

Practical Manual

on

ETHNOBOTANY, MEDICINAL AND AROMATIC PLANTS FPU - 227 3(2+1)

(For Undergraduate Horticulture students)

Dr. Manmohan J. Dobriyal
Dr. Vinod Kumar
Dr. Pankaj Lawania
Dr. Jahangir A. Bhatt



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College of Horticulture & Forestry
RANI LAKSHMI BAI CENTRAL AGRICULTURAL UNIVERSITY

Jhansi-284003

Syllabus FPU 227 3(2+1):

Practical:Field visit to different tribal regions to gain ethnobotanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Name of Student

Roll No.

Batch

Session

Semester

Course Name :

Course No. :

Credit

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CERTIFICATE

This is to certify that Shri./Km.ID No.....has completed the practical of course.....course No. as per the syllabus of B.Sc. (Hons.) Agriculture/ Horticulture/ Forestry semester in the year..... in the respective lab/field of College.

Date:

Course Teacher

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Practical No. 1

Objective: To visit botanical garden/herbal garden/medicinal plant repositories for identification of ethnomedicinal plants.

Aim: To understand the ethnobotanical plants it is necessary to identify the plants correctly on the basis of their morphological features.

Exercise: Students will identify the ethnobotanicals on the basis of broad features. These features may be their habit, leaf, foliage, stem, bark, flower, fruit, seed, odour etc. These features are not truly on taxonomic basis but unique identification characters for the general understanding and differentiation. Students will also know the local uses of these plants. Paste photographs of important plants with herbarium preparation of these plants.

List the plants you have identified (Place-----)

S. No.	Common Name	Botanical Name	Family	Habit	Major Identification Features
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Practical No. 2

Objective: To be familiar with the preparation of herbarium specimens of the Ethnobotanical / ethnomedicinal plants species.

Aim: The plant species with the ethnomedicinal values collected from the field need to have correct identification, naming and to be preserved for longer periods in the herbarium. So, to understand the procedures and protocols followed in the process of herbarium preparation from the collection of specimens' up to the process of mounting on the herbarium sheets before storing.

Material Required: Herbarium sheets, wooden block press, old newspapers, pencil/marker, thread etc.

Exercise: - Each student has to collect 25 plant species with the ethnomedicinal values from your local vicinity. Prepare the herbarium specimens for each collected species.

S. No.	Common Name	Botanical Name	Family
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2.			
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Practical No. 3

Objective: To study the distribution of tribal/ethnic people of India.

Aim: Study of tribals of India will help student to know the tribal distribution, their language, habits and ethnobotanical practices.

Exercise: Students will depict locations and populations of different tribes in India

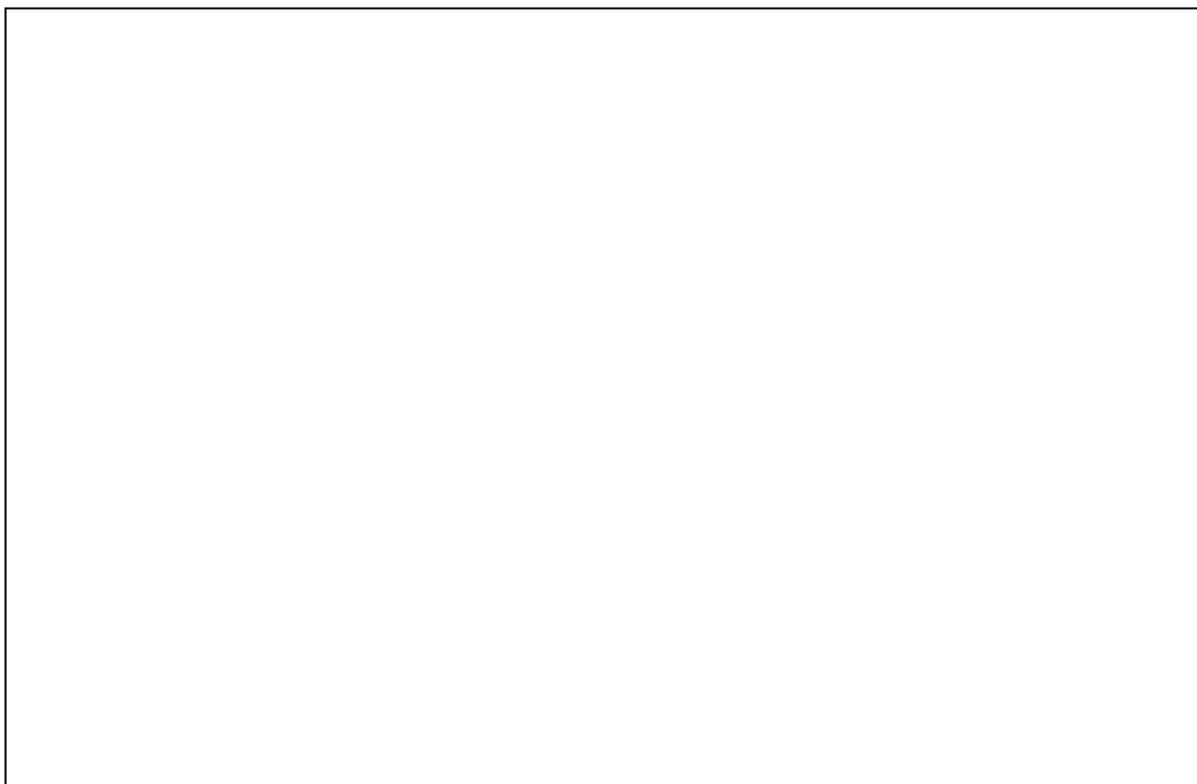


Practical No. 4

Objective: To study the tribal distribution and use of ethnobotanicals of Bundelkhand region (Uttar Pradesh and Madhya Pradesh)

Aim: Study of tribals of Bundelkhand region will help students to know their distribution, language, habits and ethnobotanical practices.

Exercise: Students will draw a map of Bundelkhand region with the different tribes, their locations and populations with the list of ethnobotanicals used by these tribes.



Important tribes

S.N.	District	Name of tribes	Major Ethnobotanicals used	Any Remarks
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Practical No. 5

Objective: To study major ethnomedicinal plants and practices followed in India

Aim: The practical exercise is important to know about different types of ethnobotanical, phytodiversity and ethnic people of the country

Exercise: Students will study the use of ethnomedicinal plants and practice in the country with the help of literature. They will gather information on important practices with respect to plants and their uses by tribal people. They will list out the ethnobotanical plants, their uses, and ethnic groups associated with particular practices.

Prepare a table for ethnomedicinal plants & practices.

SN	State/ Region	Tribal groups	Main Ethnomedicinal plants/ practices used
1.			
2.			
3.			
4.			
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8.			
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11.			
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Practical No. 6

Objective: To collect locally used ethnobotanicals

Aim: To acquaint the students with identification, collection and demonstration of ethnobotanicals. Collection of ethnobotanicals is important for demonstration, identification and utilization of these ethnobotanicals. The assemblage of ethnobotanicals is also helpful to develop curative (museumological) interest among the student.

Exercise: The students will collect locally used ethnobotanicals from market, forest or agriculture fields. They display the collected products in different groups on the basis of utilization e.g. ethnomedicine, food, veterinary medicine, fibres, dye, wood etc. The display approach may be chart, booklet, plastic box or other display material with a name, family, product and its utilization written in bottom. Every student will submit the 20 ethnobotanicals and collection will be evaluated during practical examination.

Table for information of collected botanicals

S. No.	Common Name	Botanical Name	Ethnobotanical Parts	Area	Use
1.					
2.					
3.					
4.					
5.					
6.					
7.					
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9.					
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Practical No. 7

Objective: Identification of important ethnobotanicals

Aim: Identification of plant products help in utilization of these products and authentic 11 Certification of ethnobotanicals.

Theory: Identification of ethnobotanicals is an important exercise for an ethnobotanist. Like plant identification and product identification helps in classification, utilization and collection of authentic ethnobotanicals. Product identification is very difficult than plants especially for bark, tubers, roots and rhizomes. To check adulteration, it is very important to identify correct material either by colour, smell or form before going for its chemical analysis.

Exercise: Student will identify the ethnobotanicals on the basis of colour, smell, form and type. The ethnobotanical samples will be shown from different regions of the country and students will list them as per utilization, tribal association and their present relevance. The identification marks, characteristics for diagnosis will be writing part in the practical activity by the student.

Identification of important ethnobotanicals

SN	Common Name	Botanical name	Parts used	Identification marks
1.				
2.				
3.				
4.				
5.				
6.				
7.				
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Practical No. 8

Objective: To prepare a standard proforma or questionnaire for ethnobotanical field studies.

Aim: To carry out field work related to ethnobotany it is essential to develop proforma of questionnaire. It is useful tool to collect the relevant information of the case in studies.

Theory: A standard proforma to carry out field work is necessary to execute systematic work of survey. It should be prepared in such a way that all relevant and desired facts can be collected from tribals. Questionnaire may be close or open ended. Generally, for desired and specific study closed ended questionnaire is preferred where only questions of interest are asked. In open ended questionnaire whatever information person gives is collected either relevant or not. Therefore, it is very much required to have a good proforma for field work to collect all information. A frame of proforma is given below-

General information (Informer's name, place, tribe, age, sex etc)	
General description (Geographical, political, social, linguistic, demographical, climate, vegetation, agricultural practices, forest, market etc.)	
Vegetation details	
Wildlife (animals) details	
Domesticated animals and animal husbandry details	
Ethnobotanical details	
Agricultural practices details	
Social beliefs, taboos and customs	
Any other information of interest	

Exercise: Students will develop a questionnaire for ethnobotanical field study. Proforma will be prepared as per location of study and objectives. After preparation of questionnaire students will use the same for survey in local area. Each group of students will be given topic of survey assignment like food, livestock, ethnomedicine practices etc. and after compiling they will submit the same as report.

Practical No. 9

Objective: To visit the tribal communities/villages for the collection of ethnobotanical knowledge.

Aim: To understand the ethnic practices followed by the tribal people in different domains of utilization of plant resources. Special focus for collection of information on ethnomedicinal and food practices which can be adopted for betterment of mankind.

Theory: Tribal people still practices the primitive/ethnic preparation for utilization of plants, among these ethnoagriculture, ethnomedicine and food preparations are common areas of interest. Many of these practices are also supported by scientific research. All such practices like organic farming, ethnomedicine, ethnic food practices etc. can be embraced for the better utilization of plant resources.

Exercise: Students will visit the nearby tribal villages to understand their social system, knowledge about the use of ethnobotanicals, listing of ethnobotanicals, sacred plants and practices etc followed by the tribals. Students will prepare questionnaire for this purpose to expedite the study and will record the information.

Questionnaire proforma

Name of person	
Tribe/ Ethnic group	
Village	
Practices	a. b. c. d. e. f.

Practical No. 10

Objective: To study morphological description and identification of various medicinal plants.

Aim: To understand the medicinal and aromatic plants, it is essential to identify the plant species correctly on the basis of their morphological features and physiognomy. This will help students to recognize the herbal plants, their useful parts and their morphological features for remembering their uses as per doctrine of signature.

Exercise: Students will identify the common medicinal and aromatic plants on the basis of above mentioned features as well as taxonomic classification from the surrounding areas, herbal gardens; forest areas etc. and will prepare a list with their common name, vernacular name, botanical name, family and major uses. They will take photographs of important plants and also prepare herbarium specimens of these plants. Photographic and herbarium collection have to be submitted to the course teacher for evaluation.

List the identified plants in tabular form

SN	Common Name	Botanical Name	Family	Habit	Major identification feature
1					
2					
3					
4					
5					
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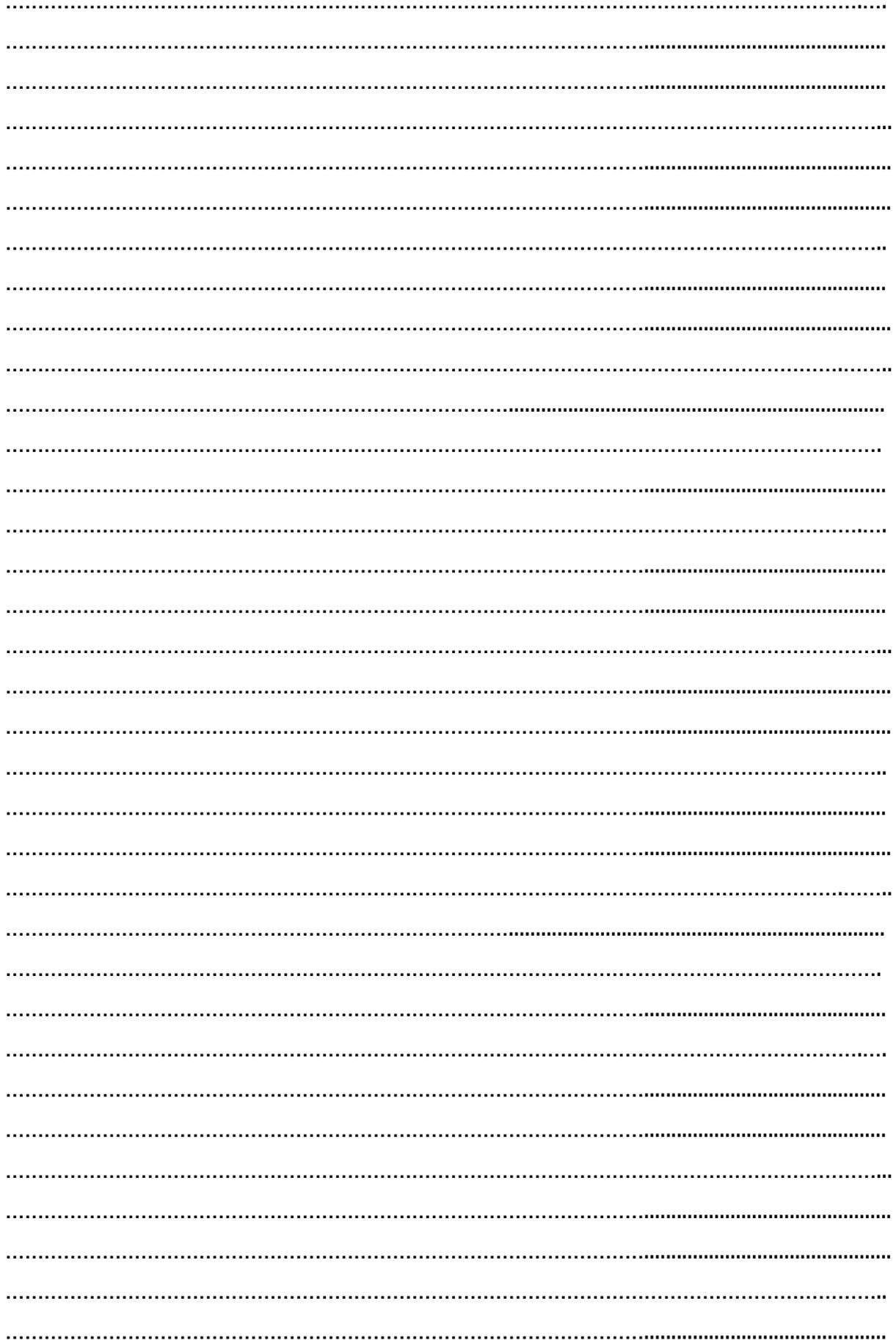
Practical No. 11

Objective: To visit and acquaint with the herbal garden cum medicinal/aromatic plant repositories.

Aim: Exposure of the student to the *ex situ* conservation approaches for medicinal and aromatic plants. It will facilitate the design, layout and establishment of these types of conservatories in local areas and germplasm repository establishment for augmentation of medicinal and aromatic plant species in regional level.

Exercise: Students will visit the herbal garden for identification, collection and augmentation of medicinal and aromatic plants. They will collect the information regarding the germplasm, its source of collection and other relevant information in tabular form as follows.

S.N.	Common Name	Botanical Name	Family	Uses	Remarks
1.					
2.					
3.					
4.					
5.					
6.					
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Practical No. 13

Objective: To collect medicinal and aromatic plants or plant parts from natural habitats.

Aim: Medicinal and aromatic plants are used for a variety of purposes. About 90% of medicinal plant products or raw drugs are collected from the wild (forest areas). Many of these plant parts cannot be clearly and easily identified especially dried bark, tubers, roots etc. Their collection from natural forests by students will help them in proper identification of plants as well as the raw drugs.

Exercise: Students will visit the nearby forest areas to collect the plant samples and plant produce or raw material of herbal drugs. Each student will collect 20 –30 samples of plants or plant parts and these will be submitted in plastic bags or containers with proper labeling for identification and demonstration. All the information of collected material will be presented in tabular form in the practical notebook as follows.

S.N.	Local name of plant or produce	Botanical Name	Family	Collection area	Uses
1.					
2.					
3.					
4.					
5.					
6.					
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Practical No. 14

Objective: To visit the medicinal and aromatic plant nurseries in local area.

Aim: Nursery visit is important for the exposure of students for better understanding of nursery practices for different medicinal and aromatic plants.

Methodology: Nursery is the main source of planting material for most of the medicinal and aromatic plants. Most of the perennial medicinal plants are cultivated from rooted cuttings and seedlings for which nursery is very important. Students will visit the nursery area and prepare a report on medicinal and aromatic plants and their nursery practices along with all the other relevant information. The practical record has to be prepared as follows

Exercise:-The students will prepare standard nursery layout in a display chart for medicinal and aromatic plant nursery.

S.N.	Local name of plant	Botanical Name	Family	Nursery Practices
1.				
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Practical No. 15

Objective: To study the propagation and nursery techniques of given medicinal and aromatic plants.

Exercise: -A group of 3-4 students will be given propagation/nursery raising exercise for 1-2 selected species during their semester. The students are required to produce at least 500 seedling/planting materials and all the work will be duly evaluated during practical examination. Write your observations in following table:

The nursery raising data will be recorded on routine basis and will be tabulated as follows

Medicinal plants information	Students observations in nursery
Botanical Name	
Family	
Habit and Habitat	
Description of Species	
Propagation method/ sowing method	
Seed pre-treatment /root hormone treatment	
Date of sowing	
Bed area and amount of seed sown	
Records of germination	
Survival percent	
Transplanting stage	
Botanical Name	
Family	
Habit and Habitat	
Description of Species	
Propagation method/ sowing method	
Seed pre-treatment /root hormone treatment	
Date of sowing	
Bed area and amount of seed sown	
Records of germination	
Survival percent	

Transplanting stage	
Botanical Name	
Family	
Habit and Habitat	
Description of Species	
Propagation method/ sowing method	
Seed pre-treatment /root hormone treatment	
Date of sowing	
Bed area and amount of seed sown	
Records of germination	
Survival percent	
Transplanting stage	
Botanical Name	
Family	
Habit and Habitat	
Description of Species	
Propagation method/ sowing method	
Seed pre-treatment /root hormone treatment	
Date of sowing	
Bed area and amount of seed sown	
Records of germination	
Survival percent	
Transplanting stage	

Practical No. 16

Objective: To visit the plantations and crop farms of medicinal and aromatic plant species in local area.

Aim: The visit to medicinal and aromatic plantations or crop areas will help in better understanding of the crop cultivation features and different stages of the crops in the field. Observation of crop performance by direct observation in the field area will be helpful in gaining of practical experiences.

Methodology: The local areas will be visited for medicinal and aromatic crops or plantations. The data will be collected for crop diversity, crop practices, agro-techniques, utilization, and market potential etc from the farmers. In this region mainly Ashwagandha (*Withania somenifera*), Coriander (*Coriandrum sativum*), Poppy (*Opium sativum*), Akarkara (*Spilanthus acemella*), Satvari (*Asparagus racemosus*), Safed musali (*Chlorophytum borivilum*), Sarpagandha (*Rauvolfia tetraphylla*), Anola (*Embllica officinalis*), etc. are commonly cultivated.

Exercise: - Students will prepare a report of their visit and will write brief particulars of visited plantation or crop areas.

Name/ Place	Crop/ plantation details	
	Crop and Variety	
	Area (acre/ ha)	
	Botanical Name	
	Family	
	Habit and Habitat	
	Propagation method/ sowing method	
	Amount of seed sown	
	Seed pre-treatment /root hormone treatment	
	Date of sowing	
	Fertigation	
	Harvesting & Yield	
	Any other information	
	Crop and Variety	
	Area (acre/ ha)	
	Botanical Name	
	Family	
	Habit and Habitat	
	Propagation method/ sowing method	
	Amount of seed sown	
	Seed pre-treatment /root hormone treatment	
	Date of sowing	

	Fertigation	
	Harvesting & Yield	
	Any other information	
	Crop and Variety	
	Area (acre/ ha)	
	Botanical Name	
	Family	
	Habit and Habitat	
	Propagation method/ sowing method	
	Amount of seed sown	
	Seed pre-treatment /root hormone treatment	
	Date of sowing	
	Fertigation	
	Harvesting & Yield	
	Any other information	
	Crop and Variety	
	Area (acre/ ha)	
	Botanical Name	
	Family	
	Habit and Habitat	
	Propagation method/ sowing method	
	Amount of seed sown	
	Seed pre-treatment /root hormone treatment	
	Date of sowing	
	Fertigation	
	Harvesting & Yield	
	Any other information	

Exercise: Perform extraction of essential oil using Clevenger apparatus and draw diagram of steps followed.

Observations:

Species for oil extraction-----

Quantity of biomass per batch-----

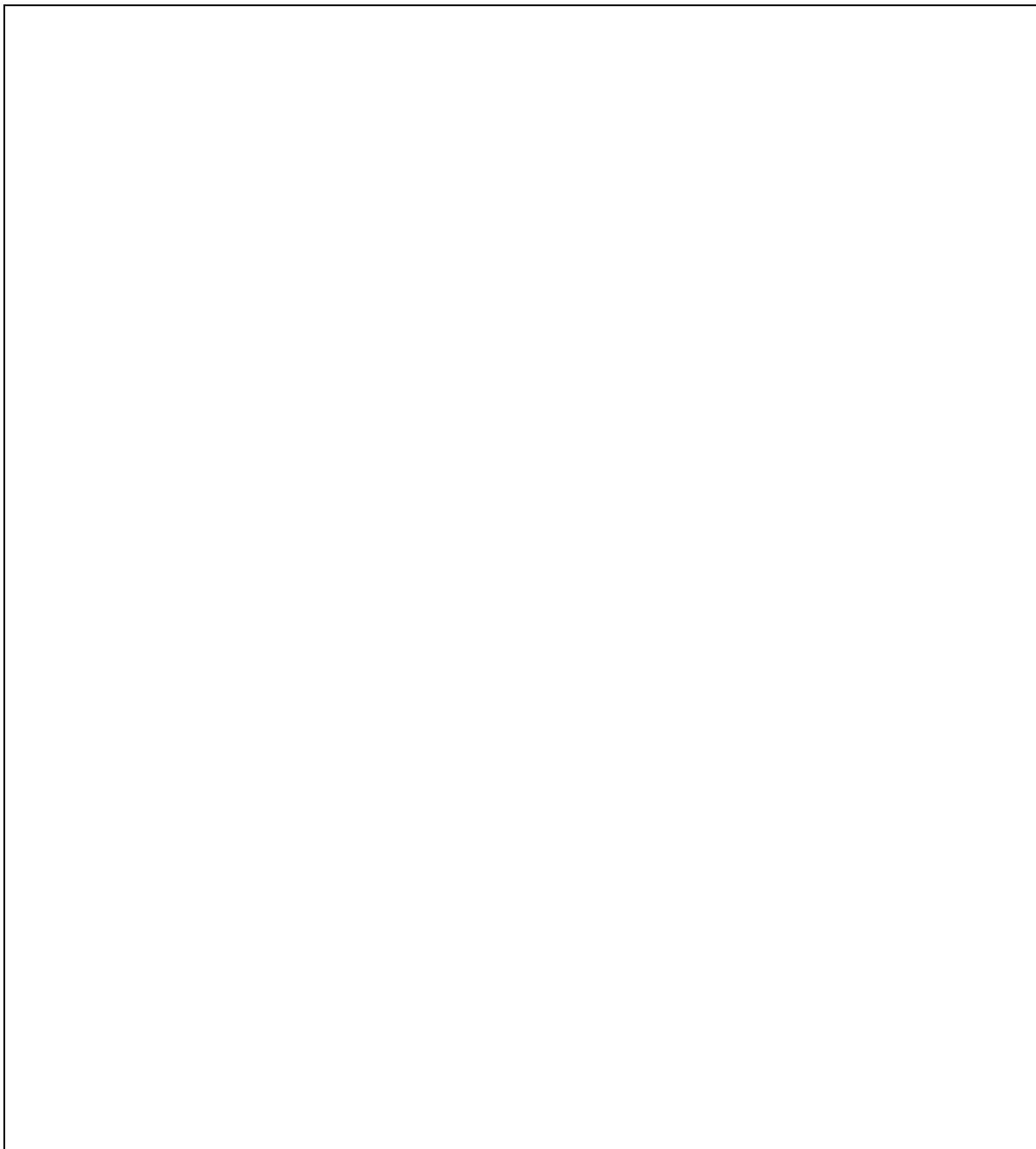
Time period for extraction-----

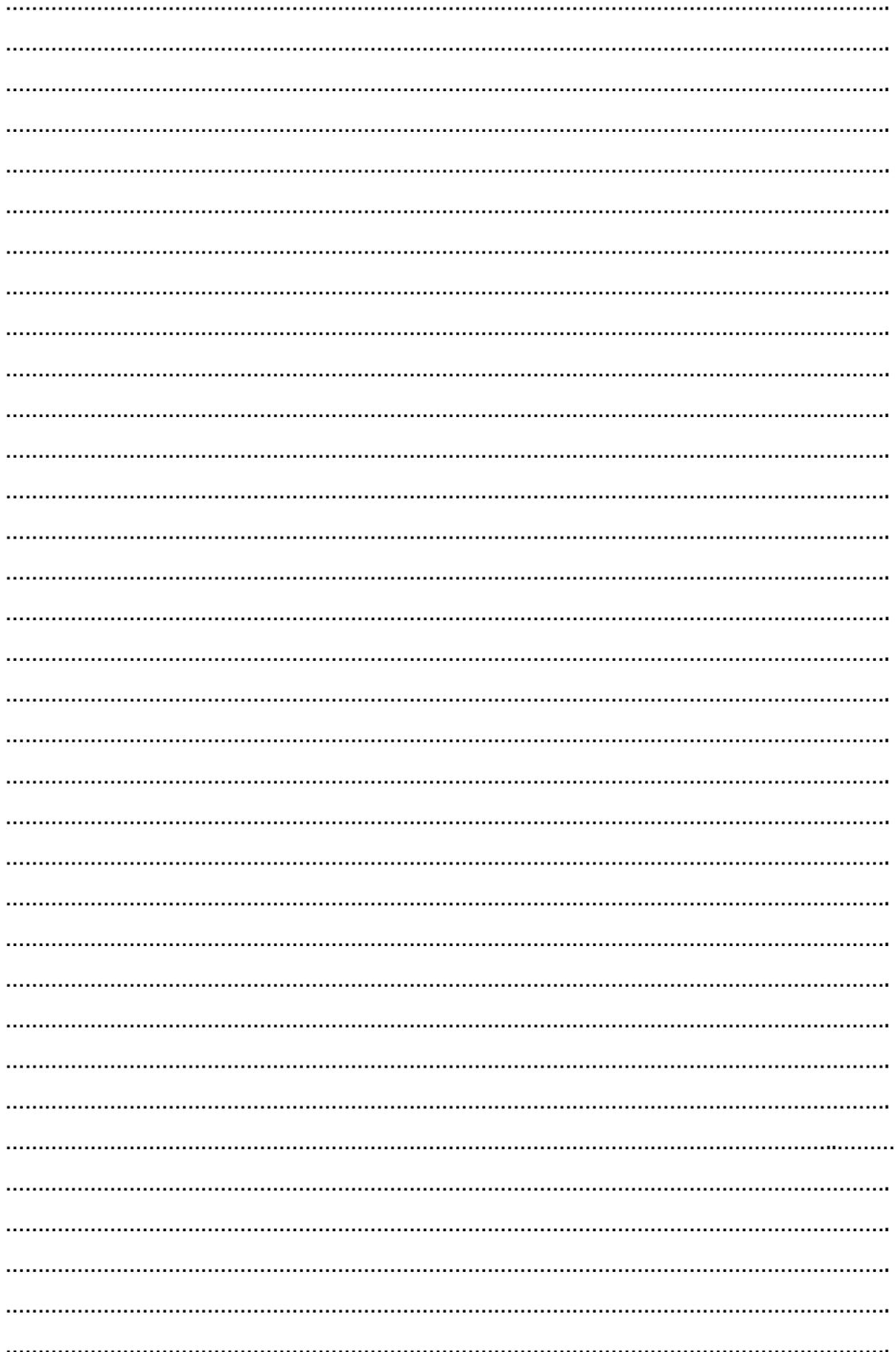
Yield of essential oil:

$$\text{Yield (\%)} = \frac{\text{weight of extracted oil (gm)}}{\text{weight of plant material (gm)}} \times 100$$

Any other observation-----

Draw a well labeled diagram of steps followed.





Practical No. 19

Objective: To study harvesting, drying, grading, storage, processing and value addition techniques for medicinal and aromatic plants.

Aim: The processes of post-harvest management and value addition techniques are essential to maintain the quality product in the competitive market. These processes if followed correctly increase the value and storage life of the herbal drugs.

Exercise: - Students in groups will carry out collection, harvesting, drying, grading, storage, processing and value addition for different locally available medicinal and aromatic plants.

Methodology: Post harvest management of medicinal and aromatic plants can be studied under following heads:

1. Harvesting:.....

.....

.....

2. Drying:.....

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3. Garbling (Dressing):.....

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4. Grading:.....

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5. Storage and Packing:.....

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6. Processing or Value addition:.....

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7. Preservation:.....

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8. Active constituents:

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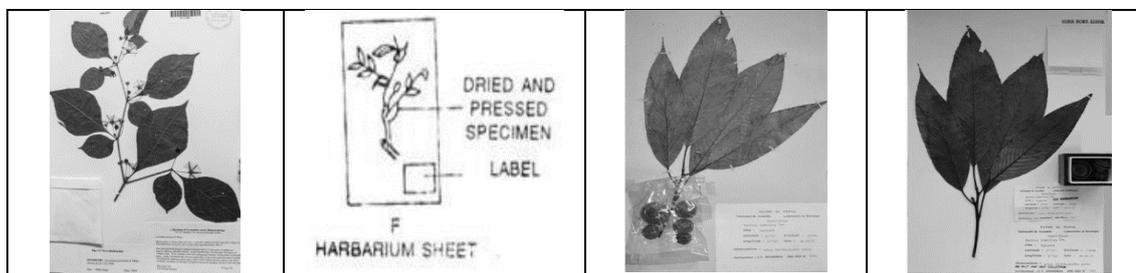
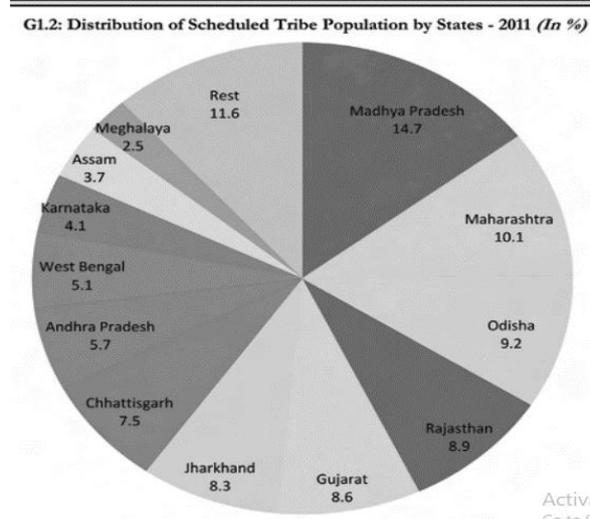
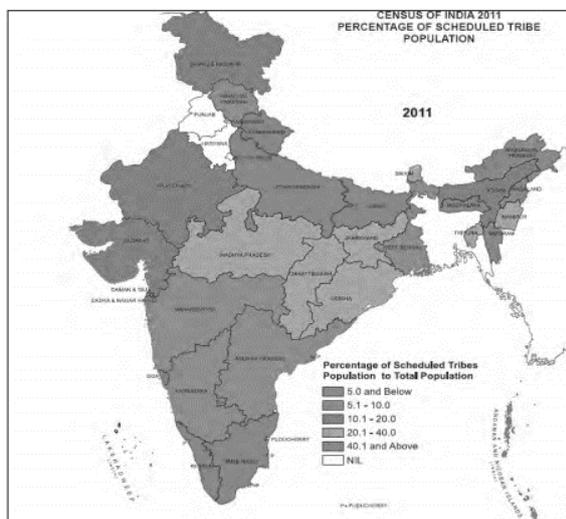
Steps in preparation of herbarium:

- **Collection:** Healthy and ideal plants which are free from insect-pests and diseases are selected. The specimen(s) should include if possible, all plant parts (underground parts, stems, leaves, flowers & fruits).
- **Pressing and drying:** Once the plant specimen is rooted out at right stage (at seedling, flowering and fruiting), it is necessary to press it and fit well inside the limits of folded sheets of paper. The pressed plants must be thoroughly dried prior to storage and mounting. Best results are obtained with the use of an electric drier that holds the presses and provides steady bottom heat between 45°C and 60°C.
- **Poisoning:** The plant specimen once dried need chemical treatment to protect them from insect attack and other destructive organisms. Thus, dipping of specimens is essential
- **Mounting:** After the specimens are dried and poisoned, they are mounted on herbarium sheets. Generally, the size of the herbarium sheet is 42 cm x 29 cm. The herbarium sheet should be of good quality and medium in weight. The specimens are placed in the centre of the sheet.

Labelling: The lower right-hand corner of the herbarium sheet should bear the label containing the information.

LABEL

Scientific name	<i>Cedrus deodara</i> (Roxb.) G. Don.
Family	Pinaceae
Vernacular names(s)	Deodar, Devadaru
Locality	Royal public park, mall road, Shimla, H.P.
Habitat	Damp, clay soil, 20 yards from riverbank, growing in dappled shade on the edge of evergreen forests
Habit	Perennial plant, up to 35 m tall, with rough bark, straight bole with conical crown
Characteristics	leaves are needle shaped with glossy green and bearing cones
Collector's name and specimen number	Sahil, 1
Date of collection	20 th March 2015

Standard herbarium sheet:**POPULATIONS OF DIFFERENT TRIBES IN INDIA**

MEDICINAL AND AROMATIC PLANTS CULTIVATION

Opportunities:

1. Widespread use of alternative medicine
2. Preference for natural products and chemicals from botanicals / herbs
3. Dwindling forest cover and reduced supplies from natural habitats
4. Availability of markets (global/ national)
5. Availability of high yielding varieties
6. Availability of agro-technologies
7. Availability of processing technologies
8. Profitable returns on sustainable basis

Advantages:

1. Generate employment through development of ancillary industries and checks migration of rural population to urban areas
2. Relatively higher net returns compared to agricultural/ horticultural crops and can be integrated into existing cropping/ farming systems
3. Some aromatic grasses can be used as fodder after extraction of essential oil
4. Bye-products can be effectively utilized for reducing cost of cultivation and increasing profits
5. Foreign exchange earnings through exports
6. Efficient utilization of work-force
7. Longer shelf life of end products
8. Low incidence of pests and diseases
9. Crops can be grown in degraded, marginal and problem soils
10. Crops are theft proof
11. Crops are not eaten by domestic animals
12. Crops are not damaged by birds
13. Crops and technologies are farmer-friendly and eco-friendly

IMPORTANT AROMATIC PLANTS SPECIES AND THEIR CULTIVATION PRACTICES

Trade Name/Scientific Name, Family	Commercial Application	Propagation Method	Agriculture practices
Citronella java/ <i>Cymbopogon winterianus</i> / Poaceae	Oil obtained from steam distillation of leaves in rich in citronellal and geranial and is used in perfumery, cosmetics and mosquito repellent formulations.	Vegetatively through slips during July/August and Feb/March, about 55,000 slips/ha	Irrigation: 4-6 during rain free period, fertilizer: 150 N, 60 P ₂ O ₅ and 60 K ₂ O kg/ha/year. Leaf blade is harvested 15 cm above the ground. First harvest comes 90 days after planting, subsequently at 3-4 months interval; economic life 4 Year
Lemon- scented gum/ <i>Eucalyptus citriodora</i> / Martaceae	The oil is used in soaps, perfumes, disinfectants, germicides and for exaction of citronellal which is used in midmarket washing and washing-up detergents.	The crop is raised through seeds; seedlings are first raised in polythene bags as the root system of the seedlings is sensitive. The seeds germinate in 4-15 days. They attain 20-30 cm height in about 12-16 weeks and are ready for transplanting.	Grow well in acidic to slightly alkaline deep soil, PH 5.5 to 8.5, Spacing 2×2 (Rainfed) and 75×75 (Irrigated), Fertilizers 60-120 kg. N in 2 or 3 equal splits, 30kg. Each of P ₂ O ₅ and K ₂ O Per/ha are applied every year.
Lemongrass/ <i>Cymbopogon flexuosus</i> / Poaceae	The oils used in perfumery and cosmetic industry and also in manufacture of Vitamin A.	Through vegetative slips during Feb / March, economic life: 4-5 yr.	4-5 harvests/year, 6-8 irrigation and fertilizer; N 150,60P ₂ O ₅ , 60 K ₂ O, FYM 10t/ha., Harvesting period May to December
French/sweet basil/ <i>Ocimum basilicum</i> / Lamiaceae	The oils are used in soaps, perfumery, flavour and pharmaceutical industries and for isolation of aroma chemicals like linalool, methyl cinnamate, methyl chavicol etc.	Seeds by direct seeding or transplanting of 6-7-week-old seedlings is adopted where irrigation facilities exist	Fertile and well drained loamy soil, spacing 60×40, FYM-20 t/ha, 120 kg. /ha N, 80 kg/ha P ₂ O ₅ and 40 kg/ha K ₂ O per/ha., Irrigation weekly once, harvesting 65-75 days after planting when the plant is in full bloom stage.
Menthol mint/ <i>Mentha arvensis</i> /	Oil is source of natural menthol used in flavour	Vegetative propagation through suckers; 5q suckers for direct	It is a 6-7 months crop, soil well drained fertile loamy soils, Spacing 45×45cm, Irrigation weekly one an

Lamiaceae	and pharmaceutical industries.	sowing and 1q/ha suckers are required for nursery and transplantation of seedlings	time, Fertilizers N 160, P ₂ O ₅ 50 and K ₂ O 40 kg/ha., First harvest 100-120 days after planting, second harvest after another 60-70 days
Palmarosa/ <i>Cymbopogon martinii</i> Poaceae	It is used in perfumery and cosmetic industries, flavoring of tobacco and in soaps.	Propagated during rainy season through seeds 10-12 kg/ha. Seed for direct sowing and 2.5 kg/ha. Seed are required for nursery and transplantation of seedlings	Fertilizers: N 100, P ₂ O ₅ 50 kg/ha/year. In poor red soil of Deccan plateau, N up to 250 kg/ha gives good result. 46 irrigation (during rain free period). The crop is harvested 3-4 months after planting; 2-3 harvests obtained in the first year and 3-4 in subsequently year. Economic life 4-6 year
Rose-scented geranium/ <i>Pelargonium spp.</i> Geraniaceae	The eaves and branches are steam distilled to get "oil of geranium" used in high-grade perfumery product and soaps.	Through stem cutting, about 40000 plants/ha during November to February	Spacing 60×60, Irrigation Alternative days for a month; later on, at 5-7 days interval, fertilizer: 150-200 kg N, 60 P ₂ O ₅ and 60 K ₂ O kg/ha., 2-3 weeding and regular hoeing are required, Harvest after about 4-5 months
Vetiver/ <i>Vetiveria zizanioides</i> Poaceae	The roots are steam distilled to get vetiver oil, which used in high-grade perfumers.	Vegetatively through slips; planting during February and July-August; 40,000 slips/ha.	Roots are harvested 18-10 months after planting. Soils of medium fertility do not require fertilizer. For red laterite soils in South India, fertilizer N 20, P ₂ O ₅ 40 kg/ha is required as basal dose at the time of planting. Vetiver is cultivated as a rain fed crop; 1-2 irrigation: required if planted during dry period.

IMPORTANT MEDICINAL PLANTS SPECIES AND THEIR CULTIVATION PRACTICES

Name /family	Economic part and chemical constituents /uses	Propagation Method	Agriculture practices
<i>Abelmoschus moschatus</i> (Kasturi bhindi), Malvaceae	Seed volatile oil contain fenisol, ambrettolide oil used in perfumery, flavouring and cosmetic industries	Seeds are sown at a spacing of 60x45 cm during April- May Seed rate: 6kg/ha	Transplanting after 20 days of sowing Spacing: 60x30 cm. FYM 15 t/ha, NPK: 120:35:40 kg. ha. The pods are harvested in about 6 months during Nov.-Dec. when turn black and dried under shade. seed yield 1.5-2.0 q/ha
<i>Andrographis paniculata</i> (kalmegh) Acanthaceae	Whole plant Andrographolide. Flavonoids. bitter tonic used in fever, worms, dysentery, liver and digestive complaints.	Seed sowing; June Seed rate:400 g/ha Can also be propagated by cuttings	Transplanting after 45-50 days Spacing: 30x30 cm. FYM: 25t/ha NPK: 75:75:50 kg/ha. 1 st harvest after 90-120 days. 2 nd harvest after 60 days of 1 st harvest. Before storage the harvested plants are dried for 3-4 days under shade. Dry herb yield 2-2.5 t/ha
<i>Asparagus racemosus</i> (Shatavar) Asparagaceae	Tuberous roots, asparagins, saponins Used for nervous disorders, cough, burning sensation, enhance lactation	Propagated by seeds and root tubers Seed sown: April-Lune Seed rate: 1.5-2.0 kg/ha. Vegetatively through division of tuberous roots	Seedlings are transplanted when they are about 8-10 cm long. spacing: 60x60 cm. FYM: 30t/ha NPK 95:45:30 kg/ha. Roots are harvested after 18 months of sowing, washed, dried and stored in air tight containers. Fresh root yield: 140-150 q/ha Dry root yield: 12-15 q/ha.
<i>Cassia angustifolia</i> (Senna). Leguminosae	Leaves and pods Glycosides (Sennoside A and sennoside B). It also contains sennoside D. useful in constipation, jaundice and laxative.	Can be grown in February-march or October-November. Seed rate 20 kg/ha broadcasting and seed soaking in water for 12 hrs give maximum germination of seeds.	Transplanting after 8 weeks Spacing: 45x30 cm. FYM: 5-10 t/ha NPK: 100:50:30 kg/ha. Foliage harvested after 50-90 days of sowing second picking after 90-100 days and third between 130- 150 days when entire plants are removed. harvested crop is dried in 10-12 days. Dry leaves 15 q/ha pods yield: 7 q/ha.
<i>Catharanthus roseus</i> (periwinkle, sadabhar) Apocynaceae	Roots and leaves, Ajmalicine, serpentine, reserpine from roots Diuretic, antidiabetic Vincristine and Vinblastine have importance in cancer therapy	Nursery raising in March –April Seed rate: 500g/ha. It can be broadcasted in June-July Seed rate: 2.5 kg/ha Propagated through softwood cuttings	Transplanting after 2 months of sowing. Spacing: 40x30 cm. FYM: 10-15t/ha, NPK: 40:30:30 kg/ha. The crop is harvested after 12 months of sowing. The plants are cut and dried for stems and leaves. Yield: leaves 4 t/ha stem and roots 1.5 t/ha each
<i>Gloriosa superba</i> (Kalihari) glory lily Liliaceae	Tubers and seeds colchine. Useful in treating gout rheumatism	Propagated by seeds or tubers. seeds are sown in Feb.-March. tubers are also planted in Feb. March	Tubers are transplanted after one year Spacing: 45x60 cm. FYM:25-30 t/ha. NPK: 40:50:75 kg/ha. harvesting of roots and capsules is done in October-November, then the capsules are dried in shade to separate pericarp. seed yield : 1.5 q/ha (1st year), 2.5-3.0 q/ha (2 nd yr)
<i>Rauwolfia serpentina</i> (sarapgandha) Apocynaceae	Roots Reserpine, serpentine. Useful in snake bite, inset bite, hypertension	Propagated by seeds, stem cuttings and root cuttings. seeds sown in third week of May Seed rate: 6 kg/ha	Root cuttings (1 q/ha) are planted at spacing of 45x30 cm during spring season. Root stump: about 5 cm of roots intact with a portion of stem above the collar are directly transplanted in field. FYM; 25-30t/ha. NPK:

			30:60:30 kg/ha. roots are harvested after 18 months of planting. 1 st year: 11.75 g/ha 2 nd yr: 22 q/ha.
<i>Withania somnifera</i> (ashwangadha) Solanaceae	Roots Alkaloids such as withanine, somniferine Use insomnia, weakness, inflammation, rheumatism. Valued as potent tonic	The seeds are sown in June-July in nursery beds either by broadcasting (10-12 kg/ha) or in lines (5-6 kg/ha)	Transplanting of seedlings is done after 25 to 30 days of sowing at spacing of 60x 60 cm. FYM: 2-3 q/ha NPK: 50:20:70 kg/ha. harvesting of roots in Dec.-Feb. after 150-180 days of sowing. Roots are cut and graded according to thickness. Dried root yield: 5-7 q/ha.

PROPAGATION OF MEDICINAL PLANTS THROUGH CUTTINGS

Major factors governing success of propagation by cuttings in MAPs

1. Physiological maturity of the cutting
2. Length of the cutting
3. Leaf retention on the cuttings
4. Season and environmental conditions
5. Influence of rooting media
6. Growth regulators
7. Role of microbial inoculants

Herbaceous cuttings:

- These are made from succulent, non-woody plants.
- Terminal cuttings or nodal cuttings of 7 to 12 cm long with leaves retained at the upper end are taken.
- *Coleus*, *geranium*, *Bacopa monnieri*, *Centella asiatica*, *Pogostemon patchouli* etc.

Soft-wood cuttings:

- Softwood cuttings are prepared from soft, succulent new growth of plants and are commonly employed for the propagation of herbs. The cuttings are usually 8 to 12 cm long with leaves retained at the upper end.
- Examples are *Nothapodytes nimmoniana*, *Pelargonium graveolens*, *Tylophora indica*, species of mints (*Mentha spp.*), brahmi (*Bacopa monnieri*) and other herbs.

Semi-hardwood cuttings:

- Semi-hardwood cuttings are usually prepared from partially mature wood of the current season's growth.
- Examples are *Adhatoda vasica*, *Bixa orellana*, *Boswellia serrata*, *Clerodendrum indicum*, *Crataegus oxyacantha*, *Embelia ribes*, *Ginkgo biloba*; *Jasminum sambac*, *Leptadeni areticulata*, *Nothapodytes nimmoniana*, *Piper longum*, *Plumbago rosea*, *Plumabgo zeylanica*, *Ruta graveolens*; *Salacia fruticosa* are commonly propagated by this method.

Hardwood cuttings:

- Hardwood cuttings are taken from dormant, mature stems of more than one year and are commonly adopted in MAPs such as Indian Myrrh, *Rosa spp.*, *Henna* etc
- Examples are *Celastrus paniculata*, *Jasminum grandiflorum*, *Lawsonia inermis*, *Nothapodytes nimmoniana*, *Premna integrifolia*, *Rauwolfia serpentina*, *Streblus asper*, *Rosa damascena*, *Taxus baccata*, *Vitex negundo*, *Wrightia tinctoria* are propagated through hardwood cuttings.

Leaf cuttings:

- In leaf cuttings, the leaf blade, or leaf blade and petiole, is utilized in starting new plants.
- Adventitious buds, shoots, and roots form at the base of the leaf and develop into a new plant; the original leaf does not become a part of the plant. Examples is *Bryophyllum*, routinely propagated through leaf cuttings.

DIFFERENT METHODS FOR THE EXTRACTION OF ESSENTIAL OILS.

Distillation or Hydro distillation: It is most commonly used method of extraction. It is defined as separation of the components of a mixture of two or more liquids by virtue of differences in their vapour pressure. There are three methods of hydro-distillation.

- (i) Water distillation:** In this method plant material comes directly in contact with the boiling water. Through this method, powdered material like almond and others like rose petals and orange blossom are distilled.
- (ii) Water and steam distillation:** In this method plant material is supported on a perforated grid with some distance above the bottom of still, which is filled with water. In this method steam is fully saturated, wet and never super-heated. It is employed for seeds and roots.
- (iii) Steam distillation:** In this method saturated or super-heated steam is introduced through open or perforated coils below the charge or above the grid. This method used for herbs and leaf material.
- (iv) Combination** is the process of preparation of raw material for distillation. The thick and woody plant material is fragmented before distillation. Combination apparatus necessary for this operation are of various designs.

Enfleurage or Cold Fat Extraction: This process is applied where the distillation may have deleterious effect on the essential oil through hydrolysis, polymerization and resinification. Where delicate oil is lost in high volume of water or where flowers continue to produce fragrance after the harvest e.g. Jasmine and tuberose. An enfleurage process is carried out in cool cellars and fat base (corps) is prepared for adsorption of fragrance. Rectangular wooden frame with glass fittings are coated with fat for spreading the fresh flowers in lower surface and fat adsorption on upper surface. Normally mixture of one part of highly purified tallow (ox or sheep fat) and two parts lard (Fat of swine) gives required corps. Flowers are charged

after 24 hours and saturated fat is removed, which is called pomade.

Maceration or Hot fat extraction: The flowers, which stopped their fragrance after harvest like rose, orange, violet and *Acacia* are extracted by maceration. In this process batch of hot fat is systematically treated with several batches of flowers until it becomes quite saturated with flower fragrance. Fragrant fat is called pomade. For every batch, extraction lasts for one and half hours. On commercial scale 80 kg of corps is heated to about 80°C temperature and charged with 20 kg of fresh flowers each time.

Solvent extraction: It is comparatively a recent process in which all types of perfumes are extracted with the help of volatile solvents like petroleum ether, chloroform. Fresh flowers are charged into specially constructed extractor at room temperature and treated carefully with purified solvent. Solution is pumped out in an evaporator and condensed.

Expression: This method involves squeezing any plant material at great pressure in order to press out the oils or other liquids e.g. Citrus oil from rinds and juices. Oil is separated from juice by centrifuging.

Super critical fluid extraction (SCFE): It is most recent method of extracting essential oils from the material of plant origins, where fragrance and flavour ingredients resemble their source. The raw material is enclosed in a cylindrical container with porous ends, which is located in the extraction chamber. The temperature and pressure are selected (above its critical temperature at 31°C and pressure 73.8 bars) according to the material and desired end product. Super critical carbon dioxide circulates through the plant material, dissolving the essential oil. SCCO is an excellent solvent for a wide range of natural substrates.

GLOSSARY

Absolute: It is a perfume material highly concentrated and it is entirely alcohol soluble.

Achene – [Fruits] {type} A more or less small, dry fruit that does not split open at maturity (indehiscent), with a typically thin, close-fitting wall surrounding a single seed.

Acuminate – [Leaf apices, Leaflet apices, Petal apices, Phyllary apices, Sepal apices] {shape} gradually tapering to a sharp point, forming concave sides along the tip

Acute – [Leaf apices, Leaflet apices, Petal apices, Phyllary apices, Sepal apices] {shape} Tapering to a pointed apex with more or less straight sides, the sides coming together at an angle of less than 90°. (Compare with acuminate and obtuse.)

Alternative: a drug which alters function of an organ.

Alternate – [Leaves] {insertion} Positioned singly at different heights on the stem; one leaf occurring at each node.

Anaesthetic: an agent to produce partial loss of the sense of pain, touch, temp., etc.

Analgesic: a drug that reduces or relieves pain

Androecium – A collective term for all the stamens and any closely associated structures in a flower.

Antidote: an agent that counteracts the action or effect of poisons.

Antiemetic: agents which prevent or lessen tendency to vomit.

Anthelmintic: a drug that acts against helminths.

Antipyretic: agents that reduce fever.

Antiseptic: agents that arrest development or reproduction of microorganism.

Antispasmodic: allays, relaxes and has a sedative effect on nerves.

Aphrodisiac: stimulates sex desire or power.

Astringent: contracts of tissues and checks secretions.

Axillary – [Buds, Inflorescences, Seed cones] {position} On the stem just above the point of attachment of a leaf (or leaf scar) or branch; borne in the axil of a leaf or branch

Bifoliate – [Leaves] {complexity form} Compound with two leaflets; two-leafleted or geminate.

Bisexual (1) – Having functional reproductive structures of both sexes (i.e. male and female) in the same flower or cone.

Bulb – [Stems] {type} A short, vertical, usually underground stem with fleshy storage leaves attached, as in onions (*Allium cepa*).

Capsule – [Fruits] {type} A dry fruit that opens (dehisces) in any of various ways at maturity to release few to many seeds.

Carcinogen: any agent that causes cancer.

Carpel – The basic ovule-bearing unit of flowers, thought to be evolutionarily derived from an infolded leaf-like structure; equivalent to a simple pistil or a division of a compound pistil.

Catkin – [Inflorescences] {type} A pendent, more or less flexible, spike-like inflorescence with numerous small flowers, typically of only one sex (unisexual), lacking petals and subtended by scaly bracts, as in willows (*Salix*) and birches (*Betula*); catkins are often wind pollinated and fall as a unit after flowering or fruiting.

Cauline – [Leaves] {position} With leaves positioned along the stem above ground level.

Colic: pain due to contraction of muscles in walls of intestines, caused by gas, etc.

Compound – [Leaves] {complexity} Divided into two or more equivalent parts, as a leaf that consists of multiple, distinct leaflets; not simple.

Concrete: It is non-purified form of essential oil obtained mostly by means of solvent extraction; plant pigment and waxes are present. From concrete 45-55% absolute is recovered.

Cordate– [Leaf bases, Leaflet bases, Leaflets, Leaves] {shape} Heart-shaped, with the notch at the base.

Corymb – [Inflorescences] {type} A racemose inflorescence with the individual flower stalks (pedicels) progressively shorter toward the apex so the flowers are all at about the same level, forming a flat or rounded surface across the top.

Cymose – In the form of a simple or compound cyme; bearing cymes.

Decurrent– [Leaf bases, Leaflet bases] {shape} With the leaf base extending downward along the stem.

Deltoid – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Similar in shape to an equilateral triangle, with the point of attachment

along one of the sides; like the Greek letter delta.

Demulcent: substances to soothen surfaces, particularly mucus membranes.

Dermatitis: inflammation of skin causing discomforts like eczema.

Diaphoretic: causes sweating or perspiration.

Disinfectant: a substance which destroys harmful germs, bacteria, viruses, etc.

Diuretic: an agent that induces or stimulates flow of urine.

Drupe – [Fruits] {type} A fleshy fruit that does not split open at maturity (indehiscent), with a soft outer wall and one or more hard inner stone(s) each usually containing a single seed, as cherries and plums (Prunus).

Elliptic – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Widest near the middle, with convex sides tapering equally toward both ends [modified from W&K, p. 36]; in the shape of an ellipse or narrow oval.

Emetic: agent causing vomiting

Ensiform – [Leaflets, Leaves] {shape} Long and moderately slender, flat in cross section, gradually tapering to a pointed apex; sword-shaped; as an Iris leaf. (Compare with awl shaped, linear and lorate.)

Epilepsy: a nervous disorder involving temporary loops of consciousness.

Expectorant: controls cough by regulating bronchial secretions.

Extrait: It is an alcoholic solution of odorous part of pomade. This is an intermediate product in the preparation of absolute from pomade.

Filiform – [Leaflets, Leaves] {shape} Long and very slender, basically round in cross section and of uniform diameter; thread-like.

Fixative: The materials which slow down the rate of evaporation of more volatile material in perfume composition. e.g. Sandal wood, Patchouli.

Follicle – [Fruits] {type} A usually dry fruit, with one interior chamber or locule, and splitting open (dehiscing) lengthwise along a single line, as in milkweed (Asclepias).

Fusiform – [Buds] {shape} Elongate, broadest at the middle, evenly tapering to either end, and rounded in cross section; spindle-shaped.

Glabrous – [2-4-year-old twigs, Buds, Leaf lower surface, Leaf upper surface, Petals, Petioles, Phyllaries, Rachises, Sepals, Young twigs] {pubescence} Lacking plant hairs (trichomes).

Haemorrhage: discharge of blood from blood vessels.

Hallucinogenic: a drug or substance that produces hallucinations.

Hispid – [Buds, Leaf lower surface, Leaf upper surface, Phyllaries, Sepals, Young twigs] {pubescence type} with stiff, bristly, usually stout-based hairs.

Hypogynous – [Flowers] {perianth position} With the perianth (the whorl of sepals and petals) not fused into a floral cup of any kind and arising at the same level as the base of the ovary.

Hypotensive: agents to reduce blood pressure.

Indehiscent – Not splitting or forming an opening at maturity, the contents being released for dispersal only after decay, digestion or erosion of the structure, as certain fruits, such as achenes and berries, that retain their seeds when ripe.

Insomnia: sleeplessness.

Lanceolate – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Several times longer than broad, widest near the base and tapering to a point at the apex; lance-head-shaped. (Compare with oblanceolate.)

Laxative: a mild purgative.

Monocious – [Plants] {distribution of gender} Having functionally unisexual (i.e. separate male and female) flowers or cones, which are borne on the same plant; each plant thus possessing both male and female reproductive structures.

Multilocular – With more than one interior compartment or locule.

Narcotic: agents which tend to paralyse nervous system, producing stupor or even death.

Nearly sessile – [Flowers, Leaflets, Leaves, Seed cones] {form of attachment} With a very short, somewhat indistinct stalk.

Oblong – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Shaped like a compressed oval, with the sides approximately parallel for most of their length.

Obovate – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Egg-shaped with the point of attachment at the narrower end; inversely ovate.

Ovate – [Leaflets, Leaves, Petals, Phyllaries, Sepals] {shape} Egg-shaped in outline, with the broader end near the base.

Ovule – The structure in flowering plants and gymnosperms which when fertilized develops into a seed.

Panicle – [Inflorescences] {type} A branched raceme, the main axis either determinate or indeterminate, and the lateral branches racemose; more loosely, a much-branched inflorescence of various types.

Parietal – [Placentation] {type} Attachment of ovules on the inner wall, or intrusions of the wall, of a compound ovary with a single inner compartment (unilocular). (Compare with marginal placentation.)

Peltate – [Leaf bases, Leaflet bases] {shape} Having the leaf stalk (petiole) attached to the lower surface of the leaf, usually near the center.

Perianth – The collective term for the outer sterile parts of a flower, comprising the calyx (sepals) and the corolla (petals) when both whorls are present.

Pistillate – [Flowers] {gender} Having functional pistils, but no functional stamens, making the flower unisexual and female.

Placentation – The arrangement of ovules within the ovary.

Polygamous – [Plants] {distribution of gender} Having both bisexual (combined male and female) and unisexual (separate male and female) flowers or cones, which are borne on the same plant or on different plants of the same species.

Purgative: an agent that causes evacuation of bowels.

Reflexed – [Leaves, Petals, Sepals] {vertical orientation} Bent backward or downward. (Compare with appressed, ascending and spreading.)

Reniform – [Leaflets, Leaves] {shape} Broader than long, broadly rounded and notched at the base; kidney-shaped.

Reticulate – [Leaf venation, Leaflet venation] {form} With a clearly visible network of interconnecting veins.

Sedative: soothes or allays irritability.

Sessile – [Flowers, Leaflets, Leaves, Seed cones] {form of attachment} Without a stalk, positioned directly against the bearing structure.

(Compare with petiolate, petioulate, nearly sessile and stalked.)

Sinus – The space or recess between two divisions or lobes of an organ such as a leaf or petal.

Staminate – [Flowers] {gender} Having one or more functional stamens, but no functional pistils, making the flower unisexual and male.

Stimulant: an agent that increases functional activity of an organ or whole body. .

Stipule – A relatively small, typically leaf-like structure occurring at the base of a leaf stalk (petiole), usually one of a pair; stipules are sometimes in the form of spines, scales or glands.

Succulent – [Plants] {habit} Juicy, fleshy and often thickened, as the stem of a cactus or the leaves of Aloe

Superior – [Ovaries] {position} With the ovary not fused to any portion of a floral cup, the whorl of sepals and petals (perianth) and/or stamens (androecium) thus arising from beneath the ovary.

Trifoliolate – [Leaves] {complexity form} Compound with three leaflets; three-leafleted or ternate. (Compare with bifoliolate, biternate and triternate.)

Unilocular – With a single interior compartment or locule.

Valvate – [Bud scales] {type} With scales (usually two) meeting by the edges without overlapping.

Vermifuge: a drug which kills or causes expulsion of intestinal worms.

Whorled – [Leaves] {insertion} With three or more leaves positioned on the stem at the same level; three or more leaves occurring at each node.

Winged – [2-4-year-old twigs, Petioles, Rachises] {special surface features} Having one or more elongate, relatively thin protrusions or appendages that loosely resemble wings, as the twigs of winged elm (*Ulmus alata*).