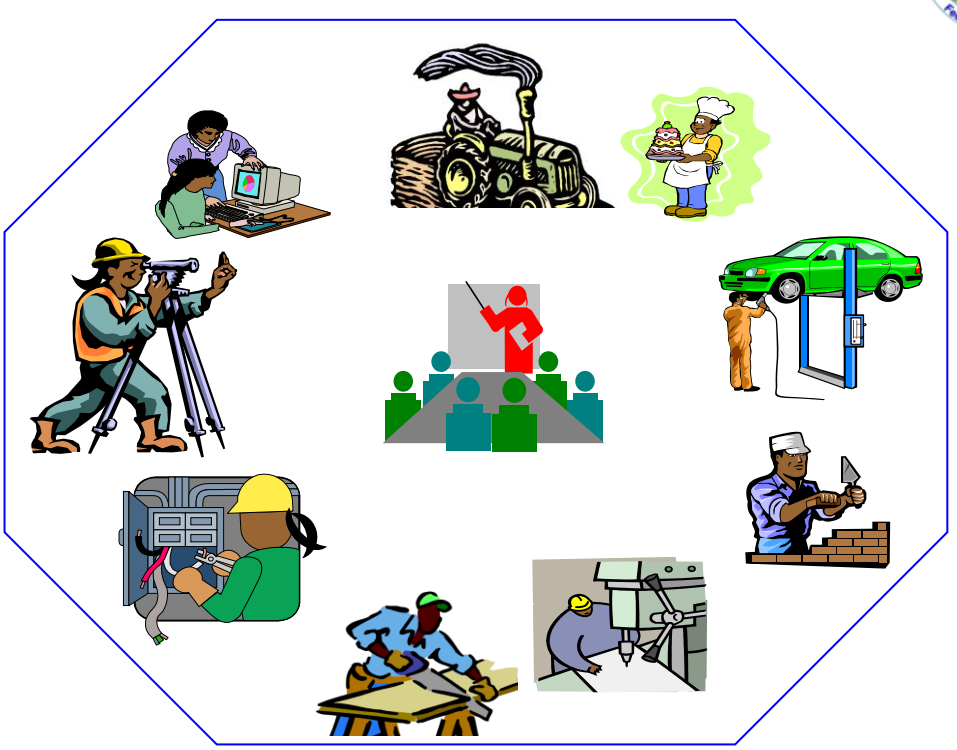

Natural Resources Conservation and Development Level III

Based on March 2018, Version 3 Occupational standards

Module Title: - Promoting Sustainable Non-wood Forest Product Utilization

LG Code: AGR NRC3 M12 **LO (1-5) LG (53-57)**

TTLM Code: **AGR NRC3TTLM 0621v1**

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East Africa Skills for Transformation and Regional Integration Project (EASTRIP)

Table of Contents

LG #53	LO #1- Prepare for monitoring

Instruction sheet

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

- Monitoring environmental parameters
- Altering environmental parameters
- Identifying OHS, legislative and organizational

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:

- Monitor environmental parameters are against the needs of the plants and enterprise guidelines.
- Require alter environmental parameters as, to meet the needs of nursery plants and market requirements.
- Identify and follow Applicable OHS, legislative and organizational requirements relevant to monitoring

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 your performance is satisfactory proceed to the next learning guide,

1.1 Introduction

The broad terms "non-timber forest resources" (NTFR) or "non-timber forest products" (NTFP) refer to natural resources collected from forests apart from sawn timber. For example, considered non-timber forest products to be "all the biological material (other than industrial round wood and derived sawn timber, wood chips, wood-based panel and pulp) that may be extracted from natural ecosystems, managed plantations, etc. and be utilized within the household, be marketed, or have social, cultural or religious significance".

Non-Timber Forest Products (NTFP) provide substantial inputs into the livelihoods of very large numbers of people in developing countries, and their production and use can constitute one of the main demands placed upon the forest resource. A complete understanding of the NTFP situation is therefore central to both the task of conserving and managing tropical forests, and of ensuring that these forests continue to contribute appropriately to the welfare of local populations. The Center for International Forestry Research (CIFOR) is conducting research in the field of NTFP.

Throughout the tropics hundreds of millions of people derive a significant part of their livelihood from a vast range of non-timber products that they harvest from forests. In many cases hunting and gathering practices have their origins rooted deep in the past and are based upon a highly developed understanding of forest systems. Economic development and improved communications lead to new opportunities for people hitherto/previously dependent on forests and to both new markets for their products and new competition from cultivated or synthetic substitutes. We know that the extent of dependence on these products is enormous but we have very little basis upon which to predict the likely evolution of the use of non-timber forest products or the future lifestyles of the people who depend upon them.

1.2 Environmental parameters

Environmental parameters include precipitation, underground water level, evaporation, historical air temperature, and construction weather conditions.

- **Environmental monitoring** is a tool to assess **environmental** conditions and trends, support policy development and its implementation, and develop information for reporting to national policymakers, international forums and the public.

  ✓**Air Monitoring -** is the systematic, long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air.

  - ✓ **Water Monitoring** can be defined as repeated (with a defined frequency) analysis of **water quality** in permanent points, data processing and prognosis of trends to support actions focused on interception and remediation of adverse anthropogenic impact on the aquatic environment.
  - ✓ **Waste Monitoring-** is a crucial part of any **waste** management strategy. Our clients need to make sure that levels of emissions from their projects or operations meet regulatory requirements for the health & safety of the community.
  - ✓ **Remote Sensing**- is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect **remotely sensed** images, which help researchers "sense" things about the Earth.

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 (2 point)

1. Environmental parameters include

   A. Precipitation B. Underground water level C. evaporation and temperature D. All

2. Utilization of Non-Timber Forest Products within household

   A. Social value B. marketed C. cultural or religious significance D. All

3. _____ is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance

A. Air Monitoring B. Water Monitoring C. Remote Sensing D. Waste Monitoring

Test II: Short Answer Questions

1. Define Non-Timber Forest Products (2 point)

   _____
   _____

2. _____ is a tool to assess **environmental** conditions and trends, support policy development and its implementation, and develop information for reporting to national policymakers, international forums and the public (2point).
3. _____ is the systematic, long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air(2point).

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

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

Information Sheet 2- Altering environmental parameters

2.1. Environmental parameters

Meteorological **factors** (**temperature**, wind speed, humidity, etc.) along with their climatological regimes (warm or cold anomalies and dry or wet periods, etc.), can **affect** both biological and chemical components of this interaction. Among the disruptive effects of climate change, ecological changes are particularly feared and monitored, also because of their influence on many aspects of human life.

Non-timber forest products are now big business, and numerous efforts are currently under way to promote the exploitation of these well-publicized and highly desirable tropical resources. Great attention has been focused on the selling process, e.g., on developing markets for different products, on implementing local processing and value-added strategies, and on ensuring an equitable distribution of the income that has been generated. Securing land tenure or usufruct rights for local collector groups has also been an important component of the development of these resources. Clearly, there are good reasons for emphasizing these socio-economic factors.

It is somewhat surprising, however, that the ecological factors associated with the exploitation of these forest resources have so rarely been addressed. Maintaining a reliable income flow over time requires that the forest resource upon which this flow is based be maintained as well. If this resource is depleted through over-exploitation, destructive harvesting or poor management, no new markets, cottage industry or land tenure system will make very much difference. In the long term, ecology is probably the real bottom line here.

2.2. Values of non-timber forest resources

Economic values

- Despite the immense importance of non-timber forest plant resources, their value is rarely taken into account in land-use planning.
- Nor are the economic values of these products and the services they provide rarely taken into account in assessing Gross Domestic Product (GDP).

- Cash income from the sale of NTFR can be very variable, however, even for the same resource category

Nutritional values

- Starchy staple food from a few species of cultivated plants form the bulk of peoples food in the tropics - either rice, maize, sorghum or millet (Gramineae), cassava (Euphorbiaceae) or potatoes (Solanaceae).
- In some parts of the tropics, the starchy staple foods are from sago palm (Metroxylon sagu), taro (Colocasia esculenta) or arrowroot (Maranta arundiacea). Bush meat commonly provides an important protein source in the tropics and gathered plant foods an important source of dietary supplements to the starchy staple diet.

Social and cultural values

- The social and cultural values linked to foods and medicines are a reflection of the value placed on NTFR. Even airfreight is used to transport edible and medicinal plants, regionally or internationally to meet culturally driven demand.

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. List and discuss Values of non-timber forest resources (5pts).

_____,

_____

2. What is the cause for altering environment (5pts)?

_____

_____

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

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

Information Sheet 3- Identifying OHS, legislative and organizational

1.1. Introduction

Safety is the safe of being free from danger. Occupational health and safety (OHS) information is discussed and shared with colleagues. As always we should be aware of safety requirements and attempt to observe safety rules in order to eliminate serious injury to ourselves or others. Basic cause of accidents is faulty attitude toward safety, Failure to recognize danger and Emotion. Non wood forest product collector should follow safety precautions required in terms of personal safety, work field safety, and tools and equipment safety to avoid injuries.

3.2. Legislative and organizational

Policies that change the extraction-cultivation cycle include land policies that affect title to land and security of tenure, laws that affect labour costs, and infrastructure policy that increases access to markets (and inputs). NTFP activities can also be affected by broader economic, trade and environmental policies. Lack of security of tenure or access, for instance, is likely to stimulate household strategies focusing on activities that generate short term returns, such as destructive harvesting and shifting cultivation. The incentives for households to engage in NTFP activities is also likely to be influenced by policy and other barriers to access to NTFP markets; or by price controls and other price distortions that depress returns. The ability of community-level institutions to control and manage forest use can be affected by a number of policies. These include policies that assert government control over the forest resource and over the land and rights of usage. Also broader policy measures, such as the drive to titling of land in Africa on the grounds that customary laws and communal ownership are an impediment to agricultural development.

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: Say true if statement is correct, False if statement is incorrect (2 point)

1. Non wood forest product collector should follow safety precautions required in terms of personal safety, work field safety, and tools and equipment safety to avoid injuries. _____
2. The ability of community-level institutions to control and manage forest use can be affected by a number of policies. _____
3. Non-Timber Forest Product activities can not affected by broader economic, trade and environmental policies._____

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

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

LG #54	LO #2- Perform gum, incense and resin identifications, extraction, processing and marketing

Instruction sheet

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

- Identifying potential areas and species
- Developing Strategic plan
- Marking matured gum, incense and resin bearing trees
- Tapping and extracting gum, incense, and resin
- Collecting tapped gum, incense, and resin
- Grading gum, incense and resin products
- Supplying graded gum, incense and resin to market

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 potential gum, incense, and resin producing areas and species based on their agro-ecological zone.
- Develop strategic plan for use of available resource based on financial and human resource.
- Mark matured gum, incense and resin bearing trees for tapping
- Tap and extract gum, incense, and resin using appropriate technologies.
- Collect tapped gum, incense and resin using appropriate materials
- Grade gum, incense and resin products based on quality standard characteristics
- Supply graded gum, incense and resin to market based on demand and organizational requirements

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- Identifying potential areas and species

1.1 Morphology, habitat and distribution

1. Gum: - is an amorphous sticky substance produced in the woods of hard wood and some conifers may be in response to injury, infection or other irritation.

- Are also polysaccharides of acid salts of sugars other than glucose.
- Formed due to disintegration of internal plant tissues (cellulose) through a process called ***gummosis.***
- Gums are soluble only in water not inorganic solvents.

There are two kinds of gums: -

A) Soluble gums – Which dissolve in water to from a transparent, viscous and adhesive solution.

B) Insoluble gums- they absorb water and swell in to a thick jelly like muckily

2. ***Resin****:* -Are substances actively synthesized and secreted by plants in a specified special canals or ducts.

   i. Resin canal and production occur in the xylem, phloem and bark of many gymnosperms and in some dicotyledons.
   ii. Chemically resins are polymerised substances mixed with volatile (essential) oils; they are insoluble in water organic solvents.

1. **Incense:** - Are the plant origin substances producing a pleasant smell. They are may be pure resin, gum resin (gum mixed with resin) or gum oleoresins (gum with resin and essential oils).

Natural gum tree species are found in many lowland areas of the country. They form one of the most widespread vegetation types of the country (*Boswellia-Acacia-Commiphora species*). Natural gum-bearing trees found in the administrative regions Amhara (true frankincense and gum Arabic bearing spp widely found in Gonder and Gojam, and sparsely in wello and Shewa), Oromia (gum Arabic and black incense of Borena), Bensgangule (gum Arabic), Somali region (gum olibanum-ogaden and gum myrrh), Gambella, Afar region (gum myrrh and Oppoponax), Southern Nations,

Nationalities and peoples (SNNPRS) (mzrrh-Sidamo and gum Arabic), and Tigray (gum olibanum with the highest quality and gum Arabic)

Difference between gums and resins

Gums are viscous substances which are secreted by the bark of certain trees. **Resins**, on the other hand, are gluey and viscous substances which may be whiteish, brownish, or red and are secreted by certain trees when they are incised. **Resins** contain an essence and are usually not water soluble.

1.2 Frankincense/ gum oilbanum

Boswellia is one of the 17 genera described in the family Burseraceae, which is estimated to encompass about 500-600 species worldwide (Vollesen, 1989; Kindeya Gebrehiwot et al., 2002). In Ethiopia, only two genera, namely *Boswellia* and *Commiphora*, have been recorded with a total of 58 species (Vollesen, 1989). The genus *Boswellia*, in turn, is composed of about 20 species in the dry regions of tropical Africa, including six in Ethiopia namely *B. papyrifera* (the common/true incense tree species. *B. papyrifera* is a tree of 12 m high, found at 950-1800 m, widely distributed in North and west part of the country and in large amounts in the Tigray, Gondar, Wollega and Gojam provinces and sparsely spread in Wello and Shewa (Vollesen, 1989). *B. rivae* (distributed in southern Ethiopia namely Sidamo, Gamo Gofa) and *B. ogadensis (*endemic) located in Acacia-Commiphora bush land (Hararghe, Bale, Sidamo, Gamu Gofa), *B. pirottae(*endemic *)*, *B. neglecta* and B. microphylla. *Boswellia* is widely distributed from West Africa to Arabia and South to Northeast Tanzania, also in India and one in Madagascar (Vollesen, 1989; Azene Bekele-Tessema *et al*., 1993; FAO, 1995). It is centered in Northeast Africa where about 75% of the species are endemic, including two in Ethiopia and five in Socotra (Vollesen, 1989).

Traditionally, plants of *B. papyrifera* with diameter at breast height (DBH) of 10-12 cm are said to be optimal for tapping. Trees with less than 12 cm DBH may not be able to recover their wound after tapping. Olibanum gum can be collected seven to nine times a year from a single olibanum resin-producing plant, with yield ranging between 100 and 1000 gm, and averaging at 500 gm per year. The life span of an olibanum gum bearing

plant is not precisely known, but is estimated between 25 and 50 years. Hence, such a plant could produce, on the average, 12.5 to 25 kg of olibanum gum throughout its life span. A resin period of up to two to three years is required for the space on the stem to be completed, especially when the wounding spots are about to meet or join one another. One taper collects, on the average, 10-12 quintals (1-1.2 tonnes) of gum olibanum (Wubalem et al., 2003).

Frankincense/olibanum resins (also called olibanum Tigray type) are mainly obtained from *B. papyrifera.* Frankincense is the dried, gummy exudation obtained from various tree species of the family Burseraceae. It is available in small tears or lumps of white-yellowish or yellow-reddish color, with a slight smell. Women carry out the cleaning and grading processes. Gum drops of export type are classified according to their size and purity in seven grades (black gerzo, 1st grade Tigray type, 2nd grade, Tigray type, 3rd grade Tigray type, Gum Humera type, Gum Harar/Sidamo type and Gum seyal) with the first four for exportation and the rest for local market.

At present, the parastatal, NGPME only export gum olibanum, myrrh and Oppoponax, and not gum Arabic that is exported by private companies. The commercial product is available in different qualities from dust, siftings, to tears; and they fetch different prices depending on the quality, size, color and species origin range between 0.6–1.5 US$/kg (Vivero, 2001), and now increasing this amount. In the period 1996-2000, the figure of exported Frankincense gum reached 2714.5 MT, producing an equivalent of more than 28.7 million BIRR in foreign currency. Germany imports a significant amount of Ethiopian incense gum (more than half of total exports) and France has also a great demand from the perfumery industry. Reliable data on the production and utilization of exudates in Ethiopia is not available. The national average annual output of exudates during the period 1978-1991 was 1500 tonne. Since 1992 production has leveled to over 2 000 tonne/year with nearly 50% of the production absorbed by export markets.

1.3 Myrrh

The Genus *Commiphora* includes 150-200 species up to 3 m high (Vollsen, 1989) reputed for their commercially valuable resins are named gum/true myrrh (*Commiphora myrrha, syn. C. molmol*) incense and gum Oppoponax depending on the species. This

resin is obtained from a small shrub, *Commiphora myrrh,* which is principally found in Ogaden, Bale and Sidamo. Several species of C*ommiphora* produce Myrrh, which are used locally. The chief *Commiphora* gum of highly economic importance is myrrh, produced by *C. myrrha*.

1.4 Gum Arabic

Acacia senegal is a multipurpose African tree (subfamily Mimosoidae, family Leguminosae), highly valued for centuries for gum Arabic production. Gum Arabic is another important NTFPs, which is obtained from natural stands and plantations of *Acacia senegal.* This species grows up to 2-6 m, occasionally 15 m high. It occurs in significant amounts in the provinces of Gojam and Gondar along the Sudan border (NFTA, 1991).

Today in Africa *A. senegal* is grown primarily for gum, but plays a secondary role in agricultural/agroforestry systems, restoring soil fertility, and providing fuel and fodder (NFTA, 1991). This tree occurs naturally on sandy soils, pH 5-8. About 7100 Km wide African "gum belt", and mainly in the 300 km wide "gum belt" (Central Sudan, Nigeria, Mali and western Ethiopia) where annual precipitation is around 300-600 mm and altitudinal range 100-1700 m in Sudan, to 1950 m around Nakuro, Kenya (NFTA, 1991; Danida, 2000). The "gum belt" is located from East Africa (Ethiopia) to West Africa (Senegal) including Tanzania (Figure 1 to be scanned and included). A total of 17 Acacia species were identified as producing gum in Africa which are collected by local communities-either for export and/or domestic use (Chikamai, 1996).

Areas in Ethiopia with relevant forest stands of *A. senegal* can be found in the western and southern part of the country namely west Tigray and Amhara, Benshangul, Gambela, SNNPRS and Borena zone in Oromia. Commercial gum Arabic from Ethiopia is produced mainly from four different botanical sources namely *A.senegal var.senegal*, *A.seyal var.seyal* and *fistula*, *A. Polyacantha* (Sheraro and Metema districts) and *A. drepanolobium* (Sidamo, Yavelo district), which are only, distinguished on the basis of different production areas. *A. senegal produces* gum Arabic with the highest quality. Gum of lower quality, also sold under the name of gum Arabic, is obtained from natural

stands of A. seyal (Arero and Negele districts) , a species widely found in the Rift valley depression, especially on sites subject to annual water logging.

Gum Arabic has been used for at least 4000 years (NFTA. 1991). It is dried exudation from the stems and branches of A. senegal or closely related species. Gum Arabic of Ethiopia from A. Senegal are in general of two types: Humera (Kordofan type) is produced from A. senegal var. senegal in the north and north western parts in the areas of Humera and Sherero (Tigray region) as well as Wello (Amhara region), while Sidamo type (characterized by high viscosity) is produced from var. kerensis in the southern (Sidamo, Oromiy region) and south eastern/Hararage (Fike and Hamero areas in Oromiya and Afar regions) parts (Chikamai, 1996). Annual production has never exceeding 300 tonnes and has declined due largely to the loss of trees, which have been cut down, for charcoal and fuel wood.

Africa is the world leading producers and exporter of Gum Arabic. Main producers and supplying African countries are Sudan (80%), Chad and Niger (NFTA, 1991), which may in the future Ethiopia also benefit in the international market. The yield per hectare per year of producer countries ranges between 30 to 40 kg in case of open stands and as much as 100 kg in case of dense stands. The price for the good quality gums ranges between 3-3.5 US$/Kg (Vivero, 2001).

Average annual production quantity for *A. senegal* is 250-300 tonnes/year where, about 150-200 tonnes/year from the north and 100 tonnes from south of the country while *A. seyal* is 50-100 tonnes/year (Chikamai, 1996). Annual production of gum Arabic (from *A. senegal* and *A. seyal* species) in the period 1988-1999 has been 300-400 tonnes. Species that contribute up to 95% of the total gum entering international trade comprising about 70% of *A. senegal and about 15-25% A. seyal.* The remaining about 5% is contributed in the main, by gum relatively low quality species *A. Polyacantha*, and *A. drepanolobium* (Chikamai, 1996). The current world production is around 40,000 tonnes per annum (Chikamai, 1998), and Ethiopia's share in the world market is rather negligible (100 MT in 1999).

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: choice best answer

1. Formed due to disintegration of internal plant tissues (cellulose) through a process called gummosis is _____

A. Incense B. Gum C. Resin D. All

2. Which dissolve in water to from a transparent, viscous and adhesive solution.

A. Insoluble gum B. Soluble Gum C. Resin D. all

3. Are substances actively synthesized and secreted by plants in a specified special canals or ducts?

A. Incense B. Gum C. Resin D. All

4. Resin canal and production occur in

A. Xylem, B. Phloem C. Bark of many gymnosperms D. All

5. Natural gum tree species are found in many lowland areas of the country

A. True B. False

Test I: Short Answer Questions

1. What are the two type of gum? _____ and _____
2. List some gum Arabic source of species.

_____

_____

_____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 2- Develop strategic plan

2.1. Purpose of strategic planning

Even within a species, however, it is possible for resin from different natural populations, as well as individual trees within the population, to have different chemical (and therefore different sensory) characteristics.

The **purpose** of **strategic planning** is to set overall **goals** for gum, incense and resin product and to **develop** a **plan** to achieve them. It involves stepping back from your day-to-day operations and asking where gum, incense and resin is headed and what its priorities should be.

The 5 Steps of the Strategic Planning Process

1. Determine your **strategic** position.
2. Prioritize your objectives.
3. Review and revise the **plan**
4. Execute and manage your **plan**
5. Develop a **strategic plan**

Strategies should map long-term **plans** to objectives and actionable steps, foster innovative thinking, as well as anticipate and mitigate potential pitfalls. **Strategic plans** often look out 3-5 years, and there may be a separate **plan** for each individual objective within the organization.

Who Should be Involved?

- those who will be implementing the **plan** (e.g. management, staff, volunteers);
- those who will be affected (e.g. members, users, etc);
- those who will monitor its implementation (e.g. Management Committee); and.
- others who can contribute to its development (e.g. community activists, funding bodies, etc).

2.2. Elements of a Strategic Plan

- Vision Statement.
- Mission Statement.
- Core Values.
- SWOT Analysis
- Long-Term Goals
- Action **Plans**.
- Yearly Objectives

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. Write the **purpose** of **strategic planning** (3pt).

_____

_____

2. What are the 5 Steps of the Strategic Planning Process (3pt)?

_____, _____,

_____, _____

_____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 3- Marking matured gum, incense and resin bearing trees

3.1. Marking

Tree **marking** can be undertaken for a number of purposes. For ease of identification, **mature** trees are taken for gum, incense and resin.

Gum exudes from cracks in the bark of wild trees. In Africa, it is regularly tapped from trees, which are about six years old by making narrow transverse incisions in the bark of stems and branches in February and March. In about a month, tears of gum form on the surface and are gathered. Trees begin to bear between 4-18 years of age and are said to yield only when they are in an unhealthy state owing to poor soil, lack of moisture or damage.

Trees or shrubs; branches often terminating in spines; outer bark often papery and peeling, inner bark usually greenish with resinous usually aromatic sap, wood with milky latex.

Gum production is carried out by collecting exudates from trees in natural stands by random picking from naturally and/or accidentally exuding trees by peasants and pastoralists. Gum collection is considered secondary as it is carried out while executing other activities perceived to be more important namely firewood collection and livestock.

The main tree species making up the broad-leaved deciduous woodlands of western Ethiopia other than B. papyrifera include Balanites aegyptiaca, Combretum adenogonium, C. collinum, C. molle, Terminalia spp., Grewia spp. Gardenia spp., Flueggea virosa, Acacia polyacantha, A. senegal, A. seyal and Sterculia setigera. Of these, B. papyrifera, A. polyacantha, A. senegal, A. seyal and Sterculia setigera are known to yield commercial gums and resins.

Figures 3.1: Acacia–Commiphora (small-leaved deciduous) dryland forest dominated by Commiphora and Boswellia species in the southeastern and northeastern parts of Ethiopia

Source ; worku (2006)

Figure 3.2: Semi-desert vegetation with scattered Commiphora and other species in northeastern Ethiopia (Afar). Photo © Lemenih M.

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 purposes of tree marking (5pt?

_____

_____

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-- Mark matured bearing trees

Objective to identify matured tree for gum, incense and resin collection

Procedures

1. Collect personal protective equipment and wear them while you are producing gum, incense and resin tree species
2. Identify materials, tools and equipment that are important for producing gum, incense and resin tree species
3. Check all materials, tools and equipment is to be functional.
4. Follow safe operation and maintenance of the working environment.
5. All tools used shall be kept in good working condition, be properly sharpened where applicable, and should be restricted to the use for which they are intended.
6. Mark mature gum, incense and resin bearing trees

4.1. Tapping

Tapping is the artificial wounding of the stems and branches of trees for the production of gums and resins. It involves shallow blazing (wounding) of the stems and branches by shaving off the bark using a sharp instrument, locally available..

i) Boswellia and Commiphora spp Tapping of Boswellia trees takes place during the dry season, starting in late September, and continues until March. Tapping for frankincense involves making incisions in the bark and the phloem with a special tool locally known as “mingaf”. The gum solidifies while on the trees and it is collected every three weeks. Gum olibanum is available in small tears or lumps of white yellowish-reddish colour (Ogbazghi, 2001). After collecting the dried resin, the original wound is re-opened to allow a steady flow of the more resin. Seven times per harvest season, each tree, is revisited and wounded. Off-season rains may interrupt tapping and resin collection activities.

According to the tappers, tree size determines the number of tapping points per individual tree. Small trees ranging 10-20 cm in diameter are tapped at four points and larger trees at six points. The tapping points should be facing east and westwards, as this is believed to enhance the yield. In spite of these guidelines, over-tapping and use of inappropriate tapping methods by unskilled labourers take place and damage Boswellia trees (Ogbazghi, 2001). Natural regeneration was only found in non-grazing areas with untapped Boswellia stands. How tapping affects the reproductive cycle, particularly the production of viable seeds is still unknown.

ii) Tapping of Acacia spp.

The Sudanese introduced the business of gum arabic collection to Eritrea in the early 1950s. However, owing to the protracted war of liberation (1961-1991) this resource is not exploited to the fullest. There are various ways of obtaining gum arabic. The first is the collection of natural gum exudates collected from trees and the second is tapping acacia trees for gums. Some farmers and pastoralists collect from acacia species gums that ooze naturally. In this case, the gum collection is not their sole occupation, and

hence they accomplish collection side by side with herding and farming activities. The second way of getting gums is tapping trees. This is particularly true for Acacia senegal and Acacia seyal. Presently, most of the gum comes form naturally growing trees. Acacia plantations have been initiated as part of the forestation and reforestation efforts as well as to integrate the acacia species into the farming systems as an agro forestry intervention. The idea is to grow these multipurpose trees as alley crop or border shelterbelts to mitigate the adverse effects of land degradation. Integrating of this valuable species into the farming system would not only enable farmers to obtain maximum yield from the sale of gums but also get fodder to their livestock and wood for fire to their households. Tapping of Acacia for gums starts at the beginning of the dry season. Good rainfall followed by dry and hot weather conditions are favourable for obtaining good harvest of gums. Gum production per tree increases with increase in the local temperature. Cold season may reduce or even stop gum production. Unusual rains may also interrupt gum collection.

Dry forests comprise the largest forest resources in Ethiopia. Their contribution to rural livelihoods, the national economy and ecosystem stability is significant, although not yet properly accounted for. An important feature of Ethiopia's dry forests is their richness in Acacia, Boswellia and Commiphora species. These trees are the source of gums and gum resins, which are the most important export commodities of the Ethiopian forestry sector. During the past decade, the total export volume and foreign currency earnings from gums and gum resins have increased. However, it is important that this increase in the volume of products is accompanied by responsible forest management.

Photo 1. Partial views of dry forests of Ethiopia (upper left: *Acacia-Commiphora* forest in Borana, southern Ethiopia; upper middle and right: *Boswellia* forest in Metema, north-western Ethiopia) and their gum resins (bottom row, from left to right: frankincense, gum arabic, gum talha and myrrh).

Figure 4.1.Extracted gum Arabica and myrrh

An extract is simply the soluble portion of the resin produced by treatment of the raw material with a suitable organic solvent, with or without the application of heat. The terms ‘resinoid’ and ‘absolute’ are frequently applied to resin extracts although the terms are not used rigorously or consistently and this sometimes leads to confusion. Strictly, resinoids are extracts of the resin (whether it be frankincense, myrrh or opoponax) in which the solvent is a hydrocarbon or has a hydrocarbon nature. An absolute is a highly concentrated alcoholic extract of the resin, prepared either directly from it or from the previously prepared resinoid.

- The insoluble part of the extract consists of any foreign matter such as pieces of bark, sand or dirt and any organic matter which is insoluble under the conditions of the extraction.
- The soluble extract is separated from the insoluble part by decantation or centrifugation, or by filtration using a filter press after addition of filter aid. The solvent may be retained to give a liquid extract or evaporated off to give a soft (semi-solid) or hard (solid) extract, depending on how much solvent is removed.
- The extraction yield depends very much on the quality of the raw resin.
- The hard extract is a glassy solid, pale brown or amber in the case of frankincense and darker for myrrh and opoponax.

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. What is tapping (3pt)?_____
   _____
2. What are the foreign matters that exist in insoluble part of the extract?
   _____
   _____
3. How separate the soluble from insoluble extracts

_____
_____

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-- Tap and extract gum, incense, and resin

Objective: To facilitate the gum, incense, and resin collection

Procedures:

1. Collect personal protective equipment and wear them while you are producing gum, incense and resin tree species
2. Identify marked gum, incense and resin tree species
3. prepare materials Tapping and extracting gum, incense, and resin
4. Tapping involves making incisions in (wounding) the tree body.
5. Incisions are made by shaving off the bark of the trees using sharp instruments.
6. The depth, intensity and frequency of the incisions vary according to the tapper, as no standards, training or monitoring apply to the practice
7. Repeatedly tapped at intervals of 30-40 days throughout the dry season for up to 3 or more years
8. Follow safe operation and maintenance of the working environment.

5.1. Collecting tapped gum, incense, and resin

Harvesting of natural gums, including frankincense, is believed to have a long history. In Ethiopia, harvesting of natural gums is done manually by labor-intensive traditional methods of tapping. One Governmental and several nongovernmental organizations are actively involved in frankincense production and commercialization activities in different regions of the country. Tapping and collection of frankincense is carried out following a specific pattern around mid-September up to the offset of the dry season, usually June. The technique of tapping usually involves the shaving of a very thin, i.e. 2 mm deep and 4-8 mm wide, external circular layer of the bark starting at 0.5 m from the base of the stem using a hand tool, locally known as 'Mingaf' (Fig. 1B) (Girmay, 2000).

Once the first tapping is done, the second tapping will take place after 30-40 days, and involves a moderate widening of the wound, which will be started during the first tapping. This tapping process will continue for three to four months until the wound has reached 4 cm in width. Usually three such tapping spots are made on each side of the plant, but they could also be four in some cases. Thus, six to eight tapping spots are made as a whole on each plant depending on its size (Girmay, 2000). After each wounding/incision, the exudate starts to ooze and becomes dry in two to three weeks when it will be ready for collection. The wound is renewed immediately while collecting the gum to prevent the hole through which the exudate comes out from drying. The whole process is repeated at intervals of two to three weeks until the onset of the rainy season.

The collection of gum olibanum is normally stopped during the first week of June since the plant starts producing leaves, which enable it to start the process of photosynthesis. During this period (October-June), one taper collects, on the average, 10-12 quintals, and an average of 500 g of frankincense is obtained from individual trees per tree per season (Girmay, 2000).

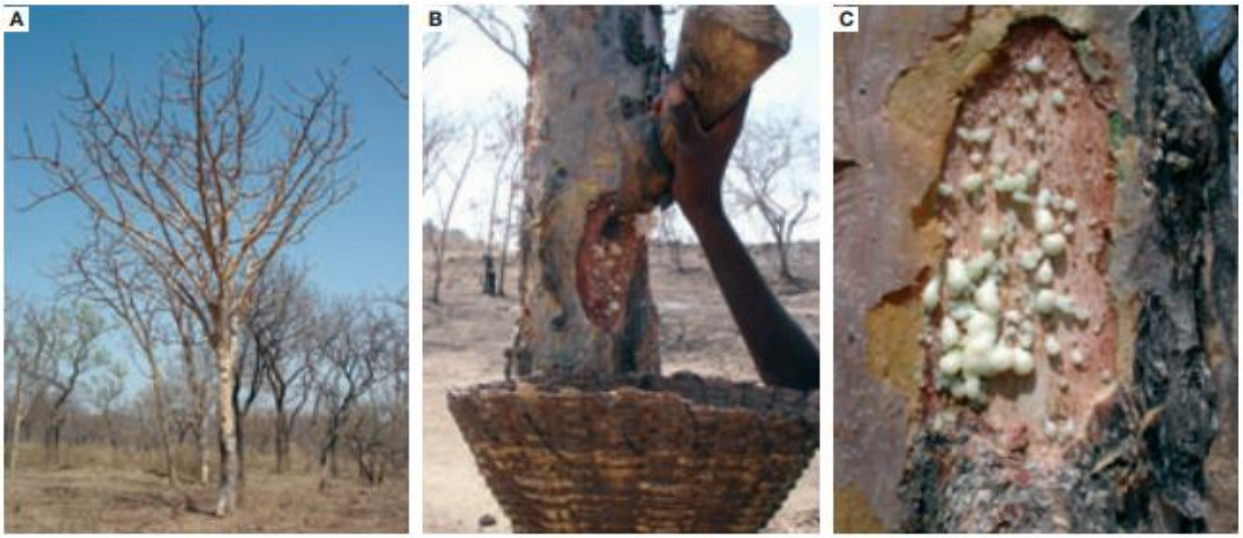

Figure 1. Tapping of *B. papyrifera* tree and collection of frankincense. A: *Boswellia trees*. B; Tapping and collection of frankincense from the tree and; C: tapped tree with frankincense exuding.

Gum tapping in Ethiopia differs from place to place and, hence, there is no one described method considered as standard (Mulugeta and Demel, 2003). A common tapping practice for gum olibanum in the north is by scrubbing the bark of frankincense trees using local tools. Tapping depth, width, frequency, etc. are all dependent on the experience of local tapper.

- In the south and south-eastern parts of the country, incense that oozed naturally is collected.
- In these parts of the country the producers are herdsmen, women and children (Mulugeta et al., 2003).
- Gum/resin collection is not their sole occupation, but they accomplish collection side by side with herding.
- Similarly, the majority of gum arabic and gum Commiphora (myrrh, hagar, opopanax, etc.) in Ethiopia are collected from natural exudation.
- Exception is in the northwest of Ethiopia where small scale tapping trial is exercised for the production of gum arabic.

Self-Check – 5	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 tapping and collection of frankincense in Ethiopia (3pt?

   _____
   _____

2. What is Method of harvesting of natural gums in Ethiopia?

_____
_____

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1—Collect tapped gum, incense, and resin

Objective: To supply the products to local and national market

Procedures

1. Collect personal protective equipment and wear them
1. Identify the tapped trees for gum, incense and resin
2. Prepare collection materials
3. Picking of incense tears from stems after maturity
4. Use vessel for collected gum, incense, and resin

5. Store in appropriate places until marketing

6.1. Grading

The harvested resin is first stored in temporary stores established at the harvesting sites. Later on, it is transported to permanent stores for processing. Processing of the resin involves the manual cleaning, sorting and grading of the raw product, which is usually done by women. Accordingly, the collected gum is sorted into five grades on the bases of size, colour and brightness (Girmay, 2000).

The final products are, then, sold in international markets (the first 2 quality grades) and the least qualities for domestic use, which will be used in coffee ceremonies, churches, etc

6.2 Process of Gum, Incense and Resin Products

Processing of natural gum at the processing centers involve manual cleaning from impurities, selection and grading principally based on color and tear sizes. In the case of gum olibanum (Tigray type), sieves of different mesh sizes, 6, 4 and 2 mm, are used to sort the tear granules into different size grades, while eye sorting is done for color. Five major grades are identified at most processing centers, sometimes refined sub-divisions as first choice grade A, first choice grade B, second grade, third grade, fourth grade special and normal, etc. are observed in commerce.

The first choice grade olibanum is a bigger and pure white tear, a second grade is a pea size and whitish tear, third grade called sifting are fine but white pieces. The fourth grade consists of bigger granules of brown to dark colored tears, and finally the fifth grade called grablings consist a mixture of powdery resins of both darker and whiter pieces as well as impurities like bark that are often left behind. All the grading like the collection is done manually. While the first, second and third grades are exported, the fourth and fifth grades are sold on domestic market. No grading is done for the Ogaden and Borena quality olibanum. On the other hand, myrrh is sorted into five grades (grade 1 to 5), while gum arabic & talha in most cases are only cleaned but not sorted into different grades. Information obtained from the various enterprises engaged in natural gum trade indicate that prices for the various natural gum and quality grades are more or less stable for the last five years.

After seasoning in the field under shade, the incense is transported to permanent warehouses for further processing. Processing of Tigray type olibanum involves cleaning, sorting and grading of the gums. The entire operation is manual and is usually done by women.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: choice the best answer (3 Pts. each)

1. Processing of the resin involves

A. Manual cleaning B. sorting C. grading of the raw product D All

2. One of the following is /are the base for grading gums

A. Size B. Color C. Brightness D. All

3. Which one is not aim of transporting incense to permanent warehouses?

A. Further processing B. Cleaning C. Sorting and grading D. tapping tree

4. The first choice grade olibanum is __

A Pea size and whitish tear B bigger and pure white tear

C. bigger granules of brown to dark colored tears D All

5. One of the following is not export standard

A. First grade B Second grade C. Third grade D Forth grade E. C and D

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-- Grading gum, incense and resin products

Objective: To rank the gum, incense and resin products

Procedures

1. Collect personal protective equipment and wear them
2. Transport the collected gum incense and resin to warehouse
3. cleaning,
4. sorting and
5. grading of the gums
6. store in appropriate places

7.1 Supplying graded gum, incense and resin to market

Gum arabic is the oldest and best known of all natural gums. The genus Acacia is the second largest within the Leguminosae family (sub family Mimosoidae) and contains at least 1,000 species. A total of 17 Acacia species were identified as producing gum in Africa which are collected by local communities-either for export and/or domestic use (Chikamai, 1996). The gum arabic-yielding Acacia species grow in semi-arid areas and the vast majority of gum arabic, which enters international trade, originates in the so-called gum belt of Sub-Saharan Africa, extending from the northern parts of West Africa eastwards to Sudan and Ethiopia. A little gum is of Indian origin (Chikamai, 1996). Gum arabic from Sudan (from the Kordofan region) is the highest quality and sets the standard by whichother «gum arabics» are judged (Verbeken et al., 2003). Gum arabic samples collected from A. senegal from North-Western Ethiopia (Metema), showed a nearly identical chemical properties with a gum sample of the same species obtained from Kordofan (Ermias, 2003). Commercial Acacia gum from Ethiopia is produced from different botanical sources. Gum arabic of commerce is produced from A. senegal, A. seyal and A. polyacantha, which are only distinguished on the basis of different production areas (Chikamai, 1996; Getachew and Wubalem, 2004). Annual production of gum Arabic from A. senegal and A. seyal species in the period 1988-1999 was 300-400 tone. A. senegal comprises about 70 % and A. seyal about 15–25% of the species that contribute up to 95% of the total gum entering international trade. The remaining 5% which is relatively low quality gum is contributed mainly by A. Polyacantha and A. drepanolobium (Getachew and Wubalem, 2004).

7.2. Native plant species Ethiopia's drylands

Ethiopia's drylands are endowed with native plant species in the genera Acacia, Commiphora, Boswellia and Sterculia, important tree species known to produce commercial gums and gum resins.

Major gums and gum resins of international commerce produced in Ethiopia are

- gum arabic,

- frankincense/olibanum,
- myrrh, opoponax and
- gum karaya.

Gum arabic of commerce in Ethiopia is obtained from two Acacia species: Acacia senegal and A. seyal both of which are collected and traded separately. Frankincense/olibanum is a gum resin tapped from several species of the genus Boswellia, and in Ethiopia five Boswellia species produce three different quality olibanum namely Tigray, Ogaden and Borena type frankincense. Myrrh, opoponax and myrrh like gum resins are products of Commiphora species, several of which are either indigenous or even endemic to Ethiopia. Gum karaya is produced by species of the genus Sterculia mainly from the species Sterculia setigera, which is also indigenous to Ethiopia. The commerce of gum karaya is undeveloped in the country unlike the other gums and gum resins.

Enterprises engaged in natural gum production and marketing in Ethiopia acquire the products from two sources:

ii) from products collected by hired tappers from forest stands obtained through concession and,

iii) direct purchase of gum/resins collected from local collectors (farmers/nomads or producer cooperatives).

The collected gum/resin is filled in sacks and stored in temporary stores in the field, some times for prolonged period as the stores are located far off-road, until transportation is organized for delivery.

The marketing starts from producer intermediary exchange where producers are selling the products to intermediaries. The intermediaries carry the products to established sellers in the local market.

7.3. Factors affecting the commercialization of the resources

i) **Location/Inaccessibility of the Resource Sites**

Production, processing and marketing of natural gum in Ethiopia is also hampered by the inaccessibility of gum producing regions since they are located far from ports or market centres. In most cases the gum must be transported over 1000 kilometres of

rough roads to the capital for processing and packing, and then to the port of Djibouti for shipment, which ultimately escalates the cost of production. In addition security risks in boarder areas contribute to the high production and/or transport cost.

ii). Lack of Quality Awareness

Lack of quality awareness and backwardness of production, storage, processing and transportation techniques are among the limiting factors for good prices and thus expansion of natural gum commercialization in Ethiopia. Therefore, the need to improve the quality, particularly purity of gum and resins produced and marketed in order to retain or increase markets cannot be over-emphasized.

iii). Uncontrolled Trade and a Sluggish Transaction in Export Trade

Registered enterprises complained that lack of control on both domestic and export trade of gum resin products in Ethiopia is affecting the expansion of official commercialization of the product. The fact that unregistered traders do not pay tax is affecting the competitiveness of registered tax paying traders and is discouraging the later groups from expanding their commerce of gum resin products of the country. It is also indicated that too slow transactions in export trade is holding money for long time and is affecting the turnover, and thus the quantity of trade per year.

Self-Check – 7	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 the major gums and gum resins of international commerce produced in Ethiopia (5 pts)

   _____

   _____

2. What are Factors affecting the commercialization of the resources? (3 pts)

   _____

   _____

3. What are the two sources of Enterprises engaged in natural gum production and marketing in Ethiopia acquire the products? (4 pts.)

   _____

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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 Mark matured bearing trees

Task-2 Tap and extract gum, incense, and resin

Task-3 Collect tapped gum, incense, and resin

Task-4 Grading gum, incense and resin products

LG #55	LO #3- Produce Mushrooms

Instruction sheet

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

- Setting criteria for identification of edible mushrooms
- Identifying edible mushrooms
- Preparing required materials
- Cultivating and managing edible mushroom
- Collecting and packing edible mushrooms
- Supplying packed edible mushrooms for market

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**:

- set Criteria for identification of edible mushrooms from poisonous ones
- identifY Edible mushrooms from poisonous mushrooms based on various identification criterion
- Require materials like agar and growing media are prepared for cultivation and utilization of edible mushrooms.
- Cultivate and manage edible mushroom based on organizational requirement
- Collect pack, and make edible mushrooms are ready for market.
- Packed edible mushrooms are supplied to local market in accordance with hygienic requirement and market demand

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- Setting criteria for identification of edible mushrooms

1.1. Introduction

Mushrooms are fungi, generally considered to be lower forms of life, belonging to the plant kingdom. There are about 45000 known species of fungi and about 2000 of them are considered edible. Of these, less than 25 species are widely accepted as an item of food and only about a dozen of them have been commercially cultivated.

The term **mushroom** is generally used to denote the edible fleshy fungi. The poisonous ones are called the toadstools. Both of them represent a short stage in the lifecycle of fungi.

Many of the important commercially hunted forest mushrooms form a symbiotic association with the roots of some tree species to form a new structure, called mycorrhizal (Fungus-root). It may be possible to enhance the growth of mycorrhizal through the inoculation of seedlings (or other forest management practices), and in this way combine wood fibre and non-timber production.

Why Mushrooms

- Rich in Proteins, Vitamins and Minerals
- Do not contain cholesterol
- Low in calories
- Considered health food and are medicinal
- Cultivation generates income, food and job
- Mushroom spent waste or compost used as fertilizer and animal feed.
- High Riboflavin, thiamine and Nicotinic acid
- Good source of essential Minerals such as calcium and phosphorous

Many **mushrooms** can be identified only by examining the color of spore prints or by examining spores and tissues under a microscope. Look for **mushrooms** with gills that are brown or tan. While some **mushrooms** with white gills are **edible**, the most deadly and poisonous **mushroom** family—Amanitas—nearly always have white gills.

Select **mushrooms** without red on the cap or stem. Choose **mushrooms** with white, tan or brown caps and stems.

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. Define mushroom(3 pts)

   ---

2. Many of the important commercially hunted forest mushrooms form a symbiotic association with the roots of some tree species to form a new structure, called_____. (3 pts)
3. Many mushrooms can be identified only by _____ or _____(4 pts)

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

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 2- Identifying edible mushrooms

2.1. Classification of Mushrooms

All edible fungi under cultivation in to 2 groups

A. Ascomycotina

Among Ascomycotina only very few are edible. E.g. Morchella Spp. and Tuber spp.

Majority of Ascomycotina are small and only few are fleshy. They have a special spore-forming cell called Ascus. Ascus is a sac like structure containing 8 ascospores.

B. Basidiomycotina

Majority of edible fungi (Mushrooms) are

- Group- Basidiomycotina
- Class - Basidiomycetes
- Order - Agaricales
- Mushrooms do not have green chlorophyll bodies that help manufacture their own food.
- Should be provided with food like cellulose, glucose and starch which with the help of enzymes, they produce are broken down into smaller molecules and absorbed by hyphae for the growth and development. Resulting cell (Fruiting body) store a lot of Nutrients.

2.2. How Mushrooms Grow in Nature

- Produce spores
- Spores are very minute and microscopic
- Spores dispersed through wind
- When they happen to fall on decaying wood, straw, manure and litter or on the ground the spores germinate and develop mycelia
- Under natural conditions the mycelium lives buried in the soil or in the substratum.
- When conditions are favourable the reproductive structures (fruiting bodies) are formed.

- These structures of Ascomycotina are called Ascocarp
- Basidiomycotina-Basidiocarp

2.3. Identification of edible Mushrooms

Natural mushroom flora of any area varies according to climate, vegetation etc. There are a number of edible mushrooms native to each locality. They occur only during the particular season. With certain amount of experience and knowledge the edible mushrooms can easily be identified.

The essential parts of a mushroom as described earlier are the pileups, gills and stipes. By careful examination of these parts, the characteristics of a collected mushroom can be studied. For a detailed study of the same a microscope is essential.

The following guidelines will help in enumerating the characters of an unknown mushroom. With little experience and patience and using a microscope one can easily master the technique and can identify our common mushroom flora.

2.4. Poisonous Mushrooms

There are a number of mushrooms, which are poisonous. It is often a very difficult proposition to properly identify the edible mushrooms from the poisonous ones. There is no easy to follow rule or prescribed standards to identify them. It can be done only by the identifications of the particular species. Some tests are often suggested, but none are reliable. It is stated that silver spoon or silver coin would turn blackish when they are dipped in a dish of poisonous mushrooms, exudations of milky substances from damaged fruit bodies.

In fact only very few mushrooms are really poisonous. Even the well proved edible ones may sometimes show allergic reactions to individuals. Some of the highly poisonous ones are – *Amantita phalloides* (death cap.) *A*. *Pantherina* (Panther cap.) *A. Muscaria* (fly agaric) *Inocybe patouillardi*), *Cortinarius speciosissimus, C.orellanus* etc.

Always use only known species collected wild for food purpose. It is always advisable to check the edibility by taking a small quantity of the same first, even in proven cases. Use only fresh and undamaged mushrooms. Poisoning by secondary invaders like bacteria, fungi, insects etc., are also known. Consuming alcohol after taking mushroom

is also known to cause allergic reactions especially with some of them like species of Coprinus. Some of the mushrooms are deadly poisonous. These are grouped into four basic types.

Among these the protoplasmic toxins are the most serious ones.

1**. Protoplasmic toxins**

The important group under this is the species of Amanita like A. Phalloides, known by the common name, 'Death cap' and *A.virosa,* the "Destroying angel". No other group of mushrooms has such complex toxins. The toxins are of two groups, Phallotoxins and amatoxins. In the Death cap, there are six related phallotoxins and five amatoxins.

Thus, eating such poisonous mushrooms can result in complex symptoms like abdominal pains, diarrheal and vomiting. If proper treatment is not given, the patient dies soon by kidney and liver damage. The only helpful treatment is early dialysis.

2. Muscatine poisons

A second group, known as Muscatine poison affects the central nervous system, resulting in vomiting, profuse sweating and convulsions. ***Amanita muscaria*** is the best example for this. Others of the group are some of the species of Clitocybe. Inocybe etc. Atropine is used as an antidote for this type of poisoning.

3. Gastro-intestinal irritants

A number of species of mushrooms cause digestive disorders. Species of the genera, Coprinus, Lactarius, Tricholoma, Russula etc., are some of the examples. However, in most cases the irritant substances are destroyed while cooking.

Common Poisonous Mushrooms

1. Amanita muscaria
2. Amanita phalloides(Death Cap)
3. Amanita virosa (Destroying Angel)
4. Cortinarius speciossimus
5. Inocybe patouillardii

Self-Check – 2	Written test

Name…… ID…… Date…….

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

1. **Test I: choice the best answer** (**2pts each)**
2. Ascomycotina that having a special spore-forming cell called _____ (2pts)

   A. Ascocarp B. Ascus C. Basidiomycotina D muscaria

3. Which one of the following is correct about Basidiomycotina**?**

   A. Group -Basidiomycotina B. Class –Agaricales C. Order- Basidiomycetes D.all

4. The structures of Ascomycotina are

   A. Ascocarp B. Ascus C. Basidiomycotina D muscaria

5. Which one is not Common Poisonous Mushrooms

   A. Amanita muscaria C. Basidiomycotina

   B. Amanita virosa D. Amanita phalloides

6. How Mushrooms Grow in Nature?

   A. By Produce spores C. on decaying wood, straw, manure and litter

   B. Spores dispersed through wind D. All

7. The essential parts of a mushroom as described earlier are

   A. Pileups B gills C. stipes. D Alll

Note: **Satisfactory rating – 7 points** **Unsatisfactory - below 7 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 3- Preparing required materials

3.1. Potato dextrose agar (PDA)

Usually for culturing Mushrooms, Potato dextrose agar (PDA) or oats agar medium is mused. The PDA is prepared by using 250 g peeled and sliced potatoes, 20 g glucose or ordinary white sugar and 15 g agar per litter of water.

- Cook the potatoes in 500 ml water for 15 minutes or until they are soft and filter the extract. Melt the agar in another lot of 500 milliliter water.
- Mix the 2 solutions and make up the volume to 1 litter and dissolve 20 g of glucose in this solution.
- **OATS AGAR** Cook 50g oats in 500 ml water and take the extract filtered through cloth.
- Mix this with melted agar.
- Addition of glucose is not necessary for oats agar.
- The media thus prepared can be kept in convenient containers for sterilization
- Usually in laboratories they are taken in 250 ml conical flask or in test tubes.
- For ordinary purposes of the Mushroom growers it can be taken in empty liquor bottles (350ml) at the rate of about 15 to 25ml per bottle.
- The containers are closed with cotton plug and sterilized in an autoclave or pressure cooker at 1.02 kg/cm2 pressure for 20 minutes.
- After this the media bottles are taken out and allowed to solidify with the bottles lying flat /slanting position on the table.
- When cooled and solidified they are ready to be used

3.2. Materials and equipment

The substrate on which button **mushroom** grows is mainly prepared from a mixture of plant wastes (cereal straw/ sugarcane bagasse etc.), salts (urea, superphosphate / gypsum etc), supplements (rice bran/ wheat bran) and water. In order to **produce** 1 kg. of **mushroom**, 2.2 kg of dry substrate **materials** are required.

Materials used for substrate

- Plastic bags (polypropylene 7” x 12.5”)
- Plastic necks (about 4 cm diameter)
- Cotton plugs Cover filters (square piece of filter paper)
- Rubber bands Sawdust (cover top of substrate pile with rice sacks to maintain humidity)
- Rice bran
- Calcium sulfate
- Calcium carbonate
- Magnesium sulfate

Materials used for inoculation

- Alcohol lamp
- Sorghum coated with spawn
- Fire
- Square paper (5’’ x 5’’)
- Rubber bands
- Cotton Alcohol
- Pasteurized substrate bags

Materials used for tissue culture

- Special needle (insulated handle)
- Alcohol lamp
- Alcohol
- Cotton (gauze)
- Matches or lighter
- Bottles with PDA
- Laminar flow cabinet (or protected environment)
- UV lamp

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. List Materials used for tissue culture (5 pts.)

   _____

2. What is PDA? (3 pts.)

   _____

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-- Prepare media from PDA materials

Procedures for PDA preparation

The PDA is prepared by using 250 g peeled and sliced potatoes, 20 g glucose or ordinary white sugar and 15 g agar per litter of water.

1. Cook the potatoes in 500 ml water for 15 minutes or until they are soft and filter the extract. Melt the agar in another lot of 500 milliliter water.
2. Mix the 2 solutions and make up the volume to 1 litter and dissolve 20 g of glucose in this solution.
3. **OATS AGAR** Cook 50g oats in 500 ml water and take the extract filtered through cloth.
4. Mix this with melted agar.
5. Addition of glucose is not necessary for oats agar.

6. The media thus prepared can be kept in convenient containers for sterilization
7. Usually in laboratories they are taken in 250 ml conical flask or in test tubes.
8. For ordinary purposes of the Mushroom growers it can be taken in empty liquor bottles (350ml) at the rate of about 15 to 25ml per bottle.
9. The containers are closed with cotton plug and sterilized in an autoclave or pressure cooker at 1.02 kg/cm2 pressure for 20 minutes.
10. After this the media bottles are taken out and allowed to solidify with the bottles lying flat /slanting position on the table.
11. When cooled and solidified they are ready to be used

Information Sheet 4- Cultivating and managing edible mushroom

4.1. Mushroom cultivation

Mushrooms are commonly used for various dishes in different shapes and forms. The most commonly and easily cultivated mushrooms in ethiopia are oyster mushrooms (*Pleurotus Ostreatus*), ear mushrooms (*Auricularia polytricha*), shitake, Button and straw mushrooms (*Volvariella volvacea*).

Mushroom cultivation can be summarized with the following major steps:

Step 1. About mushrooms

Step 2. Producing PDA medium

Step 3. Selecting tissue culture

Step 4. Multiplying spawn on sorghum seeds

Step 5. Producing substrate bags

Step 6. Pasteurizing bags

Step 7. Inoculating bags with sorghum seeds

Step 8. Incubating bags

Step 9. Opening bags

Step 10. Maintaining and monitoring

Step 11. Harvesting

Step 12. Cultivating straw mushrooms

Step 13. Packaging

Step 14. Marketing

Step 15. Processing

Step 16. Waste management and recycling

Step 17. Troubleshooting

Step 18. Preparing the mushroom house

Step 19. Starting the business

Step 20. Keeping records

Step 1. About mushrooms

There are three different groups of mushrooms. Selecting the right type of mushrooms to be cultivated must be based on climatic conditions and market demand. Mushrooms offer a wide range of proteins, vitamins and minerals necessary for the body and are becoming more popular and in demand.

Step 2. Producing PDA medium

How to well prepare spawn production is necessary for proper spawn multiplication. This part can be extended in further projects, in the case where a disabled person wishes to expand his knowledge and start spawn production. Only those trainees that are especially interested in this part will have specific activities and hands on training. In general, this part will be only theoretical.

Step 3. Selecting tissue culture

A young, fresh and very healthy mushroom is used to prepare a tissue culture. This procedure is very delicate and requires extensive understanding and an extremely clean environment. It may not be suitable for beginners in mushroom cultivation.

Step 4. Multiplying spawn on sorghum seeds

This is also a highly specialized part of mushroom production and will attract only a few trainees due to its complexity. Therefore, only basic theory will be given, mostly in the classroom. Trainees should, however, know how to select and buy good quality spawn from various suppliers. They should also know all steps involved in mushroom cultivation to allow future expansion of their mushroom farm.

Step 5. Producing substrate bags

Extensive practice will be required by trainees to make sure that they can produce spawn bags by themselves or be able to verify the quality of bags of spawn bag producers. This is hands-on training and will be, with the subsequent steps, the focus of training.

Step 6. Pasteurizing bags

Pasteurization is necessary to completely sterilize substrate bags. If bags are not properly pasteurized due to insufficient residence time in the pasteurization chamber or because temperature is insufficient, bags will be contaminated resulting in poor growth of mushrooms or complete spoilage of bags.

Step 7. Inoculating bags with sorghum seeds

Inoculation must be done with extreme caution. It is an extremely delicate step that will ensure higher yield with disease free substrate bags. Work must be done near a flame from an alcohol lamp during inoculation.

Step 8. Incubating bags

During incubation, moisture, light, temperature and ventilation must be monitored constantly. Incubation time will differ according to the type of mushroom and climatic conditions.

Step 9. Opening bags

Following incubation, mushroom bags must be opened according to the type of mushrooms.

Step 10. Maintaining and monitoring

Maintenance of the mushroom house is crucial for higher yields. When kept clean, there are less insects and pest, less disease. Bags must be checked individually and kept clean.

Step 11. Harvesting

Harvesting should be done at least twice a day to ensure that mushrooms are selected young and healthy. When harvested at the right time, not too big, mushrooms can keep

for a longer time and their taste is sweeter and more delicious. Depending on the type of mushroom, one substrate bag can produce a total of 250 to 500 grams of mushrooms.

Step 12. Cultivating straw mushrooms

Straw mushrooms are very popular in South East Asia and are cultivated using a straw bed. Because of their popularity and market demand, it is interesting to learn how to cultivate this type of mushroom.

Step 13. Packaging

When selling on the fresh food market or from the farm directly very little packaging is required. Most people use plastic or paper bags.

Step 14. Marketing

Marketing remains the key to a successful enterprise. Care must be taken to always review the competition and to offer clients reliability of supply and quality of mushrooms.

Step 15. Processing

Processing of mushrooms is limited only by a person's imagination. There are already numerous methods and recipes, which can offer value, added products. Nevertheless, in rural areas, the market may be small because of financial limitations.

Step 16. Waste management and recycling

Waste must be handled properly in each step of the mushroom cultivation process. Recycling and utilization of waste is not only a good way of preserving our environment but also of saving money.

Step 17. Troubleshooting

It is necessary to know the most common problems found in mushroom production, their symptoms and their remedies. Although this section will never replace the advice of an expert, it should help solve basic problems and help identify problems before they occur.

Step 18. Preparing the mushroom house

Mushroom houses can be built for as little as 500 Baht (US$ 12) made of readily available yet appropriate materials such as rice straw, grass, dried leaves, used rice bags and tree branches.

Step 19. Starting the business

As an entrepreneur in mushroom production, it is necessary to have basic knowledge in management and bookkeeping. This will allow tracking of profit and losses.

Keeping records is very important since it allows monitoring of all expenses incurred in mushroom production. It also allows to verify how much profit is generated in the business and identify how certain costs can be reduced in order to generate more profit.

4.2. Multiplication of Culture

- The mother culture either isolated or obtained from a reliable source is to be mass multiplied for preparation of spawn.
- Using an inoculation needle transfer a small piece of the agar culture to the media in the bottle.
- The inoculation needle is to be flamed before and after use.
- The hot needle is to be cooled by touching the media before using for transferring the culture; otherwise it will kill the fungus.
- The inoculated bottles are kept undisturbed for a few days and by this time the fungus will grow as a cottony white mat.
- If any other abnormal growth is observed as contamination such as cultures are to be rejected.
- Once the whitish fungal growth has filled up the agar surface such as bottles are ready to be used.

How to Prepare Mushroom Spawn or Seed

- Grains like wheat, Maize, sorghum, paddy, bajra etc. can be used as substrates for making spawn.
- Clean the grains and half cook the same with water.
- The grains should not split and release the starch.
- After cooking the grains are taken out, excess water drained off

- Allow to cool down and dried by spreading over a clean paper.
- When completely dry they are thoroughly mixed with 50-60 g of caco3 (calcium carbonate/chalk powder) per kg of grain.
- The processed grains are filled in empty clean bottle, filled to two third capacity.
- The filled up bottles are then properly plugged with non-absorbent cotton plugs and sterilized in an autoclave at 1.02kg/cm2 pressure for 2 hours.
- After these bottles are taken out, cooled and inoculated with a culture of the mushroom under aseptic conditions.
- Inoculation is done by placing small bits of the fungal culture or by transferring four or five grains from an already grown bottle.
- Plug the bottle again with the same sterile cotton plug.
- The inoculated bottles are to be incubated for spawn run in a cool place for 10-
- 15 days.
- The mycelium of the mushroom can be seen completely filling up the bottle as whitish growth.

4.3. Method of Production (Oyster Mushroom)

- Take fresh straw (paddy, wheat or oats) and Cut into small pieces of 3-5 cm length. Soak them in water for 4-6 hours and then boil for half an hour.
- Drain the water and dry the straw in shade till it is neither too dry nor wet.
- Take polythene bags of 60x30cm size and make holes of 1cm dia.
- Fill the bag with straw to 10 cm height and then inoculate with the spawn.
- Likewise prepare 4-5 layers of straw and spawn alternatively.
- The last layer ends up in straw of 10 cm ht.
- Keep this in a spawn running room maintained at a temp. 22-280 c,
- Relative humidity 85-90%.
- After 15-20 days when the spawn running is completed cut open the polythene bag and take it to cropping room and allow it to grow for 5-6 days and harvest the mushroom.
- Yield 0.5 – 1.0 kg/bed.

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. What are steps you follow for Mushroom cultivation? (20pts)

_____
_____
_____
_____
_____

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

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-- Cultivate and manage edible mushroom

Objective: To Prepare Mushroom Spawn or Seed for production

Procedures for Prepare Mushroom Spawn or Seed

1. Grains like wheat, Maize, sorghum, paddy, bajra etc. can be used as substrates for making spawn.
2. Clean the grains and half cook the same with water.
3. The grains should not split and release the starch.
4. After cooking the grains are taken out, excess water drained off
5. Allow to cool down and dried by spreading over a clean paper.

6. When completely dry they are thoroughly mixed with 50-60 g of caco3 (calcium carbonate/chalk powder) per kg of grain.
7. The processed grains are filled in empty clean bottle, filled to two third capacity.
8. The filled up bottles are then properly plugged with non-absorbent cotton plugs and sterilized in an autoclave at 1.02kg/cm2 pressure for 2 hours.
9. After these bottles are taken out, cooled and inoculated with a culture of the mushroom under aseptic conditions.
10. Inoculation is done by placing small bits of the fungal culture or by transferring four or five grains from an already grown bottle.
11. Plug the bottle again with the same sterile cotton plug.
12. The inoculated bottles are to be incubated for spawn run in a cool place for 10-
13. 15 days.
14. The mycelium of the mushroom can be seen completely filling up the bottle as whitish growth.

Operation Sheet 2—prepare tissue culture

Objective: To Multiply tissue culture for spawn/ seed

Procedures for Multiplication of Culture

1. The mother culture either isolated or obtained from a reliable source is to be mass multiplied for preparation of spawn.
2. Using an inoculation needle transfer a small piece of the agar culture to the media in the bottle.
3. The inoculation needle is to be flamed before and after use.
4. The hot needle is to be cooled by touching the media before using for transferring the culture; otherwise it will kill the fungus.
5. The inoculated bottles are kept undisturbed for a few days and by this time the fungus will grow as a cottony white mat.
6. If any other abnormal growth is observed as contamination such as cultures are to be rejected.
7. Once the whitish fungal growth has filled up the agar surface such as bottles are ready to be used.

Information Sheet 5- Collecting and packing edible mushrooms

5.1. Collecting edible mushrooms

As deadly as some toxins may be, touching the **mushroom** is harmless. The harmful toxins in **mushrooms** must be consumed in order to harm **you**. **Collecting mushrooms** for consumption is unsafe and even experts **have** died from **picking** the wrong **mushrooms**. Mushrooms generally come up naturally under moist conditions. Grasslands, Woodlands, Orchards, Marshlands, dung, decaying organic matter, etc. are all the well-known abodes of fungi. There are some common names also to designate the particular groups of fungi coming up in specific substrates. For e.g., those on dung are coprophilous, in leaf litter as Humicolous, on wood, tree stumps etc. as Lignicolous, on grasslands as praticolous and so on. Some mushrooms grow in grasslands in circles known as 'fairy rings'.

For collection of mushrooms, we have to wander along large areas of wooded lands, preferably having a sizeable number of tree stumps or fallen woods in different stages of decomposition. Mushrooms can be expected on all kinds of terrain including rocky areas, damp marshy lands, shrub forests, dense rain forests, garden land etc. The fleshy types usually appear in large numbers just after the pre monsoon showers, when there is a clear spell before the onset of monsoons. Areas to be closely observed for the presence of mushrooms include decomposing organic matter, hollow tree stumps, rotten tree trunks etc. Always try to select specimens showing all stages of development from the button to the expanded cap stage. Carefully dig up or cut from the substrate the entire fruit body. The associated plants should be recorded, especially trees which serve as substrates. It is advisable to collect mushroom in paper bags and pack loosely with provision for aeration.

The materials required for collection include large baskets, small containers, glass or plastic tubes, brown paper bags, hand lens, a sharp knife etc, Details regarding the specimens collected should be noted down according to the format.

Mushrooms should be **refrigerated** immediately after purchase. They can be stored in their original packaging or repackaged to allow for air circulation. To extend their freshness, store **mushrooms** in a paper bag and **refrigerate**. **Mushrooms** will last approximate one week in the refrigerator.

5.2. Packing edible mushroom

Mushroom Packaging consists of 100 percent biodegradable and renewable material that can be recycled directly in and by nature. **Mushroom Packaging** therefore contributes to “up-cycling” by providing new value to agricultural waste that otherwise has few other uses and low economic value.

Edible fungi such as mushrooms are highly perishable and deteriorate few days after harvest due to its high moisture content. **Mushroom**-based **packaging** is not only a boon for the environment but also a **cost-effective** and sustainable alternative to its petroleum-based counterparts.

Common packing materials are

- Plastic
- Glass
- Steel
- Aluminum
- Paper and Paperboard
- Wood

Self-Check – 5	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 (2pts each)

1. The well-known abodes of fungi are:

A. Grasslands B. Woodlands C. decaying organic matter D. All

2. It is advisable to collect mushroom in paper bags and pack loosely with provision for aeration. A True F. False

3. The materials required for collection include all except one

A. Small containers B plastic tubes C. a sharp knife D. All E. None

4. Duration of mushroom in the refrigerator is

A. one week B. Two week C. one month C. two months

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

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 for each task. The project is expected from each student to do it.

Task 1- Prepare media from PDA materials

Task 2- Cultivate and manage edible mushroom

Task 3- Prepare tissue culture

LG #56	LO #4- Manage and Utilize Bamboo

Instruction sheet

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

- Identifying potential bamboo producing areas
- Identifying and propagating existing bamboo species
- Harvesting and processing matured bamboos
- Assessing and supplying harvested bamboo to market access

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 potential bamboo producing areas based on their agro-ecological zone.
- identify and propagate existing species of bamboo in each agro-ecological zone based on various means of propagation
- Harvest and process matured bamboos for various purposes based on available technology and handled with appropriate post-harvest handling techniques.
- Assesse and supply market access for harvested bamboo to local, regional, and national level based on its quality

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.
4. Ask your trainer for assistance if you have hard time understanding them.
5. Accomplish the “Self-checks” which are placed following all information sheets.
6. 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).
7. If you earned a satisfactory evaluation proceed to “Operation sheets
8. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
9. If your performance is satisfactory proceed to the next learning guide,
10. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

1.1. Morphology, habitat and distribution

I. *Morphology*: bamboo belongs to the tribe Bambsoidae of the plant family poaceae. It is also called ***grant grass***.

- They are perennial grasses of extremely gregarious habit.
- Their stems are called *Culms,* which arise from woody rhizomes.
- The culms generally grow in-group, which is termed as *clump.*
- The point on stem from which leaf grows are called *nodes* & the area between two nodes are called *internodes.* Woody rhizomes also bear many roots.

1.2. Classification of bamboo

There are three types: -

1. Sympodial or clump forming – are found in tropical Zone mainly low land.
2. Monopodial or erect and non-clump forming bamboos generally found in sub tropical zone in high land.
3. Climbing bamboo- found in temperate zone or high land.

Bamboos vary in size from leaf forms to small thin sticks stems sometimes they are as high as 30m and 30cm diameter.

Morphological components:

a) The leafy aerial part called *Culm*
b) The underground rhizome
c) The underground roots

a. Culm – buds on underground rhizome develop into stem called culm, initially the new shoot of culm grow very rapidly & attain the maximum height within 3-4 months before branching. At this shape, culm sheath covers the lower part of inter node & disappears where culms grow part of internodes & disappears where culms grow old, most of the bamboos have hollow culm & only few have solid culms.

The culm sheath is a modified leave & arranged alternately in two opposite ranks, which protect,

- Tips of new culm
- Works as a nurse to protect culms against injury & desiccation;
- There is no terminal bud in the culm & consequently no terminal growth.
- The height/ growth in the culm takes place due to the successive elongation of the inter node.

b) Rhizome:

The basal portion of the culm usually swollen with shoot, inter nodes grows horizontally & ***remains*** at the soil surface or slightly below is called rhizome.

- Bamboo rhizomes are underground modifications
- Bears several buds & covered by underground sheath called ***scales***.
- Each bud contains a complete bamboo in its embryo & has about 35 or telescopic internodes.
- Sympodial rhizomes are solid, short & thick only here lateral bud produce new rhizomes each of which eventually produce a solitary culm.
- Monopodial rhizomes continue horizontal growth until constrained by branches bearing lateral buds most of which give rise to culms directly. They are long, slender & hollow. The slender roots coming out of the rhizome are the feeding organs.

C) Root

The roots of bamboos form the underground portion & remain within 1m depth of the soil surface. Some of the roots coming out of rhizome generally help in nutrition.

1.3. Developing bamboo based on agro ecology

- Its distribution is largely governed by RF, T, Altitude & soil
- Most bamboos require a T^0 of 8^0C-36^0C, a minimum of 1000 mm annual RF & high atmospheric humidity for good growth. Few species thrive in areas having RF range <750 mm.
- They thrive in all type of soil except in very dry soil
- They usually found in moist valley, sheltered depressions, along streams & lower hill slopes, but occasionally occur in higher slopes & hill slopes.

- Usually occur mixed with or under tree species.

In Ethiopia, bamboo is naturally found in Masha-anderacha, Bonga,Tiliku gesha, Assosa, Mambuk, & Bale areas between 700-3600masl elevation.

In areas like Gurage, Sidama, Insibara (Hawi zone) farmers grow bamboo. In general total areas of bamboo ranges from 626 to 979ha.

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: Match column A with column B (2pts esch

A	B
1. stems	A. found in temperate zone or high land.
2. *clump*	B The in-group grow culms
3. *nodes*	C. The point on stem from which leaf grows
4. *nternodes*	D. found in tropical Zone mainly low land
5. Sympodial or clump forming	E. . area between two nodes
6. Monopodial and non-clump forming	F. *Culm*
7. Climbing bamboo	G. found in sub tropical zone in high land.

Test 2. give short answer

1. List Morphological components of bamboo.

   _____

2. The basal portion of the culm usually swollen with shoot, inter nodes grows horizontally & ***remains*** at the soil surface or slightly below is _____

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

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet 2- Identifying and propagating existing bamboo species

2.1. Bamboo species

In Ethiopia only two species of bamboos found. i.e. high land bamboo and low land bamboo.

High land bamboo/ Aundenaria alpine k. schun

Distribution in south and south west part mainly Masha- anderacha, Bonga,Tiliku & Tinishu gesha forest, Hagerselam, Gore, Jemjem,and on Bale mountains b/n 2400-3600masl altitude.

- It covers a total of about 129_ 626ha.
- Are mainly monopodial, i.e. erect type growing 6-8m usually and some
- times 12-15m high and 7-10cm in diameter.
- Flowers 15-40 years and then die out.
- Has hallowed stem.

Low land bamboo /Oxytenthera abssyinnica (A.Rica)/

Mainly distributed in low land region of western and north-western parts between 700-1700masl. Also found in central high land & wet kola climatic zones at 500-1600m elevations.

- It is the hardest and often found on very poor soils.
- It is sympodial, clump forming.
- Grow to about 7m heights
- Has a solid stem up to 10 cm in diameter at the base
- Its leaves tips are spiny
- Flowers at about every 7- year and the clumps die down.

2.2 Tending and propagation of bamboo

a) **Natural Regeneration**: - The Natural Regeneration of bamboo occurs after gregarious flowering. Under favourable conditions of moisture and temperature, sufficient number of seeds germinates during the rainy season.

- Regeneration is better in areas where mineral soils are exposed to good physical condition.
- The seedlings need replacement (thinning out) after one or two years as initial regeneration is very profuse. In due course of time, they form clumps & future crop.
- Fire, grazing, trampling of rhizomes, removal of new shoots by different agents results in congested clumps, & thus its growth is retorted. Hence, protection from such agencies is necessary for proper growth in Natural areas.

b) Artificial regeneration

i. By seed

- If seed sown within 1-2 month of seed collection, it germinate within 5-10 days.
- Seeds of most species lost their viability gradually after 2-3 months.
- Bamboo seeds are light in weight & small except some species with large seed.
- In case of direct sowing, the seeds are sown in lines 3-5 m apart.

ii. ***By seedling*** – nursery seedlings are also used as direct sowing

- 6-10 month old seedlings are planted in the field.

In some cases they remain in nursery for 1-11/2 years-10 develop rhizomes once rhizomes develop, these are separated & planted in the polythene bags, then transferred to field.

In general, the seeds are sown in seed beds in September /October seeds take 10-20 days to germinate, after 3 months the seedling pricked out in to polythene bag & refilled & then seedlings are planted.

iii. By offset cuttings

- Many species of bamboo are propagated by rhizomes
- The New rhizomes are dug out form the clumps & planted in new area.
- Rhizomes are taken out just before rainy season, as buds are most active during this period. As the rain starts these buds starts growing.

- ✓ For large-scale plantation this method is not, suitable between the availability of rhizomes is very much restricted.

iv. Rhizome cutting

- Is most common for species with monopodial bamboos
- In this method, one-year-old Culm with its rhizome & root system is dug up. The Culm is cut to 1m high & the whole thing is planted in the season of rest, so that the season of active vegetation. Which usually begins with the rains, may find them well in position & capable of taking roots early.

Stem Cutting or Culm cutting

- This method involve cutting of a 1 year or 2-3 years Culm into two node sections. Each section so planted obliquely with one node buried. One or two node cutting planted horizontally with one node exposed also gives good result.

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: choice the best answer (2pts each)

1. One is not **Artificial regeneration of bamboo**

A. Natural Regeneration B. By seed C. By offset cuttings D. By seedling

2. The New rhizomes are dug out form the clumps & planted in new area

A. Seed B. offset cuttings C. seedling D. All

3. It is not the characteristic of **High land bamboo**

A. It covers a total of about 129_ 626ha C. Has hallowed stem
B. It is the hardest D All

Test 2: Give short answer

1. What is Stem Cutting or Culm cutting propagation (4pts)?

_____

_____

2. What are the different between high and low land bamboo (5pts)?

_____

_____

Note: **Satisfactory rating – 7.5 points** **Unsatisfactory - below 7.5 points**
You can ask you teacher for the copy of the correct answers.

Operation Sheet 1—propagate bamboo

Objective: To acquire the trainee preparing bamboo development

Procedures

1. Prepare the site of propagation (bed)
2. Pick and sterilize the correct tool to cut the bamboo.
3. Cut a 10 inches (25 cm) piece of bamboo at a 45° angle. Each piece you cut from the bamboo should contain at least 3 or 4 nodes, the rings that wrap around the stalk. The bamboo should be at least 1 inch (2.5 cm) in diameter if you want to successfully grow from a cutting
4. Inserting the cutting into prepared bed
5. Mulching
6. watering

3.1. Harvesting

Harvest bamboo shoots in the spring when the **plants** first begin to **grow**, cutting them at ground level with a sharp knife and choosing those that are about 6 inches high. ... Take only a few shoots from a new **planting** to ensure the adult **plants** will continue to **grow** and expand.

Bamboo harvesting can take place every 3 to 5 years due to the high speed at which the plants grow.

Unlike all trees, individual **bamboo** culms emerge from the ground at their **full** diameter and **grow** to their **full height** in a single **growing** season of three to four months. During this time, each new shoot **grows** vertically into a culm with no branching out until the majority of the mature **height** is reached.

These plants also thrive in a variety of climates across the world and are not restricted to growing in one country.

In many countries, particularly those with tropical climates, giant bamboos grow as forests.

Bamboo harvesting takes place at different ages of the plants growth according to the product requirements.

The harvested bamboos are useful for making different products at different ages, with many of these products and materials being covered throughout this site.

For example, the recommended age to harvest for products to use in the construction industry is 3-6 years yet for some craft uses they may be harvested at a younger age depending on the species.

To select culms that have the greatest strength for building purposes it is important that the culms are at the right age.

If the culms are older than 6 years they may have been subjected to insect damage on the interior of the plant but it will be difficult to assess.

When harvesting, it is best to cut just above the node at the base and to carry out the harvest immediately after new shoots have started to grow. At this time the plant will have given all it's starch to production of the new culms leaving less in the harvested culms.

To create special shapes or effects, bamboos can be bent or straightened through a process of heating and clamping until cool.

Figure: 3.1 Bamboo products

Building and construction makes use of the wide variety of building products now available made from this highly sustainable building material.

As wood becomes more and more scarce and valuable, bamboo harvesting will hold its own as a desired resource outside of the tropical climates where the benefits of its use have been known for centuries.

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: write True if statement is correct, False if statement is incorrect (2pts each

1. Bamboo harvesting can take place every 3 to 5 years due to the high speed at which the plants grow. _____
2. Bamboo harvesting takes place at different ages of the plants growth according to the product requirements. _____
3. The recommended age to harvest for products to use in the construction industry is 10 years yet for some craft uses they may be harvested at a younger age depending on the species.. _____

Note: **Satisfactory rating – 7.5 points** **Unsatisfactory - below 7.5 points**

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

4.1. Bamboo market

Bamboo market in Ethiopia is not well developed and bamboo marketing as a viable alternative for farmers has become a very challenging issue. In Ethiopia, bamboo utilization is limited to house construction, fences and some rudimentary furniture and household utensils as well as bamboo resources and products are currently not properly managed and utilized (INBAR, 2007). Development of bamboo resources and marketing system requires a good understanding of factors affecting decisions to engage, develop, and benefit from the bamboo resources across the major bamboo-growing regions.

Ethiopia has the largest resource of **bamboo** in Africa, estimated at around one million hectares, accounting for 67 percent within the continent and seven percent of the world total. It is estimated that by 2015, the world **market** for commercialized **bamboo** products reached $20 billion US dollars.

Bamboo-growing area sells their bamboo products, including bamboo culms, at local and roadside markets, at regional markets. The producers also use bamboo for domestic consumption.

4.2. Bamboo Products

Because of its combined strength and light-weight, **bamboo** is one of **the** most **used** building materials, particularly in areas of **the** world where it is found in abundance. Historically and today, is an important resource to build bridges, houses, scaffolding, falls, floors, roofs and other structures.

Figure 4.2. Bamboo products

The further processing of bamboo as:

- Bamboo toilet paper.
- Bamboo on-the-go utensils.
- Bamboo Speakers.
- Bamboo towels.
- Bamboo Bottle.
- Bamboo solar battery.
- Bamboo floors.
- Bamboo computer accessories

According to Zenebe, et al. (2014), the price of bamboo products mentioned in table 4.2 below. The price is not constant because of market fluctuate.

Table 4.2. Bamboo furniture specifications and selling price by the Ethiopian Tourist Trade Enterprise (October 2010). Area = seat area; FH = front height; BH = back height.

Furniture	Specification				Selling price ($)
	Area (cm × cm)	FH (cm)	BH (cm)	Color	
Chair	43 × 43	46	100	Varnished/natural/brown	14.50
Chair with design	47 × 46	46	86		19.09
Chair with design	45 × 42	46	94	Varnished/natural/brown/green	14.50
Sofa (single seater)	55 × 60	42	76	Natural/brown	10.00
Sofa (double seater)	69 × 110	42	76		19.91
Garden chair	54 × 70	33	67		30.00
Coffee table	80 × 50	50	50	Varnished/natural/brown	20.64
Dining table	80 × 80	77	77		42.27
Partition	174 × 5	170	170		52.36
Partition with leather	150 × 5	185	185		89.73
Bed	135 × 205	45	100		126.45
Bedside drawer	45 × 40	58	78		28.36
Drawer (5 parts)	80 × 50	90	90		63.18
Shelf	75 × 42	170	170	Natural/brown	38.82
Shelf	90 × 42	105	105		22.36

Source: Zenebe M. et al., 2014

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: write True if statement is correct, False if statement is incorrect (2pts each)

1. Bamboo market in Ethiopia is well developed
2. Development of bamboo resources and marketing system requires a good understanding of factors affecting decisions to engage, develop, and benefit from the bamboo resources across the major bamboo-growing regions

Test 2: Give short answer

1. List some bamboo products in materials and compare with your local uses of bamboo products.

   _____
   _____

Note: **Satisfactory rating – 7.5 points** **Unsatisfactory - below 7.5 points**

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

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 for each task. The project is expected from each student to do it.

Task 1- Prepare propagate bamboo

LG #57	LO #5- Conserve, manage, utilize and market medicinal plants

Instruction sheet

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

- Identifying potential medicinal plants
- Documenting identified medicinal plants in herbarium
- Identifying endangered medicinal plants
- Developing conservation and utilization strategy
- Managing and utilizing medicinal plants
- Making conserved medicinal plants for market
- Supplying identified parts to pharmaceutical industries

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 potential medicinal plants based on their medicinal value
- document Identified medicinal plants in herbarium based on herbarium techniques
- Identify endangered medicinal plants based on their abundance and density.
- Develop Conservation and utilization strategy is in participation with the community.
- Manage and utilize medicinal plants in accordance with their use and required management types
- Make Conserved medicinal plants ready for market based on parts used as a medicine
- Supply Identified parts to pharmaceutical industries based on demand and type of industry.

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.
4. Ask your trainer for assistance if you have hard time understanding them.
5. Accomplish the “Self-checks” which are placed following all information sheets.
6. 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).
7. If you earned a satisfactory evaluation proceed to “Operation sheets
8. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
9. If your performance is satisfactory proceed to the next learning guide,
10. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Identifying potential medicinal plants

1.1. Identifying medicinal plants based on indigenous knowledge

Botanists identify plants using herbarium specimens that is dried, pressed plants in folders or mounted on paper or card. The advantage of herbarium specimens is that they take up little space and that they last for hundreds of years. Using them, a botanist can compare a specimen collected with hundreds of other specimens whose identities have been verified by specialists over many years.

Therefore, samples of medicinal plants should be collected and prepared as herbarium specimens.

The specimens should include all the organs required for accurate naming, such as flowers, fruits, seeds, roots and normal leaves. Vernacular names are useful and important, but are not always easy to correlate with scientific names.

One plant species can have many vernacular names, each used in a different part of the plant's range. Conversely, one vernacular name may refer to different plant species in different areas. Nevertheless, vernacular names are often a useful clue to the scientific identity of a plant, and are needed in communicating back to the practitioners who use the plants.

Although the species is the normal unit of plant classification, botanists may further divide species into subspecies (major subdivisions, usually on a geographical basis), varieties (small, local or otherwise distinctive variants) and forms (usually individual genetic variants within populations).

These subdivisions are particularly important for medicinal plants, as the medical effect of the plant may vary from one variant to another. Indeed, many species consist of a range of distinct chemical forms, types or races, which cannot be recognized one from another by their visible characters, but have markedly different chemical properties, which may influence their pharmacological content.

Specimens should be adequately labelled. The label should include a unique reference consisting of the collector's name and a sequential number .Material from the same collection, such as microscope slides, should always carry the same reference. The label should also include full details of the locality and habitat, as well as those characters of the plant which cannot be seen in the dried specimens, e.g. the height of trees, the colour of flowers.

The specimen should be identified with the scientific (Latin) name of the plant. In practice, there is a high level of miss-identification, both of herbarium specimens and even in the literature. Therefore the determination should be checked by a competent taxonomist; this requires access to a major herbarium and to reference literature. It is estimated that there are around 250,000 species of flowering plants in the world, and many of them need specialists for their identification. Groups of plants for which specialists are most often needed include orchids, palms and grasses. One problem in naming plants is the occurrence of synonyms – more than one scientific name for the same plant. The correct name is the one that conforms with the International Code for Botanical Nomenclature, but in some cases botanists may disagree over which name is correct, in others well-known names may be overturned for technical reasons and in others botanists may not know which are the correct names without laborious nomenclatural research. More frequently, however, botanists may disagree over the taxonomic position or rank of a plant, so leading to more than one name for it, each equally valid. To ensure consistency of names, especially when plants are mentioned in legal texts, it is recommended that the national herbarium (or equivalent organization) should prepare a list of Standard Names, which would then be followed in legislation and in the literature.

There are even cases, albeit rare, where the same scientific name is used by two different authors for two quite different plants. For this reason, the name of the botanist or botanists (called the "authority who coined the name should be added after it (except when a list of a Standard Names is followed).

1.2. Conserving identified species

A. Indigenous medicinal plants (imp)

1/ *Adhatoda Shimperiana*.

Local name: Sensel (Am) dhumuga (Or).

- Habit-erect shrub, usually branched from bases, form fences.
- Ecology: found in fences around house.
- Grows at an alt. 1250-2500m
- Part used – leaves: - to treat malaria
- Root & leaves – for headache treatment
- All part used to treat excessive pellagra
- Mode of use: fresh leaves crushed & boiled with water & then one cup per day taken.

2. *Brucea antidaysenterica* (‘ Brucca’ named after James Bruce (1730- 1794) a Scottish traveller in Ethiopia in the years 1768-1773, who brought seeds of these plant to Europe)

Antidysenterica: Active against bad bowels e.g. Dysentery

Local name: Setanbuna,wagines (Am) konanyo (0r) hatouw (s)

Habit: erect shrub or small tree, branched from base.

Ecology: Can be found at alt. 1000-3700 m, often found in deforested areas or at forest edges.

Part used –root, bark –treat dysentery; fruit & leaves treat dysentery and diarrhoea & fever

Root and leaves treat rabies, fruit and leaves also applied to animal wound.

2. *Calpurina aurea* (*subdecandara*)

“Aurea” derived from Latin word ‘aurums ‘ gold referring to golden yellow.

Local name: Digita /Misirki (Am) Cheka, solitu (Or) Chekisa (Gam.)

Habit: erect evergreen shrub.

Ecology: grow in highlands of East Africa at alt 1200-2800m grow in slopy mountain, forest edge & over grazed area, may be found flowering in all months of the year.

Part Used –Sap of leaves & root –for eye- disease, Vomiting, Amoebic dysentery and animal diarrhoea. Flower is used against stomachache and root against scabies (skin disease)

Mode of use- for stomach by drinking leaves decoction; and for scabies –roasting the grounded fruit with butter and as ointment.

4. Croton macrostcyus

Local name: Bisana (A) ,Mekanisa (or), Masincho (Sid) ,Wago (k)

Habit: an evergreen tree

Ecology: is a common tree in the highland parts of Ethiopia (1400-3400). Found on the slops as secondary forests, uncultivated land etc.

Part used: fruits, bark, root

Mode of use: - pulverized bark with dried kosso flower (soaked all night) is effective purgative and Antihelminatic drinking)

5. *Emblia Schimperi*

Local name: Enkoko (AM.T) Hanku (Or)

Habit: a diocious, woody climber or seldom shrub.

Ecology: grow along creeks, on mountain slopes in clean forest, up to 2600m.

Parts used: fruit – against worm (tapeworms and round worms).

Mode of use: dry fruits chewed after and the jewel is followed (this is done after kosso), one teaspoon of fruit three times a day. The dry fruit can also taken by boiling in water.

Remark: Some people believe that fresh fruit is more effective than leaves used. In East Africa an alignment for swollen breast, dry of mother women with difficulties in birth use, to relieve pain.

6. *Hagenia abyssinica*

- Local name: Kosso (Am) heto (Or) trade name kosso (East Germany)
- Habit- a diocious rarely a polygamous tree.
- Ecology: commonly found in every province at alt. > 2000 m usually grow wild, also planted around churches e.t.c.

- Part used: Female inflorescence (flower) against tapeworm. (by eating with banana)
- Mode of used: Powdered flowers in cold water, hot water, in Tej, Tella, usually left for one night in the morning and the medicine is taken before breakfast.
- The dosage depends on healthiness of individuals (8-12) dried flower is used)

Remark-the name kosso used in several ways to refer to the tree, the disease (tape worm) the female flower, the medicine. However, the real name of the parasite is banna in Amharic.

7. *Lepidium sativum*

- Local name: Feto (Am/Or) Shufu (Harer) Shimp (kef)
- Habit –an erect annual herb and tap rooted.
- Ecology: grow on both poor and good soil, Seldom cultivated but grow mixed with teff (alt. 750-2900m).
- Part used: against skin disorder, asthma, amoeba.
- Mode of use: seed flour with water used for skin disorder (ointment), seed flour taken with honey against amoebic dysentery, ground seeds with water camel disease (Zagag) seeds chewed for asthma.

8. *Phytolacca dodecandra*

- Local name: - endod (Am.or) endot (T) hanjoo (Mod)
- Habit- a liana seen shrub
- Ecology- Common plant in all provinces especially in high altitude 1300-3000m). The plant can be found flowering or fruiting in all months of the year.
- Part used- all part
- Mode of use: decoction of root & seed is taken as a remedy for veneral disease (through drinking).
- Fresh root is pulverized and a cup of the squeezed liquid is taken against; rabies, stomachache, to induce abortion & to hinder preface.
- In South Africa a check ful of leaves and young shoots are chewed & the juice swallowed, then aborting start 10 hours later.

Remark: the plant is highly poisonous (especially ripe fruit and bark & root) thus, the right dosage in the medicinal applications is necessary.

9. *Tamarindus indica*

- Local name: homor (Am) aradeb (T) roka, boka (Or)
- Habit: large evergreen tree.
- Ecology: Common in semi arid tropical region up to 1300m.
- Part used: all part
- Mode of use: Roots are used in remedy against sleeping sickness, Leprosy, cough, fever,
  - ✓ Wood decoction- Purgative, gonorrhoea
  - ✓ Level decoction eye disease, intestinal comloants
  - ✓ (as dysentery, Worm) wound, fever, malaria.

10. *Mysine africana*

- Local name: Kachamo, Kachu Gujamo (Am, Or) Varamole (Somali)
- Habit: an erect, densely branched evergreen shrub.
- Ecology: grow wild in mountain region at alt. of 1750-3800m, flowers found the whole years round.
- Part used; all part
- Mode of use: powder fruit drunk with water/eaten with injera to treat tapeworm & roundworm.
- Fresh leaves eaten by women to relieve menstruation pain & to stop bleeding.

2.3. Exotic medicinal plants

1. ***Azandrachta indica* (Neem)**

Habit: tall deciduous tree, Leaves decoction is used to treat ulcers, & eczema, Bark for a stringent & antiperiodic, malaria, Oil extracted from seed for skin disease, ring worm and Bark, gum, leaf & seed as a mixture with water used to treat snakebite & scorpion sting.

2. ***Rauwolfia Serpentina***

Useful for snake bites, mental illness, moon disease. Its root part is one of the crudest drugs used in modern countries in the treatment of central nervous system (that are: maniacal, insanity, snakebite, schizophrenia, insomnia & intestinal disorder.

Habit: effect evergreen herb around 0.5 cm in height

Ecology: grow in different climatic conditions preferring hot & humid tropics

3. ***Dioscorea Species***

Part used- rhizome and used as antipyretic, antibiotic, and anti fertility agent.

4. Atropa belladonna

- Habit- tall & straight tree
- Ecology: grow wild in forests at 1800-3600 m but cultivated in India.
- Part used: leave tips & roots used for commercial drug.

5. ***Artemesia maritime***

A shrubby aromatic species, in which the yellow flower is the best remedy for intestinal worm.

6. ***Pyrethrum Species****: g*ood insect repellent.

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: write True if statement is correct, False if statement is incorrect (2pts each)

1. One plant species can have many vernacular names, each used in a different part of the plant's range. _____
2. The advantage of herbarium specimens is that they take up little space and that they last for hundreds of years. _____

Test 2: Give short answer

1. List some species name (scientific and local) and their use as medicine (10 pts.)

no	Scientific name	Local name	uses

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

Note: **Satisfactory rating – 7points** **Unsatisfactory - below 7points**

Information Sheet 2- Documenting identified medicinal plants in herbarium

2.1 Documentation

An **important** function of the **Herbarium** is to house voucher specimens of authentic **medicinal plant** material. Many journals now require voucher specimens to be deposited and held in **herbaria** for future reference of taxonomic classification or identification.

Mode of use: dry powdered part of the root mixed with milk or water (at a spoonful of it with a cup of camel milk twice per day) against dysentery. Decoction of fruits & leaves can also use similarly. Crushed fruits with honey or butter are very ointments for wounds; chopped fruits of the plant are applied to wound of camel. After identified the medicinal trees and shrubs documentation is a crucial. According to area species name(scientific and local), habit, ecology and uses can be documented.

For the most part, the potential of practitioners of traditional herbal medicine to serve as partners in the process of drug discovery and in providing healthcare services is not equitably acknowledged. Hence, documenting traditional medicinal plants and the related traditional medical knowledge is important in order to facilitate the discovery of new sources of drugs and promote sustainable use of natural resources in Ethiopia

2.2. Guide lines

This documentation is a guide to herbarium sheets and how to accurately and consistently record the information on them. It's quite likely that you are already familiar with herbarium specimens, and if so, then what follows may be obvious to you. Nevertheless we'd appreciate it if you'd spend a few minutes reading this text, as it's important to the success of the project that everyone follows the same conventions.

Documentation guidelines

- Taxon names and determination
- Collectors
- Dates

- Herbarium (provenance)
- Locality (collection site)
- Accession number
- Notes

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 1: Give short answer

1. Writ the steps you follow for herbarium(5 pts.)

   _____

   _____

2. List documentation guidelines (5 pts.)

_____

_____

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

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

Operation sheet 1: Prepare herbarium specimens

Objectives: To document herbarium specimens

Steps of herbarium

step 1: collecting - where to collect

step 2: preparation - protecting the specimens

step 3: pressing - pressing the specimens

step 4: mounting - mounting the specimens

step 5: freezing - freezing the specimens

Step 6: identification - identifying the specimens

Step 7: Documenting and reporting specimem

Information Sheet 3- Identifying endangered medicinal plants

3.1. Endangered medicinal plants

Medicinal plants grow naturally around us. Over centuries, cultures around the world have learned how to use plants to fight illness and maintain health. These readily available and culturally important traditional medicines form the basis of an accessible and affordable health-care regime and are an important source of livelihood for indigenous and rural populations. Increasingly, medicinal species that reside in natural areas have received scientific and commercial attention.

As medicinal plants receive increased scientific and commercial attention, there is increasing pressure on the wild plant populations from which most medicinal plants are harvested. Overharvesting has placed many medicinal species at risk of extinction. Commercial exploitation has also sometimes led to traditional medicines becoming unavailable to the indigenous peoples that have relied on them for centuries or millennia.

Our ignorance becomes increasingly dangerous as the rates of loss of plants, fish, wildlife, and habitat accelerate (Marinelli, 2005). Each species lost to extinction represents not only the potential loss of life-saving cures for diseases such as cancer or AIDS, but also the loss of possible protein- or vitamin-rich foods or more productive and stable crops.

The causes for endangered medicinal plants are overharvesting, agricultural expansion, urbanization, land degradation and climate change.

There are around 6,000 species of vascular plants in Ethiopia, out of which more than 14% are said to have been used as traditional plant medicines (TPMs), while more than 1,000 species have been documented at the National Herbarium (ETH) database (Awas,2004).

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 1: Give short answer

1. What are the cause of endangered medicinal plants (5 pts.)

   _____

   _____

2. Where medicinal plants can grow? (5 pts.)

_____

_____

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

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

Information Sheet -4 Developing conservation and utilization strategy

4.1. Conservation

Medicinal plants in any country form a very heterogenous group in growth habit, distribution, reproduction, plenology and their ecological requirements. Many of them grow in open starting from wetlands to dry, arid conditions. They also extend from sea level to higher altitudes. The medicinal value of such plants vary some important ones are mountainous forms, others bordening the desert or semi desert areas. The quality and quantity of products they produce also vary depending on the habitat. The conservation methods that are followed need to be equally divergent.

Some of them are even weeds that thrive under varied conditions. In order to conserve species that grow in the open *in situ* conservation methods are appropriate but the land use policies would not permit to ear mark vast areas to save them for long in a particular location.

The conservation methods may emphasize growing the whole plants in a continuous or rotating fashion or by seed storage to conserve diversity. It is necessary to make sure that stored seeds would germinate and produce plants of good quality comparable well with mother stock from which they were collected.

Most of the medicinal plants that are selected and cultivated represent *ex situ* collections. While numerous plants are cultivated in a given area and the biomass

used, it is necessary to compare once in a while, the quality of cultivated plants with those that were collected from nature, Passport details and reproductive behaviour of cultivated plants need to be properly recorded

4.2. Strategy

Assessment of Diversity

As a prerequisite to conservation methods studies on assessment of medicinal plant diversity need to be undertaken, involving a number of scientists and institutions from various countries.

A. The information already available in various countries on inventory and cataloging has to be consolidated to identify the research gaps.
B. Species priority need to be established for each country as well as different regions of Asia with focus on ecological habitats and the medicinal plants that grow in them.
C. Eco-geographic areas with diversity of useful plants need to be identified.
D. Details regarding maintenance of diversity, characterization and evaluation, degree of domestication and cultivation should be recorded to suggest further improvements.

4.3. Conservation approaches

1. **Ex situ *Conservation***

Seed storage methods should be standardised for medicinal plants including orthodox and recalcitrant seeds, paying particular attention to rare and endangered species. The seeds collected should be used periodically to confirm the maintenance of quality of plants cultivated.

Manual on propagation methods using both seed and vegetative plant parts should be published, distinguishing the species that are easy as well as difficult to propagate. Separate programmes should be prepared both herbaceous and tree forms.

2. In situ *Conservation*

In situ conservation methods should be promoted since the products produced by plants of the same species would vary with the habitat.

The national parks and other conservation areas rich with medicinal plants should be identified and their ecological details published. Wherever possible, the identified areas that are rich with medicinal plants should be recommended to the authorities for conservation.

Conservation through use

Cultivation can also have conservation impacts, however, and these need to be better understood. Medicinal plant production through cultivation, for example, can reduce the extent to which wild populations are harvested, but it also may lead to environmental degradation and loss of genetic diversity as well as loss of incentives to conserve wild populations (Anon. 2002).

4.4. Designing complementary conservation and use strategies

The *ex situ* conservation methods may include growing the whole plants in field genebanks or by seed storage to conserve diversity. An appropriate seed storage technology for different species have to be worked out and, at the same time one has to make sure that the seeds planted produce plants of good quality comparable well with mother stock from which they were collected

4.5. Promoting sustainable conservation and utilization

Many of the medicinal plants in developing countries are extracted from the wild or fields on a contract basis and required plants are grown in their home countries and the dried materials are exported to the pharmaceutical companies in the developed countries

For further utilization of medicinal plants:

Government should encourage the traditional methods of **conservation** of forests.

In situ **conservation** encourage by establishment of natural reserves or biosphere resources.

Ex situ **conservation** through **medicinal plant** gardens, artificial regeneration of botanical gardens and arboreta.

Encourage **medicinal plant** Gene bank.

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 1: Give short answer

1. What are the differences between in-situ and ex-situ conservation approach? (5 pts.)

   _____

   _____

2. _____ and _____rich with medicinal plants should be identified and their ecological details published.

3. What is the role of government for further utilization of medicinal plants?

   _____

   _____

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

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

Information Sheet 5- Managing and utilizing medicinal plants

5.1. Managing medicinal plants

Medicinal plants are globally valuable sources of new drugs. With the increasing demand for herbal drugs, natural health products, and secondary metabolites of medicinal plants, the use of medicinal plants is growing rapidly throughout the world. According to the International Union for Conservation of Nature and the World Wildlife Fund, there are between 50,000 and 80,000 flowering plant species used for medicinal purposes worldwide. Among these, about 15,000 species are threatened with extinction from overharvesting and habitat destruction and 20 % of their wild resources have already been nearly exhausted with the increasing human population and plant consumption. The conservation and sustainable use of medicinal plants have been studied extensively.

Medicinal plant resources are being harvested in increasing volumes, largely from wild populations. In situ conservation of whole communities allows us to protect indigenous plants and maintain natural communities, along with their intricate network of relationships. Additionally, in situ conservation increases the amount of diversity that

can be conserved and strengthens the link between resource conservation and sustainable use.

Conservation of medicinal plants can be accomplished by the ex-situ i.e. outside natural habitat by cultivating and maintaining plants in botanic gardens, parks, other suitable sites, and through long term preservation of plant propagules in gene banks (seed bank, pollen bank, DNA libraries, etc.

Medicinal plants, also called medicinal herbs, have been discovered and used in traditional medicine practices since prehistoric times. Plants synthesise hundreds of chemical compounds for functions including defence against insects, fungi, diseases, and herbivorous mammals.

Barks should be **collected** from the trunk and branches. Roots and other underground parts (e.g., rhizome, rootstock, stem tuber, bulb and stolon) are best **collected** when the **plant** is in full growth. Avoid **collecting plants** in a way that kills the **plant** or damages its surroundings.

5.2. Utilizing medicinal plants

Medicinal plants are generally known and popular for a number of health **benefits** such as decreasing of blood pressure, prevention of cardiovascular diseases, or reducing the risk of cancer also due to their antioxidant activity.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test 1: Give short answer

1. List health benefits of medicinal plants (5 pts.)

   _____

   _____

2. Another nome of medicinal plants is called _____ (2pts.)

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

Note: **Satisfactory rating – 4points** **Unsatisfactory - below 4points**

6.1. Marketing conserved medicinal plants

Farmers collected medicinal plants from crop fields, home gardens and nearby forest patches. The results of the growth form analysis revealed that herbs were the most common growth form and the dominant plant parts harvested were leaves. Harvesting of leaves may not have negative effects on resource availability, provided that the plant itself is not destroyed during harvesting, which is especially relevant for herbs.

Marketing of medicinal plants was fragmented in Ethiopia markets, apart from the well-known *Hagenia abyssinica* flowers and *Embelia shimperi* seeds (both wild collected) and the cultivated *Allium sativum* and *Artemisia absinthium* that are also used as spices. The commercialization of other wild and semi-wild species is hampered by the fact that medicinal knowledge is only held by few people. Few species (*Thalictrum rhynchocarpum, Piper capense* and *Echinops kebericho*) at Gimibi and Gaba Senbeta markets, in western Ethiopia, while the few species sold by Bench communities in south-western Ethiopia doubled as spices. Some medicinal plants directly sold by harvesters without further processing. The economic importance of the trade was limited: the price of *Embelia shimperii* seeds was only 2 Ethiopian Birr (0.10 $) per glass (about 250 ml). The product was not always available and marketed in small quantities.

6.2. Objective of conserving medicinal plants marketing

- Promotion of cultivation and conservation of **Medicinal Plants**.
- To develop cultivation techniques (agro-techniques) including Quality **Plant** Materials, Irrigation, Fertilizer, **Plant** protection, Post harvest collection and Processing, which are cost effective in different agro-climatic regions of the country?

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test 1: choice the best answer

1. Farmers collect medicinal plants from
   A. Crop fields B. Home gardens C. Nearby forest patches D. All
2. Marketing of medicinal plants was fragmented in Ethiopia markets.
   A. True B. False
3. The Objective of conserving medicinal plants marketing is
   A. To Promotion of cultivation and conservation of Medicinal Plants.
   B. To develop cultivation
   C. To encourage **Plant** protection D. All

Note: **Satisfactory rating – 4points** **Unsatisfactory - below 4points**

You can ask you teacher for the of the correct answers

7.1. Pharmaceutical industries

Medicinal plants have evolved over the centuries as essential parts of African civilization and are widely recognized today as representing its rich cultural and scientific heritage. The increasing demand for medicinal plant products has renewed interest in the pharmaceutical industry in the production of herbal health care:

- formulations,
- herbal-based cosmetic products, and
- herbal nutritional supplements.

Thus, in addition to serving medical and cultural functions, medicinal plants in Africa have economic importance. Global and national markets have been growing for medicinal herbs, and significant economic gains are being realized through the sale of medicinal plant products. It focuses most of its attention on broad trends, tendencies, and the most common situations in the production and marketing of medicinal plants in African local markets.

Medicines of different classes include atropine, scopolamine, and hyoscyamine (all from nightshade), the traditional medicine berberine (from **plants** such as Berberis and Mahonia), caffeine (Coffea), cocaine (Coca), ephedrine (Ephedra), morphine (opium poppy), nicotine (tobacco), reserpine (Rauvolfia serpentina) are supplied to market.

Self-Check – 7	Written test

Name…… ID…… Date…….

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

Test 1: Give short answer

1. Writ the steps you follow for herbarium(5 pts.)

   _____

   _____

2. List documentation guidelines (5 pts.)

_____

_____

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

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

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 **4** hour for each task. The project is expected from each student to do it.

Task 1- Prepare herbarium specimen

Reference Materials

Book:

1. Adam, A. A. Eltayeb;A.M,Ahmed,A.A(2004) State of Bosewllia papyrifera(Del.) Hochst.(Olibanum gum tree)stands in Jebel Marra Darfur ,Sudan. Sudan Silva 10(1) 2004. Sudan.
2. Ali, A. H. (2005) Yield of gum Olibanum (Boswellia papyrifera (Del.) Hochst in relation to methods of tapping in south Kordofan. M.Sc Thesis. Department of Forestry, U.K.
3. Awas T: Conservation of Medicinal Plants in Ethiopia**.** In *The Proceedings of the First Medicinal Plant National Workshop Held in Addis Ababa, Ethiopia: June 30-July 2, 2003*. Edited by: Kelbessa U, Ayale A, Merga G. Addis Ababa: Ethiopian Health and Nutrition Research Institute; 2004:97–107.
4. Lal R, Junior WF: *Where Biodiversity, Traditional Knowledge, Health and Livelihoods Meet: Institutional Pillars for the Productive Inclusion of Local Communities*. Brazil: International Policy Centre for Inclusive Growth; 2011.
5. W. Tadesse, G. Desalegn and R. Alia (2007) Natural gum and resin bearing species of Ethiopia and their potential applications. Ethiopian Institute of Agricultural Research. Forestry Research Center. P.O. Box 30708. Addis Ababa. Ethiopia
6. Worku, A. 2006 Population status and socio-economic importance of gum and resin bearing species in Borana lowlands, southern Ethiopia. Master's thesis, Addis Ababa University, Department of Biology, Addis Ababa, Ethiopia.
7. Zenebe Mekonnen, Adefires Worku, Temesgen Yohannes, Mehari Alebachew, Demel Teketay, and Habtemariam Kassa (2014) Bamboo Resources in Ethiopia: Their value chain and contribution to livelihoods

WEB ADDRESSES

1. https://ngara.org/wp-content/uploads/2020/06/Production-and-Marketing-of-Gum-Resins_2.pdf
2. **https://www.cifor.org/publications/pdf_files/Books/BKassa1102.pdf**

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