infection.

Certain factors must be taken care to avoid the degradation of culm quality or loss of culm during storage.

- Immediately after harvesting and throughout the storage period, culms should be stacked vertically rather than horizontally.
- Horizontal stacking puts pressure on culms at the bottom of the pile and can injure, deform or break culms.
- Vertical stacking of green bamboo is better, because a larger surface area is exposed. This facilitates uniform and quicker drying.

- If possible, the stacking area should have a permanent floor. In case of temporary or imperfect floor or soil where the culms come in contact with the ground, they become exposed to borers and termites.
- There are other less expensive options like using polythene sheets and tarpaulin on the floor.
- A covered, or at least shaded, area is recommended for storage, to protect the bamboo from direct sunlight and rain.
- Exposure to rain will lead to re-absorption of moisture and delay the drying process.
- Exposure to sunlight may cause rapid drying, resulting in splits and cracks

2.3 Bamboo Storage and Handling

Proper storage prevents mold and rot and minimizes insect attack. Ensure the following:

I. The storage area is dry with no stagnant water on the ground.
II. Cover stock to keep rain off, reduce UV (Ultraviolet) damage, and prevent treatment leaching from poles.
III. Bamboo stock is elevated a minimum of 1 ft / 0.3 m off the ground.
IV. Bamboo stock is cross-ventilated with:
   - ✓ A clear space between the top of the bamboo stack and the roof covering.
   - ✓ Ventilation gaps between bundles of bamboo approximately every 20 inches / 0.5 m.
V. The storage area is regularly inspected, and staffs are trained in the correct procedure.

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Stacking bamboo culms above the ground helps prevent ……..and …….? (5 points)
2. What are the risks associated with improper culm storage? (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Sorting and collecting cut-offs, branches and leaves

3.1 Sorting and collecting cut-offs, branches and leaves

- The branches and leaves produced from the culms as waste material should be used as a mulching material on the remaining group of clumps, as it may serve as organic manure after its decay and hence enrich the soil.
- All cutting debris and cut off should be collected and removed away from the clump.
- Leaves should be used for manure and animal fodder
- Collecting and sorting branches, and cut off can be used for handicrafts, building material, or carbonized for high quality charcoal.
- Dead culms and branches can be collected and stored for fire wood purposes

Self-Check – 3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What are the uses for branches, leaves and cut off? (5 points)
2. How can we sort branches, leaves, and cut off? (5 points)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

4.2 Clean work area

- **Keep the work area clean.** Safe systems of work are in place and being followed. Keep the floor free of scraps and oil. Cluttered work areas invite accidents.
- Keeping workshop and storage spaces clean and dry can help prevent many accidents. Sparks can ignite scraps, sawdust and solvents. Water can conduct electricity.
- Do not stand in water, on damp floors or in the rain when working with electrical tools. Keep hands and tools dry.
- Keep wastage of the bamboo in the garbage cabinet.
- **Housekeeping**: - Each user is expected to clean up after him/her self. Good housekeeping helps ensure long tool life and a safer work area for everyone.

4.3 Tool and equipment

Tools and equipment require proper care and maintenance, not only for longevity but also to remain useful and safe for the task at hand. Here are some care and maintenance practices for tools and equipment.

Using tool and equipment

- Using tools and equipment for their right task.
- Using a tool for the task it is intended helps to keep it in its best shape.
- This reduces unnecessary damage and protects the user.
- It is also important to check whether the tools are in the right condition before using them.

Keep tools clean and in good repair.

- Always clean up power tools before putting them away.
- Avoid using tools that are or appear to be in disrepair.
- Use power tools only, for their intended functions.

Inspect tools regularly

- Regular inspection of tools is beneficial since it provides an opportunity to see if tools may need repair or replacing.

- Inspections can help to prevent a situation where a last minute trip to the store to purchase a new tool or spare parts delays a project.

Read and follow manuals

- The manuals that come with equipment, especially power tools, have important and useful guidelines.
- They instruct and advise on the best way to keep equipment in optimal condition.

Repairing and Cleaning Power Tools:-Always turn off and unplug a power tool before

I. Adjusting, oiling, cleaning or repairing it;
II. Attaching an accessory; or
III. Changing bits, blades or grinding wheels.

Proper tool maintenance

- It's important for a tool to be properly maintained and cared for to ensure it is safe to use when needed to complete a task. This safety the issue of maintaining and caring of the tools we use.
- Always store tools in its proper place. That proper place is where the tool will be protected from damage.
- Make sure that if any oil, grease, chemical gets on the tool, that the tool is wiped off and cleaned prior to storing it. This will prevent other tools from getting coated with these substances rendering them not ready to use. Also, depending on the chemical, it may damage the tool.
- Some tools need additional maintenance such as sharpening or dressing that makes it safe to use.
- Check tool handles for defects such as burrs, splinters, missing/loose grips
- Inspecting the tools on a regular basis will help reduce the chance of someone using an unsafe tool.

It does not take that much more time to inspect, clean, maintain, and store tools properly. In fact it will save time, since when you are ready to start the task; the correct tool is also ready for service. Just think how hard it would be to complete your task if half the tools were either broken or in such poor condition that you had to take time to repair it or clean it prior to use. Maintain

your tools correctly so they are ready for your assigned tasks. Even with proper maintenance, at some point, tools just need to be replaced.

Performing basic preventive maintenance

i. Read and analyze the use of preventive maintenance schedule form.
ii. Determine the types of tools and machine needed to be lubricated.
iii. Fill out a requisition slip form in releasing the lubricants needed.
iv. Secure a borrower's slip from your teacher.
v. Fill out the slip form correctly intended for the needed tools.
vi. Perform the task according to the prescribed schedule and the assigned machine.
vii. Perform lubricating procedure.
viii. Determine the parts of the machine needed to be lubricated.
ix. Apply thin coat of oil on the parts for a long period of time.
x. Open the bearing cover and apply grease.
xi. Apply grease on sealed bearing with the use of a grease gun

Importance of using and maintaining hand tools

Quality tools can be an expensive purchase, but if you take care of them, they can last longer and return the favor. Keeping your equipment well packed, washed, and repaired would save you time and money while still making your tasks and jobs even more comfortable.

i. Increases the uptime of equipment
ii. Increases operational efficiency;
iii. Increases operational efficiency;
iv. Extends the longevity of the machinery
v. Preserves the equipment's value

After proper maintenance, you need to store your tools correctly. Next, comes cleaning them properly. After that comes sharpening. Then you need to lubricate the tools in the right places. Finally, don't forget about regular inspection, and always follow the manual.

Proper storage

- Proper storage entails shielding tools from harsh weather conditions and damage.
- It is particularly crucial for metallic tools to be kept away from moisture to avoid rusting.

- Having a cabinet where these tools and equipment are stored will be vital to ensuring a secure storage area.
- Also, greasing, lubricating or oiling metallic tools and equipment is essential to prevent rust from forming while keeping the tools in the best condition for future tasks.

Self-Check – 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List down five importance of maintaining hand tools? (5 points)
2. List out how to perform basic preventive maintenance? (5 points)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Operation Sheet 1- Harvesting bamboo culm

1.1 Techniques of harvesting bamboo culm

1.1.1 Tools and equipments

I. Hatchets/axes
II. Hacksaws
III. Crosscut saws
IV. Knife
V. Hand saw
VI. Machete
VII. Diameter tape
VIII. Calipe

1.1.2 Procedures/Steps/Techniques

I. Wear proper personal protective equipment's
II. Check the occurrence of branches, culm sheath and aerial roots

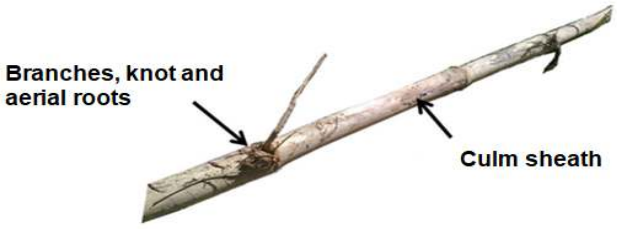


Figure 2: Branches, culm sheath and aerial roots

III. Remove branches and aerial roots using machete without damaging the skin of bamboo. Cut along the growth of bamboo

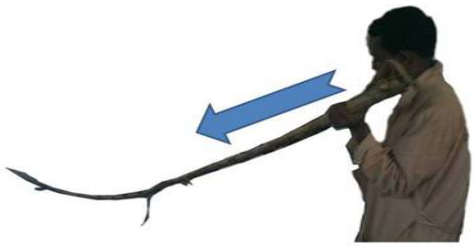


Figure 2: Cut along the growth of culm

IV. Square the bottom end of the bamboo

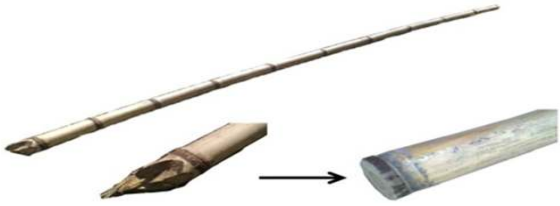


Figure 2: Square the bottom end

V. Measure the maximum length of the pole (culm) relative to the available treatment and drying equipment. Start measuring from the basal portion.

Figure 2: Measure the maximum length

VI. Square the top end of the pole (culm)

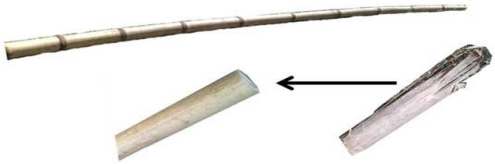


Figure 2: Square the top end

VII. Collect and sort and classify the culms according to size, diameter and quality.

VIII. Collect and store cut-offs, branches and leaves according to use.

IX. Carry out the clan work area, tools and equipment's

https://www.youtube.com/watch?v=6ASDfcP56II

How to cut bamboo branches

https://www.youtube.com/watch?v=DuU2mnJcxPM

How to Maintain Your Tools

LAP TEST	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **8** hour. The project is expected from each student to do it.

Task: 1 Perform identification and marking culm

Task: 2 Removes branches and aerial root

Task: 3 Collect harvested culms, stack and store

Task: 4 Sort and collect cut-offs, branches and leaves

Task 5: Carry out the clan work area, tools and equipment's

Reference Materials

Book:

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