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DEPARTMENT OF AGRICULTURE
Ministry of Agriculture and Forests
Royal Government of Bhutan
Thimphu: Bhutan

FOREWORD

I am overwhelmed to note that the Agriculture Research and Development Centre, Yusipang has come up with the first edition on **"How to Grow Herbs?".** The booklet developed by the researchers of the Medicinal and Aromatic Plants Section under ARDC Yusipang is commendable. It provides a summarized production guide for 16 different types of herbs.

The culinary herbs are used for flavoring and adding fragrance in cooking. Generally, the leaves which are used in cooking are referred to as culinary herbs. For example, the green or dried leaves of Rosemary, Oregano, Coriander, Basil, and Parsley are used in Western and Continental cuisines for their aromatic flavors. In Bhutan, everyone uses one or the other herbs in cooking and more so in the high-end hotels and resorts. However, herbs are mostly imported from other countries due to limited production in the country.

In recent times, with initiatives from interested individuals, entrepreneurs and the government, the cultivation of culinary herbs is picking up. This publication is timely and aims to provide a guide for the culinary herb growers, researchers, and the extension personnel working in this field.

Lastly, I hope that the booklet will be of great help to the growers.

Tashi Delek!

Kinlay Tshering (Ms.)
Director

CONTENTS

INTRODUCTION

Culinary herbs are referred to as those fresh or dried parts of the plants that are used particularly for flavoring and adding fragrance in cooking. Either their leaves, flowers, seeds, bark, root, or whole plants can be consumed fresh as an ingredient for food recipe or can be processed into value-added products such as herbal tea, butter, jellies, and flavored oils or can be dried and stored for later use.

Generally, the leaves used in cooking may be referred to as culinary herbs, for example, the green or dried leaves of rosemary, oregano, coriander, basil, and parsley are used in Western and Continental cuisines for their aromatic flavors.

The other parts of herbs such as dried fruits (pepper), bark (cinnamon), and rhizomes (turmeric) are the important spices in the Indian kitchen. Some of the herbs used in hotels and resorts in Thimphu are rosemary, lavender, chives, mint, chervil, fennel, cilantro, thyme, dill, peppermint, French tarragon, bay leaves, sage, parsley, basil, winter savory, cilantro, oregano, and galangal.

This small booklet is prepared based on the experience of the researchers working on the culinary herbs, validated the information through literature reviews. The main objective of this booklet is to disseminate the basic information regarding culinary herb production. It will serve as a guidebook or the pocket booklet for researchers, extension officials, farmers, and entrepreneurs working in the field of culinary herbs. The booklet contains step by step guide for the production of 16 different types of herbs.

CLASSIFICATION OF HERBS

The herbs can be classified into three different groups based on their growing nature and life cycle.

ANNUAL HERB

Those herbs that produce foliage, flowers, and seeds in one growing season and then die back. Such type of herbs grows quickly in the spring, reaching maturity in about two months depending upon the variety. At the end of the season, the plant flowers, set seed and dies as the winter approaches.
Example: Basil, dill, coriander, savory, and borage.

BIENNIAL HERB

Those herbs that a form leaf in the first growing season, flowers, and seed in the second season and then dies. Only a few herbs are biennial.
Example: Sage, Parsley, Chervil, Celery.

PERENNIAL HERB

Those herbs that live more than two growing seasons. Perennial herbs grown from seed may grow slowly in the first year and gain vigor and maturity in the second year. The herbs die back over the winter and return in the spring. Most of the herbs are perennial. Example: Lavender, Rosemary, Thyme, Mint, Fennel, Oregano

GENERAL PROPAGATION METHODS

Herbs can either be grown from seeds, cuttings, layering, and stolon. Seed germination for herb plants is sometimes slow and unsuccessful. Seeds can be directly sown and later thinned to a proper spacing or can be raised in the nursery and later transplanted in the main field.

SITE SELECTION AND PRODUCTION SYSTEMS

Herbs are easy to grow since it can tolerate a wide range of soil types. However, organic manure has to be applied if the soil is heavy and compact. Preferably select a warm, sunny site with good drainage and few weed problems. Herbs can be grown in protected structures or containers under greenhouse conditions or hydroponically, this may, however, require significant investments.

A protected cultivation system is best when a single herb is grown in the entire bed. However, if growers prefer to grow smaller quantities of many different herbs, the grouping of herbs with similar cultural operations and requirements in the same bed is recommended.

The raised bed with plastic mulch and drip irrigation can increase yield and produce a cleaner product. Drip irrigation is the best technology for irrigating the herbs as it keeps the root zone moist and reduces the splashing of soils which makes the leaves easier to clean. Organic mulch, plastic mulch, or hand hoeing can also help control weeds.

Harvesting time for herbs depends upon the type of herbs and market requirement. Herbs are hand-harvested, washed, and then marketed fresh or harvested, washed, dried, and packed for long-term preservation.

CULINARY HERBS PRODUCTION TECHNIQUES

In this section of the handbook, summarized production techniques for 16 different types of culinary herbs are given. It contains basic but important information such as scientific names, common use, origin, basic environment requirements, propagation, nursery preparation, transplanting, pests and diseases and harvesting and post-harvesting techniques, etc.

1. ROSEMARY

Figure 1: Rosemary, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Rosmarinus officinalis*

Family: Liliaceae

Origin: Mediterranean region

Plant Nature: Evergreen and perennial, resistant to drought, cold and pest

Parts Used: Fresh or dried leaves

Uses: Cooking, essential oils

Basic Requirements

Altitude: From 1500 to 3000 m asl

Temperature: 20 to 25°C

Annual rainfall: 500 mm per annum.

Soil type: Well-drained loam soil and any kind of soil if there is no water logging condition.

Propagation Techniques

Seed propagation: Propagation through seed is a slow process with poor germination.

Layer propagation: This can be achieved by pegging some of the lower branch under a sandy soil for rooting.

Cutting propagation: Cuttings are taken from actively growing branch. Cutting propagation is recommended.

Nursery Preparation

a) Select a nursery site having enough space and water for irrigation, which is easily accessible and manageable, receives enough sunlight and is away from strong wind.
b) Bring the soil to fine tilt
c) Nursery bed of 1 m width and convenient length depending upon the land should be prepared.
d) The beds are then applied with mixture of top soil, leaf mold and sand, sow the seeds in line or broadcast and cover with thin layer of soil.
e) Mulch the nursery beds with plant materials and provide shade with shade net.

Hardening Seedlings

Hardening of the seedlings are done before transplanting in the field

a) 2 to 3 weeks before transplantation
b) The watering is gradually reduced.
c) Seedlings are partially exposed to the sunlight.
d) Shedding materials should be removed.

Transplanting

a) Seedlings are transplanted in the main field in spring or mid-summer
b) Space: 50 cm to 60 cm row to row and plant to plant

Manure and Fertilizer

a) Manures and fertilizers can be applied according to the condition of the soil.

Irrigation and Weeding

a) Irrigation is most required until roots are well established in the soil.
b) Weeding and hoeing can be done to loosen the soil and to remove weeds.
c) Three to four weeding is required in a year.

Pest and Diseases

a) Pest – mealy bugs, spider mite
b) Disease – powdery mildew, fusarium wilt, root rot
c) Can be controlled by showering the seedlings or applying fungicide or bio pesticides.

Harvesting and Post-Harvest

a) Harvesting time depends upon the time of plantation, soil fertility, geographical and weather condition and for the purpose of rosemary, whether for essential oil or herbs.
b) For the fresh market it is harvested at the young stage having young leaves
c) For essential oil it is harvested in the bloom and only flowers are harvested.
d) Harvested rosemary should be dried at temperature lower than 39^{o}C to retain flavor of essential oil and to maintain green color.

After drying leaves are separated from stems and then graded.

2. LAVENDER

Figure 2: Lavender, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Lavandula angustifolia*, mostly cultivated species

Family: Lamiaceae

Origin: Mediterranean region

Plant Nature: 60 to 80 cm height, Shrub, perennial, tolerate heat and drought

Part used: All parts

Uses: Cooking and essential oils

Basic Requirements

Altitude: Grows upto 900 m asl and some cultivars grow better in lower altitude

Temperature: Winter mean temperature 2-4^{o}C and summer mean temperature around 20^{o}C, prefer full sun for growth.

Soil type: Prefer well-drained soil with little organic matter with pH range from 6 to 8. Avoid clay soil. Susceptible to freezing injury.

Some species can be grown in higher region with cold winter and warm summer.

Propagation Techniques

Seed: Usually propagation through seed is not recommended

Cutting: Cutting is widely used and successful method of propagation.

Layering: Layering can also be practiced by putting the tender shoots under the soil, allowing them to root, which can be later cut and planted separately.

Nursery Preparation

a) The nursery site should have enough space and water for irrigation, should be easily accessible and manageable, should receive enough sunlight and should be away from strong wind.
b) Bring the soil to fine tilt
c) Nursery bed of 1 m width and convenient length depending upon the land should be prepared.
d) The beds are then applied with mixture of top soil, leaf mold and sand
e) The seeds are sown in line or broadcasted and then covered with thin layer of soil.
f) Mulch the nursery beds with plant materials and provide shade with shade net.

Cutting Propagation

a) Take the cuttings right after flowering is completed.
b) Select a vigorously growing branch.
c) The mother plant has to be healthy and disease free. Take cuttings from the stem without flowers on bud. Remove the leaves from the lower part of the stem. Insert the cuttings into well-mixed and drained soil.
d) Water the cutting and keep the soil moist.
e) Rooting will start in about three weeks.

Transplanting

a) Seedlings are transplanted in the main field when it reaches to transplantable size of 10 to 20 cm.
b) Cuttings are transplanted in the main field after root development in three weeks.
c) Convenient raised bed is prepared for transplanting
d) Maintain enough spacing of about 50 cm to 60 cm row to row and plant to plant distance to facilitate proper growth and easy cultural and farm operations.
e) Provide good mulching during the winter to protect the new plants from wind and snow.

Irrigation and Weeding

a) Do not require regular irrigation but it is necessary during plant establishment year.
b) Spring irrigation is necessary for young plants
c) Drip irrigation is best way of irrigation to keep the foliage clean and dry and to prevent diseases.
d) Weeding should be done as and when required. The plant performs poorly if not weeded.

Pruning

a) It responds well to pruning.
b) Plant should be pruned every year after establishment.
c) Is necessary on severely winter damaged plants, so cut stem back after new growth begins in the spring.

Pruning

a) Manuring is necessary during the establishment of the plant
b) The manures can be incorporated in the root zones of the plant after weeding

Pests and Diseases

a) There are some pests and diseases like bugs, caterpillar, root knot nematodes and leaf spot, stem blight, wilt problems in lavender.

b) Do not over water or allow water stagnate.

Harvesting and Post-Harvest

a) It is usually hand harvested.

b) Use sickle or pruning shear to cut stems.

c) Harvest time varies depending upon the end use i.e. essential oil, leaves or flower.

d) Make bundles of harvested stems and dry in cool dark place.

3. PARSLEY

Figure 3: Parsley, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Petroselinum crispum*

Family: Apiaceae

Origin: Europe

Plant Nature: Biennial

Part used: All plant parts

Uses: Flavor dishes, salad, soups and stews.

Basic Requirements

a) Parley grows best in sunny or partial shade
b) It grows best in well drained loamy soil
c) Preferred soil pH 6 to 7
d) Temperature: Grows in wide range of temperature but performs best at temperature range from 7-29^{o}C.
e) Moisture – average
f) To market the fresh parsley throughout the year it can be sown 3 times in a year – staggered planting

Nursery Preparation

a) Prepare nursery bed of 1 m width, 10 cm height and convenient length.
b) Soil is brought to fine tilth and mixed with organic manures
c) Sow the seeds in line or broadcasted at 6 mm depth.
d) Sow the seeds as soon as the soil is warm in the spring.
e) Germination ranges from 3-4 weeks after sowing.

Direct seed sowing

a) Seeds can be directly sown in the field and later thinned to proper spacing.
b) Germination is a problem in cold and wet soil. Therefore, pre-treatment of seeds with a water soak for 24 hours prior to sowing will avoid the germination problem.
c) It takes 90 to 100 days for harvest.

Transplanting

a) Seeds can be raised in nursery and later transplanted in the main field with spacing of 20-30 cm apart.
b) Transplant when the seedlings are well established and true leaves are formed.

Irrigation and Weeding

a) Keep the soil moist by irrigating as and when required, water requirement may differ to place to place.
b) Weeding can be done to loosen the soil and according to the weed pressure.
c) Irrigation and weeding

Pest and Diseases

a) Some of the pests are beetle, aphids and diseases are leaf spot and downy mildew and can be controlled by insecticides and fungicide respectively and by bio pesticides.

Harvesting

a) Hand harvested or harvested manually with a knife.
b) Pick leaf by leaf for daily use.
c) Harvest and dry in a cool area for later use.

4. BASIL

Figure 4: Basil at Ganey, 2020

BASIC INFORMATION

Scientific Name: *Ocimum basilicum*

Family: Lamiaceae

Origin: Central Asia and North West India

Plant Nature: Herbaceous, Annual plant, up to 50 cm tall.

Part Used: Whole plant parts, essential oils

Basic Requirements

a) Cultivated in subtropical or temperate region
b) Optimum temperature for germination is 20^{o}C
c) Growing temperature is 7-27^{o}C
d) Susceptible to frost and cold temperature injury
e) Develop well during long day in the full sun
f) Cannot tolerate drought stress
g) Annual rainfall requirement is 700 mm.
h) Well-drained fertile soil with high organic matter content

Planting Space

a) Seeds are sown at 6 mm deep
b) Plant to plant space: 15-30 cm
c) Row to row space: 50-100 cm

Propagation

The propagation can be done through seeds and cuttings

a) The seeds can be sown or transplanted in the early or late spring after the risk of frost. Initial growth will be slow but after few sets of leaves appear then growth will increase. The field has to be mulched with organic matter.
b) Seeds cab be directly sown in the field at 6 mm depth. It will germinate in about 2 weeks after seed sowing. After the seed emergences, thin the seedling to a proper space and plant population.
c) Seedlings can be raised in the nursery in the green house. When seeds germinate and attain the height of around 15 cm, the seedlings have to be hardened and then transplanted in the main field with the appropriate spacing.

Manure and Fertilizer

a) Manure requirement depends up on the soil condition
b) Organic manure can be applied at the base of plants after weeding.

Irrigation and Weeding

a) Requires regular watering throughout the growing season.
b) Drip irrigation is the best method to maintain clean foliage and avoid fungal diseases.
c) Irrigation and weeding can be done according to weed pressure. Weed pressure will decrease the basil leaves quality.

Pests and Diseases

a) Some of the pests and diseases of basil are mites, slugs, leaf miner and leaf spot, nematodes etc. and can be controlled by pesticides or by biological control.

Harvesting and Post Harvest

a) Harvest time depend on the use of herbs.
b) Harvest using sharp knife or sickle.
c) For fresh and dried leaves, cut the foliage at 10 to 15 cm above the ground to allow re-growth before appearance of flowers.
d) For basil essential oil, plant is harvested in full bloom.
e) For fresh leaves harvest, clean, wash and remove weeds and market.
f) For dried herbs, wash, clean and dry in a cool temperature.

5. DILL

Figure 5: Dill, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Anethum gaveolens*

Family: Apiaceae or umbelliferae.

Origin: southern Russia, western Africa and Mediterranean.

Plant Nature: Annual, 60-120 cm tall.

Part Used: Whole plant parts

Uses: Cooking, essential oils

Basic Requirements

a) Requires full sunlight
b) Protect from strong winds
c) Soil temperature has to be around 15-20^{o}C
d) Well-drained sandy or loamy soil
e) pH 5-7
f) Cannot tolerate heat stress of southern climates

Planting Space

a) Seed depth: 3-6 mm
b) Plant space: 20-30 cm apart

Propagation and planting

a) The propagation is through seeds.
b) Dill is grown either in field or in containers indoor or outdoor.
c) The seeds have to be directly sown in the field from April through May.
d) Do not transplant as it has tap root system
e) Seeds will germinate around 2 weeks after sowing.
f) Light is needed during seed emergence.

Manure and Fertilizer

a) Manure has to be applied while sowing seeds but fertilizer has to be broadcasted or applied as side dressing.
b) Do not apply fertilizer directly with seed.

Irrigation and weeding

a) Over irrigation will encourage powdery mildew infestation.
b) Weeding can be done as per weed pressure.

Harvesting and Post-Harvest

a) Leaves are harvested when plant reaches the height of 15 cm.
b) Leaves contain most flavors if picked before flowering.
c) Clip them close to the stem in early morning or late evening.
d) Once flowers are formed, they will bloom and seed.
e) Cut the seed head after the seed has turned brown.
f) Hang the cut seed head in a dry, well-ventilated space and let the seed fall on a tray or plastics.

Fresh dill can directly be marketed or can be frozen in plastic bag or dried for later use.

6. THYME

Figure 6: Thyme, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Thymus vulgaris*

Family: Lamiaceae.

Origin: western Mediterranean region.

Plant Nature: Perennial, grows up to 40 cm high.

Parts used: Leaves and flowers

Uses: Cooking and essential oils

Basic Requirements

a) Requires temperate to warm, dry and sunny climate.
b) Avoid shady area
c) Needs full sun to grow
d) Annual rainfall is 500 to 1000 mm per year
e) Requires light, well-drained soil
f) Preferred soil pH 5.0-8.0

Propagation

Propagation can be done through seeds, stem cutting, layering and even by dividing plants at their roots.

Seeds

a) Seeds can be sown in nursery in green house in spring
b) Seed depth is 6 mm or less
c) Seed germinates in about 2 weeks
d) When seeds are sown in trays, it will take 6-8 weeks to reach transplanting stage.
e) Transplant in the main field after the frost has passed

Cuttings

a) There will be homogenous plants
b) Has to be taken in spring
c) Cuttings should be 5-10 cm long.

Soil preparation

a) Bring the land to fine tilth, 2 to 3 tilling is recommended
b) Prepare the bed of 1 m width, 10 cm height and convenient length for transplanting.
c) Apply enough organic manure

Planting

a) Seed can be sown or cuttings can be transplanted in the field in spring.
b) The seedling or cuttings can be established in the main field.
c) The recommended plant to plant spacing is 20 to 30 cm and row to row spacing of 15 to 30 cm

Irrigation and Weeding

a) Do not over irrigate
b) Drip and overhead irrigation are suitable
c) Organic or plastic mulch is used to reduce weeds
d) Do hand weeding.

Pests and Diseases

Some of the pest and diseases of thyme are whitefly scale, spider mite and root rot, rust, botrytis, Alternaria blight and can be controlled by using pesticides or bio pesticides and by using natural organic disease control measure respectively.

Harvesting and Post-Harvest

a) For fresh produce, harvest only the young tips.
b) For dry produce, harvest stem and leaves just as flowering begins. Cut the entire plant at 10-15cm above the ground.
c) For essential oil, thyme is harvested during late summer when flowering begins.
d) Harvesting has to be made clean using sharp knife.
e) Sun drying of thyme will decrease the quality of essential oil.
f) Thyme should be dried at the temperature lower than 40^{o}C to preserve flavor of essential oil and green color and then packed.
g) Fresh thyme has to be cleaned from foreign materials and then packed in crates for marketing.

7. MINT

Figure 7: Mint, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Mentha piperita*

Family: Menthaceae or Lamiaceae

Origin: Eurpoe and Middle East

Plant Nature: Perennial

Parts used: Stems and Leaves

Uses: Cooking, flavoring drinks, chocolates, mouth fresheners

Basic Requirements

a) Mints grow best in sandy loamy soils
b) Soil pH 6.0-7.5
c) Optimum growth temperature for mint production is 12-15^{o}C.
d) Mint growth response best in full sun to partial shade.
e) Prefers moist soil condition.

Propagation Technique

a) Mints are rarely propagated through seeds.
b) Propagation is usually done through cuttings, stolon and separation of young plants from the clumps.
c) Cutting should be treated with rooting hormones to facilitate fast rooting.

Stolon

a) Select the stolon from the soil where the plants have spread with crowed stolon.
b) Stolon should not be exposed to sun or wind to reduce growth vitality.
c) Cover the stolon with soil or other materials if not planted immediately.
d) Plant the stolon when the ground is warm and not too wet.
e) Stolon shouldn't be planted in a very dry soil.
f) Plant in damp or moist soil and cover immediately.

Young plant

a) When there is permanent warm weather.
b) Plants should be 10-15 cm in height.
c) The young plants have cluster of roots on the stems.
d) Pull the young plant with roots and plant in the soil.
e) It has advantage over growing from stolon.

Soil Preparation

a) The land is ploughed and kept fallow for a year against weed infestation.
b) After ploughing, the field is thoroughly harrowed to make soil loose and dry.
c) Make soil fine and best for plantation.
d) Recommended spacing: 30-50 cm apart.

Manure and Fertilizer

a) Manure and fertilizer application depend up on soil type and management practices followed by the growers.
b) Compost are applied during land preparation.
c) Apply fertilizer in one early spring to supply enough nutrients for mints.
d) Over fertilizing will promotes rust and diminish mint oil production.

Irrigation and Weeding

a) Regular watering during growing season but do not over water
b) Weeding can be done by hand or using herbicide

Pests and Diseases

a) Some of the pest and diseases are aphids, flee beetle, cutworm and anthracnose mints rust and verticillium wilt and can be controlled by using pesticides and ensuring appropriate watering and proper sunlight to the plants respectively.

Harvesting and Post-Harvest

a) Use sharp knife or scissors to harvest the leaves and stems.
b) Fresh leaves can be harvested throughout the growing season once plant reaches 8-10 cm tall.
c) Tender leaves and stems have the best flavor.
d) Cut the stem within 2.5 cm of the soil.
e) Quality and quantity of mint oil is highest at the flowering stage.
f) Fresh mint can be stored in water in refrigerator for a week.
g) Harvest fully-grown stem and leaves and dry in a hot shady area upside down until brittle.
h) Store it in airtight container for a year for later use
i) Each plant can be harvested for 2-3 times per season

8. CULANTRO

Figure 8: Culantro, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Eryngium foetidum*

Family: Apiaceae

Origin: Continental tropic America

Plant Nature: Biennial

Parts Used: Entire plant

Uses: Flu, diabetes, constipation and fever.

Basic Requirements

a) Grows best in moist well drained sandy loams with high organic matter
b) Grows well in full sun and most commercial plantings occur in partially shaded moist area.

Propagation

a) Culantro is sexually propagated crop and is commonly propagated through seeds

Seedling Preparation

a) Seeds can be sown in nursery and later transplanted.
b) When seeds mature it gets separated from inflorescence and germinate naturally.
c) Seeds emerge within 2 to 3 weeks.
d) Transplant in the field.

Soil Preparation and Planting

a) Can be grown in open field as well as protected structure.
b) Crop matures earlier in protected area and late in open field.
c) Soil can be prepared by mixing organic manure.
d) Transplant the seedlings with spacing of 20-30 cm apart.

Manure and Fertilizer

a) Culantro is a shallow rooted plant and needs loose soil mixed with organic manures
b) Fertilizer can also be applied.

Irrigation and Weeding

a) Irrigation is needed to keep soil moist and can be done according to the soil condition.
b) Regular weeding is needed to avoid weed competition.

Pests and Diseases

a) Culantro is a pest and disease-free crop but then few pest and diseases are observed.
b) Some of the pest and disease are lady bugs, lace wings and root knot nematode and leaf spot and can be controlled by pesticides and biological controls.

Harvesting and Post-Harvest

a) Fully-grown plants can be uprooted completely or foliage can be cut at the base.
b) Harvest during early morning.
c) Harvested leaves can be washed and packed.
d) Can be refrigerated and stored with proper packaging.

9. FENNEL

Figure 9: Fennel, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Foeniculum vulgare*

Family: Apiaceae

Origin: Southern Europe and Mediterranean area.

Plant Nature: Perennial normally grown as annual

Part Used: Entire plant including seeds

Uses: Cooking, dysentery, diarrhea, cough, cold

Basic Requirements

a) A dry and cold weather favors higher seed production. Thrives well on long sunny day.

b) Well-drained loamy soil with rich plant nutrient and lime. Favored soil pH 6.5-8.0

c) Optimum temperature for seed germination and growth is 20-29 ^{o}C and 15-20^{o}C respectively.

d) Susceptible to frost at flowering stage. High wind during maturity shatters seeds.

Field Preparation

a) Field preparation done with early rain.
b) A clean and well harrowed soil is required.
c) Plough 3-4 times in heavy soil and 2-3 times in lighter soil.
d) Soil depth 15-20 cm.
e) Plough field and level them properly.

Sowing Time

a) Early and late sowing results in yield reduction and risk of pest and diseases.
b) May to June.

Seed Rate

a) It depends on sowing method and variety.
b) Seed rate for direct sowing 10-12 kg per ha.
c) Seed rate for transplanting 2.5-3 kg per ha.

Propagation Techniques

Direct sowing

a) It can be directly sown and later thinned to proper space and plant population.
b) It is either line sown or broadcasted.
c) Plant to plant space is 20 cm. Seed depth 1.5-2 cm

Sowing and transplanting

a) 45-50 days old seedlings have to be transplanted in the field with a spacing of 60-90 cm apart.
b) Irrigate right after transplanting.
c) Mulch with straw or other materials.

Manure and Fertilizer

a) Farmyard manure and compost has to be incorporated before sowing.
b) Fertilizer are also required for better yield

Irrigation and Weeding

a) Being long duration crop it required more irrigation.
b) First weeding is required at the time of thinning and later it depends up on weed pressure

Pests and Diseases

a) Fennel is infested by many diseases like stem and root rot, drooping off, umbel blight, powdery mildew etc. and can be controlled by using fungicides.
b) It is also attracted by many insects like aphids, caterpillar, seed wasp cutworm etc. and can be controlled by insecticides and pesticides.

Harvesting and Post-Harvest

a) Harvesting time depends up on the types of product we want.
b) Pick the umbels when seeds are fully developed but still green.
c) Harvesting is done before the fruits are fully ripened.
d) It takes 170-175 days to mature.
e) Harvested umbels are dried for 1-2 days in sun and then under shade for 8-10 days.
f) Dried seeds are cleaned, sorted, graded and packed in plastic bags or gunny bags or containers
g) Stored in damped free aerated storehouses

10. CELERY

Figure 10: Celery, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Apium graveolens*

Family: Umbelliferae/ Apiaceae

Origin: British Isles, Mediterranean area

Plant Nature: Biennial but can be grown as annual

Parts Used: Stems and leaves

Uses: Cooking

Basic Requirements

a) Celery is best grown in a cool, humid and long growing season with an ample and uniform supply of moisture.

b) Optimum temperature is 15 to 21°C, with a maximum temperature at 30°C.

Propagation Technique

a) Celery is usually propagated through seeds.
b) Three years old seed should be used to ensure the absence of viable leaf blight disease in seeds.
c) Otherwise, it must be treated with hot water.
d) Sow seed 10 to 12 weeks before field planting (usually in mid-June). Approximately 60 to 80 grams of seed provide enough plants for 1 Acre.

Nursery

a) Celery can be produced in tunnel houses for early or late markets (early July to late August and from October into November respectively).
b) Main crop celery can be produced from mid-August to late October depending on the microclimate.
c) Well drained soil with a high-water table is optimum for celery production.
d) Most of the celery root system is with the top 15 cm of soil but some roots penetrate as deep as 2 feet.
e) Clay soils are generally not suitable.

Transplanting

a) Field Transplanting - The usual field spacing is 15 to 20 cm between plants in rows 60 to 100 cm apart or in paired rows 20 cm apart with 60 to 100 cm between pairs.

Irrigation and Weeding

a) For succulent and tender stalks, high soil moisture is necessary.
b) Water must be regularly supplied at frequent intervals and more moisture is needed in the last month before harvest as the most rapid growth occurs at this time.
c) About 75 cm of water are required to grow the crop to maturity.
d) Hand hoeing may be necessary depending on the weed problems.
e) Plastic mulches may be used to control weeds in some systems of production.

Manure and Fertilizer

a) Celery is a heavy feeder and a poor forager, so, on all but the richest soils large quantities of nutrients should be applied.
b) Where manure is available its use is recommended. Up to 100 tons per hectare may be applied but watch that nitrogen levels are kept under control.
c) Lime should be applied to maintain the soil pH in the range 6.0 - 6.8 (preferably above 6.5). Lower pH levels are tolerated on peat soils.

Pests and Diseases

a) Diseases: damping-off (fungi), leaf blight (fungi), pink rot (fungi), aster yellows (mycoplasma) can be controlled by using hot water treated seeds and soil solarization.
b) Pests: tarnished plant bug, aster (Six-spotted) leafhopper and aphids can be controlled by using cultural and biological methods.

Harvesting and Post-Harvest

a) Celery is harvested as soon as it reaches marketable size.
b) Cut the stalks below ground level with a sharp blade.
c) Trim off outer leaves and pack in crates.
d) It is then washed, trimmed and packed in a receiving shed.
e) Sometimes leaves trimmed are used for processing into soups or dried herb mixes.
f) Celery can be stored 1 to 2 months at a temperature of 0 to 1°C and 98 to 100% relative humidity.
g) Celery is highly perishable, and when warm and wet it decays rapidly.
h) Pre-cooling is essential and is usually accomplished by hydro cooling forced-air or vacuum.
i) Store celery in a room free from strong odors since the plant absorbs foreign flavors.
j) Laborers should wear rubber gloves as severe skin rashes can occur in some individuals.
k) Packaging in well ventilated plastic is frequently used to protect it from wilting.

11. CHAMOMILE

Figure 11: Chamomile, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Matricaria recutita*

Family: Asteraceae

Origin: Southern and Western Europe, and North and West Asia

Plant Nature: Annual

Parts Used: Stems and Leaves, flowers

Uses: Cooking, tea and oils

Basic Requirements

a) Requires cool, temperate conditions to grow well, and a temperature of 7 to 26°C. Long summer days, full sun and high heat units to produce optimum oil yields.

b) An annual precipitation of 400 to 1400 mm per season is enough to produce a good crop.

c) Well-drained, sandy or sandy-loam soil with a pH of 4.8 to 8.3, and grows in any other soils that have good drainage.

Propagation Technique

a) Chamomile is usually propagated through seeds
b) Direct seeding method is used and later thinning to desired spacing.
c) Dividing the old plants or taking out root runners can also be employed

Seedling preparation

a) Each plant normally produces from 12 to 14 sets of runners.
b) Make sure that the plants with superior qualities are used for vegetative propagation.
c) The short 2 month growing season of chamomile allows it to be interplant with other biennial herbs or planted as an early or late crop.

Transplanting

a) Chamomile is planted annually at a seeding rate of 200 to 400 gram per Acre.
b) Spacing has to be done so that a full ground cover forms as quickly as possible, and weeds are eliminated.
c) Spacing of plants should be 30 x 30 cm.

Irrigation and Weeding

a) Sprinkler irrigation should be used.
b) The soil has to be moist, especially during seedling establishment, but not flooded.
c) Weeding can be done as and when necessary.
d) Keep the plants clean during the summer by hand-weeding, as hoeing could destroy small plants.

Manure and Fertilizer

a) Chamomile does not require large quantities of fertilizers, but adequate amount of organic manure should be applied before planting.
b) It has a high sodium uptake, therefore regenerating the soil.

Pests and Diseases

a) Whiteflies, aphids, spider mites, and thrips are the major insect pests affecting chamomile.
b) Cutworms and snails sometimes pose a problem.
c) Natural pest control measures should be used.

Harvesting and Post-Harvest

a) Flower heads are harvested in the summer while it is still in full bloom.
b) Readiness is estimated according to the whiteness of the land as a result of the number of open flowers.
c) Harvesting is best during temperatures of 22 to 25 ˚C.
d) Harvesting is done by hand.
e) Flowers can be used fresh, frozen or dried.
f) Hand-harvesting for the highest quality flower head for the tea market involves collecting the flower heads from the plants, at intervals.
g) The flowers with discs starting to open to fully open, produced more oil than flowers of either less or greater maturity.
h) As plants produce more flowers, they accumulate more oil content.
i) Dried flowers should be processed for tea production as quickly as possible because quality will be lost after storage for 6 months.

12. CHIVES

Figure 12: Chives, MAP, Yusipang

BASIC INFORMATION

Scientific Name: *Allium schoenoprasum*

Family: Alliaceae

Origin: Asia and Eastern Europe

Plant Nature: perennials plant up to 20 to 50 cm tall.

Parts Used: Leaves and bulbs

Uses: Cooking

Basic Requirements

a) Light – sunny
b) Soil – loam
c) Fertility – medium
d) pH – 5.8 to 7.0
e) Temperature – cool
f) Moisture – moist

Propagation Technique

a) Seed: Chives can be grown from seed. After at least four weeks of seed sowing, the young shoots should be ready for transplant.
b) Clumps: It is also propagated through rooted clumps in spring after frost danger has passed.

Transplanting

a) Space plants 10 cm apart and rows 30 cm apart.
b) Chives grow better if it is cut down to 10 cm in the summer.

Irrigation and Watering

a) Water deeply to make sure the soil does not dry out around the root zone.
b) Control weeds through regular weeding
c) A light mulch of shredded leaves, compost, or grass will help retain moisture and control weeds.
d) Weed control is particularly important during the first 2 months of growth when the plants are growing slowly.

Manure and Fertilizer

a) Soil rich in organic matter should provide sufficient nutrients.
b) Composted manure is recommended after the first harvest every year.

Pests and Diseases

a) Pest: Thrips and root maggots usually attack chives.
b) Diseases: Pink root, downy mildew

Harvesting and Post-Harvest

a) Harvest chives by snipping off leaves from the base of the plant.
b) Cut flower stalks off at the soil line once they finish blooming. This will prevent the plant from forming seed and keep it more productive.
c) Chives are most flavorful when used fresh.
d) Extra chives can be frozen by chopping up pre-washed leaves into small pieces and freezing these in plastic containers.

13. OREGANO

Figure 13: Oregano at Ganey, 2020

BASIC INFORMATION

Scientific Name: Origanum spp. *Origanum vulgare* most commonly used

Family: Lamiaceae

Origin: Mediterranean and Eurasia

Plant Nature: Perennial

Parts Used: Leaves

Uses: Cooking, pizza flavor

Basic Requirements

a) Well-drained to dry, sandy, gravelly loam soil
b) Soil should be neutral to alkaline in pH

Propagation Technique

a) Oregano is grown from seed, cuttings, division or layering.

Propagation through cutting

a) Root divisions and cuttings taken from the new plant growth are quickest to root.
b) Remove portions of stem 7.6 to 12.7 cm in length using sharp knife.
c) Plant cuttings in light potting medium such as peat moss and vermiculite and keep moist until rooted.

Hardening of Seedlings

a) Before transplanting, plants should be hardened for about a week to acclimate them to the outdoors conditions.
b) Transplant them with a spacing of 30-45 cm apart

Irrigation and Weeding

a) Plants can tolerate moist to dry conditions, and established plants are drought tolerant
b) Irrigate during dry spells
c) Do weeding depending upon the weed pressure.

Manure and Fertilizer

a) Fertilize only on yearly basis.

Pests and Diseases

a) Diseases: mint rust *(Puccinia menthae)*
b) Pest: aphids *(Myzus persicae)*, cutworms *(Agrotis spp.)*, mites *(Tetranychus urticae)*

Harvesting and Post-Harvest

a) Best harvested just before flowering.
b) Harvest by clipping the branches to leave only the lowest set of leaves.
c) Oregano is ideal for drying because they retain their flavor better than many other dried herbs.
d) Can be dried on screens, trays, in drying baskets or hung in bunches from the ceiling in a warm, dry area.

14. GALANGAL

BASIC INFORMATION

Scientific Name: *Alpinia galanga*

Family: Zingiberaceae

Origin: Indonesia

Plant Nature: Perennial plant up to 1.5-2.5m tall

Parts Used: Rhizome/ root & leaves

Uses: Cooking, perfumery, cosmetics

Figure 13: Oregano at Ganey, 2020

Basic Requirements

a) It is a shade loving plant requiring warm climate.
b) Sensitive to front and drought condition
c) Elevation: up to 1,000 m asl.
d) Sandy loam soil, rich in organic matter

Propagation Technique

a) The plant is propagated by splitting of rhizomes which are stored in cool dry place prior to planting.

Seedling Preparation

a) Seeds are directly taken from the tuber.
b) For superior seedlings, the mother plants have to have large stems and bulbs.

Bed preparation

a) The land should be prepared with farmyard manure with a combination of green manure as a basal dose just before planting.

Transplanting

a) The Rhizomes should be planted in April to May in warmer places.
b) February to mid-April is the best time for raising the crop in colder places.
c) Planting rhizome slices 2.2 tons per Acre with a spacing of 30 cm × 30 cm for one-year crop and 1.4 tons per Acre with spacing of 45 cm × 30 cm for two-year duration crop is recommended.

Irrigation and Weeding

a) Watering is done only during long dry spells.
b) Weeding can be done as and when required depending upon weed intensity.

Manure and Fertilizer

a) Well decomposed humus or vermi-compost may also be used as manure instead of farmyard manure.

Pest and diesases

a) There is no significant pest and diseases but sometimes pigs and monkeys destroy the young stems to suck the water

Harvesting and Post-Harvest

a) Harvest rhizome when the leaves turn pale and start drying
b) Crop can be harvested after 1 or 2 years
c) Harvest Galangal roots during the early winter to prevent rotting; or leave a few hands of roots in the ground over the winter and heavily mulch the entire area to keep them warm and dry.
d) Can be stored in the vegetable drawer of a refrigerator for two to three weeks.
e) Should be plastic wrapped preferably, wrap the root first in a damp cloth, then in a plastic bag.
f) Galangal can be frozen without losing any of its flavor

15. CHERVIL

Figure 14: Chervil at Ganey geog, 2020

BASIC INFORMATION

Scientific Name: *Anthricus cerefolium*

Family: Apiaceae

Origin: Eastern Europe

Plant Nature: Annual, up to 70 cm tall

Parts Used: Entire plant

Uses: Cooking

Basic Requirements

a) Moist, cool and well-drained soil
b) Partially shaded area is best
c) Doesn't do well indoors
d) Soil pH 5.5-7

Propagation Technique

a) Chervils are commonly propagated through their seeds.

Nursery and Planting

a) Sow seed in spring or fall
b) Seeds will germinate after 1 to 2 weeks
c) New seeds should be sown every after few weeks for continuous harvest throughout the season
d) The seeds can be directly sown in the field and when seeds are about 5 cm, then thin to around 10 cm apart.
e) Chervils can either be transplanted but seedlings are fragile
f) Planting space- 30 cm apart

Irrigation and Weeding

a) Requires consistently moist soil
b) It doesn't like hot and dry condition
c) Weeding should be done depending on the weed pressure

Pests and Diseases

a) Susceptible to aphids, slugs, deer, rabbits and groundhogs

Harvesting and Post-Harvest

a) Can be harvested at any time of the year.
b) Can either use in fresh or dried form.
c) Harvested chervil can be dried in commercial dryer or oven and stored in air-tight container.
d) Chervil flavor fades with slow drying.

16. SAGE

Figure 15: Sage at Ganey geog, 2020

BASIC INFORMATION

Scientific Name: *Salvia officinalis*

Family: Lamiaceae

Origin: Mediterranean region.

Plant Nature: Perennial, evergreen shrub

Parts Used: Entire plant

Uses: Cooking

Basic Requirements

a) Grows well in rich, well-drained soil, either light or heavy.
b) Soil pH 6.0-6.5
c) Prefers full sun

Propagation Technique

a) Seeds: seeds are sown thinly
b) Seeds germinates after 10-21 days
c) Transplant the seedlings when plants are large enough after the frost season.
d) Transplant at least 40 cm apart
e) Stem cutting is easy means of propagation
f) Take 10-13 cm long cuttings from new shoots from late June to early August
g) Cuttings can be rooted in sand or in other rooting mediums
h) Once roots are induced then plant in the rows 90 cm apart

Irrigation and Weeding

a) Sage has average watering need
b) Water on regular schedule, do not let the soil go completely dry
c) Do not overwater
d) Do weeding as per the weed pressure

Harvesting and Post-Harvest

a) Harvest leaves prior to blooming.
b) Harvest the foliage or cut the entire stem if desired from the well-established plant
c) Sage can be use in fresh or dried form.
d) Dry the harvested sage by hanging the bunches of stem upside down

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