



E-CONTENT

UDAI PRATAP COLLEGE, VARANASI-221002

Programme/Class: Diploma in Plant Identification, Utilization & Ethnomedicine/BSc-IV Semester

UG, Year: II, Semester: IV, Paper: I, UNIT-I

Subject: Botany; Course Code: B040401T

Course Title: Economic Botany, Ethnomedicine and Phytochemistry

Topic: Cultivation & Uses of SPICES-Black pepper & Cardamom

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BLACK PEPPER / *Kali Mirch*

(*Piper nigrum*; Family: Piperaceae)

Origin: Western Ghats of South India (Malabar)

Plant part used: Fruits/Berry

Pepper is the most important of all spices and popularly known as the '**King of spices**'. It is a dried mature fruit of perennial ever green climbing woody vine. Black pepper is one of the most important earliest known spices produced and exported from India. It is the most valuable and important foreign exchange earner among the important spices earning nearly 50% of the total export earnings from all the spices, because of its importance in the spices and unique position in trade and large share in export earnings, it is popularly referred as **Black gold** in trade.

Area and production:

Outside India it is grown in Srilanka, Malaysia, Indonesia, Brazil, Mexico, China, Thailand and Madagascar. India accounts for **54%** of the total area under pepper in the world but its share of production is only 26.6% whereas the other countries like Brazil, Indonesia, Malaysia accounts for lesser percentage of area but with more share in the total production due to their higher productivity. In India pepper cultivation is confined to southern states only. It is grown mainly in **Kerala (96% area)**, Karnataka, Tamil Nadu and Pondicherry. Since ancient time pepper is exported from India. On an average of 85% of the Pepper produced in the country is exported to USA, Canada and Italy. However now India lost its top position due to low productivity, poor yield and rise of Indonesia and Malaysia countries.

Botany:

Black Pepper is an evergreen, perennial woody climber reaching to a height of 10 m or more. It has extensive but shallow root system. The vines branch horizontally from the nodes but do not grow longer. Based on the growth habits morphological characters and biological functions, five distinct types of stem portions can be defined in the shoot system of a pepper vine.

FIVE DISTINCT TYPES OF STEM

Main stem	Runner shoots	Fruiting branches (Plagiotropics)	Top shoots (Orthotropics)	Hanging shoots (Geotropics)
It originates from a seed or from a stem cutting. It climbs on a support the aid or aerial or adventitious roots.	They are produced from the basal portion of the main stem, growing at right angle to the main stem, usually restricted up to 50 cm from the ground.	They are produced from the nodes of the stem and they grow laterally more or less at right angles to the main stem, bearing the spikes.	Vegetative shoots which arise on the top portion of the main shoots. It gives a bushy appearance with stouter, thicker internodes and with large number of adventitious roots at the nodes. They are used for the propagation.	In a fully grown vine, some of the plagiotropics at the top portions are seen to give rise to special type of shoots which hang down and grow geotropically.

Leaves are broadly lanceolate, alternate, simple, dark green and shiny above, pale green and gland dotted underneath. Size and shape variable.

The inflorescence is a catkin. Born on opposite side to the leaves on Plagiotropic branches, 5-15 cm long, bearing 50-150 minute flowers. The flowers are Monoecious or Dioecious or Hermaphrodite (bisexual) forms occurs in different varieties. Male flowers are very few. The fruit is a single seeded berry, sessile, small, globose/oval. It has thin pulpy pericarp around the seed. It takes approximately 6 months to mature after flowering. Each spike produce 50-60 fruits. The skin (exocarp) turns from green to red on ripening and black when dry.

Varieties:

More than 75 cultivars of pepper are being cultivated in India. Majority of the cultivated types of Pepper are monoecious.

Karimunda: Most popular variety throughout Kerala. Yields good quality of Pepper.

Kalluvally: Grown in North Kerala.

Recently a number of improved cultivars have been evolved and released. They are *Panniyar 1, 2 (Krishna), 3 (Shima), 4 and 5*: released from Kerala Agricultural University and **Pepper Research Station, Panniyur**.

Sreevara, Subhakar, Panchami, Pournami – released from NRCS, Calicut.

Malabar types: Grown in Malabar region in Kerala. Examples are Balankottah and Kalluvally. Suitable for shade.

Malvad types: Grown in Malvad of Karnataka. Workaiamarata variety is preferred for white pepper.

Travancore types: These are hardy, the cuttings root easily and climb the support without external help. Examples are Karimunda, Veluthanamban and Chola.

Climate: Pepper is a tropical plant and it requires warm humid climate for commercial production. It requires an optimum temperature between 25 – 30⁰ C. A well distributed annual rainfall of 125 to 200 cm is considered ideal for pepper.

Soil: Pepper can be grown in a wide range of soils such as clay loam, red loam, sandy loam and lateritic soils with a pH of 4.5 to 6.0.

Propagation: Pepper is invariably propagated vegetatively (**stem cuttings**). The selection of mother vine for perpetuation is done as follows:

1. A variety suitable for locality should be selected for instance **Panniyar-1** for open place and **Ballankottah** for shady location.
2. A variety should be selected depending upon the system of cultivation to be followed, for instance, **Kalluvally, Panniyar-1** for monocrop system. **Balankottah, Karimunda** for mixed cropping.
3. A high yielder with high % of bisexual flowers should be selected.

The runner shoots are separated from the vine in February – March and after trimming in leaves, cuttings of 2-3 nodes each are planted either in nursery beds or polythene bag filled with fertile soil. Cuttings from middle 1/3 of the shoots are desirable as they are high yielding. Adequate shade is provided and irrigated frequently. The cuttings ready for planting in May-June.

USES

Black pepper is a versatile spice with numerous culinary, medicinal, and industrial applications.

1.Culinary Uses: Black pepper is a staple ingredient in many cuisines worldwide.

The alkaloid '**piperine**' is considered to be the major constituent responsible for the bitter taste of black pepper, it is absent in leaves and stems. The characteristic odour is due to presence of a volatile oil, present in cells of pericarp containing **Phellandrine** and **Caryophylline**. It is used as a seasoning in various dishes, including soups, and meat dishes. The spice is known for its pungent, slightly bitter, and slightly sweet flavour, which enhances the taste of many dishes.

One of the principal values of pepper is its ability to enhance the seasoning of dishes. It is valued for its characteristic aroma, hot pungent and biting taste and is mainly used for flavouring and seasoning.

The aromatic odour of pepper is due to an essential oil, while the pungency is due to *Oleoresin*

2.Medicinal Uses: Black pepper has been used in traditional medicine for centuries due its potential health benefits. Some studies suggest that black pepper may have anti-inflammatory, anti-cancer, and digestive properties. Additionally, the spice is believed to aid in weight loss, improve skin health, and boost brain function. It is considered a powerful remedy for various disorders such as dyspepsia, malaria, delirium treatments.

The Egyptians used it for embalming. The Asians are said to have used it as an aphrodisiac. It is extensively used in Ayurvedic medicines. Pepper extract acts as a effective repellent.

3.Industrial Uses: Black pepper is also used in the manufacturing of various products, such as perfumes, soaps, and cosmetics. The essential oil extracted from black pepper is used as a flavouring agent in the food industry and as a fragrance component in the cosmetic and aromatherapy industries. It is largely used as preservative by meat packers and in canning, picking and baking confectionery and preparation of beverages. Oil and black pepper is a valuable adjunct in flavouring of certain beverages and liquors.

Cultural operation:

The pepper vines are tied firmly as and when they grow. The tying is done around the node, so that the nodal region is firmly attached and pressed against the standards so as to allow the roots to cling to the standards. This is an important operation which has to be attended to carefully as otherwise the vine will have no support. The another practice is that when vine reaches at a height of 75 to 100 cm without branches all the leaves are removed except the terminal 3-4 leaves. The defoliated portions are covered with friable fine soil. This aid in establishing a well developed system and lateral branches may arise out of them.

Training and pruning:

The vines are trimmed at the top and prevented from growing too tall for convenience of picking. In Tamil Nadu, pepper vines trained on Silver Oak standards are pruned at 6 m height from ground level for easy picking. The vines are trained up the support to give one main shoot and two lateral orthotropic shoots. These are pruned regularly to encourage the development of lateral fruiting branches but these lateral branches should not be tied to support, as this would discourage the bushy side growth.

Manuring:

Judicious and regular manuring is necessary to get good yields. About 10 kg of well rotten cattle manure or compost is given in April-May. Fertilizers to supply 100 g Nitrogen, 40 grams Phosphate and 140 gm of Potash/standard for vines at 3 years and above age may be applied annually in 2 split doses in April-May and August – September. During the first year of planting 1/3rd of this dose and in second year 2/3rd of the dose may be applied.

Harvesting:

Pepper vines start yielding usually from the 3rd/4th year. The vines flower in May-June. It takes 6-8 months from flowering to ripening stage. Harvesting is done from November to February in plains and January to March in hills. When one or two berries on spike turn red in early the whole spike is plucked. Yields vary with the variety and season. A full bearing vine yields one kg of dry pepper.

Harvesting of pepper is carried out according to the purpose for which it is harvested.

For preparation of **WHITE PEPPER** the berries are harvested at a slightly advanced stage of ripeness, i.e. when the berries turn red (bright orange). To get **BLACK PEPPER** the berries are gathered at young stages.

Yield:

Pepper vine attain full bearing stage in 7th or 8th year after planting. Yield starts declining after 20-25 years and replanting has to be done thereafter. Seven or eight year old pepper vine gives 800 to 1000 kg of Black Pepper/ha.

Processing of pepper:

Almost all produce in India is processed in to black pepper and only a very limited quantity is converted in to white pepper.

Black pepper:

It consists of fully developed, but unripe dried berries of Pepper. The harvested spikes are sun dried for 7 to 10 days on cement floor or mats, until the outer skin becomes tough black, shrink and wrinkled. Drying is carried till the moisture content get reduced to 10-15%. Then the dried berries are separated from the spikes by beating or rubbing between hands or trampling them under the feet. For making good quality of Black pepper of uniform colour, the separated berries are collected in a perforated bamboo basket or vessel and the basket with the berries is dipped in boiling water for 1 minute. The basket is then taken out and drained. The treated berries are sun dried on a clean bamboo net or cement floor. The recovery of black berry is about 33%.

White pepper:

This consists of dried pepper and it is prepared by removing the outer skin along with the pulp before drying. White pepper is prepared by one of the two methods.

I. Water Steeping technique:

It is a traditional and slow method. It involves 5 steps.

- A. Steeping:** Spikes with fully ripe berries are filled in gunny bags and are steeped in flowing water for about 7-8 days. During this steeping process, the skin gets loosened from the seed.
- B. Depulping:** At the end of steeping, the berries are taken out and the skin with the pulp is removed either by rubbing between hands or by trampling under feet.

C. Washing: The depulped seeds are then washed and cleaned with fresh water repeatedly (3-4 times).

D. Drying: The cleaned seeds are sun dried for 3-5 days on cement floor or mats till they become white and the moisture gets reduced to 10-15%.

E. Polishing: The dried seeds become dull white after processing. They are further cleaned by winnowing or rubbing with cloth.

The percentage of recovery of white pepper is about 25% of ripe berries.

II. Steaming/boiling technique:

This is an improved and quick method developed at CFTRI, Mysore. It involves 4 steps.

1. **Boiling:** Freshly harvested spikes or berries are boiled for about 15 minutes.

2. **Depulping:** The boiled berries are pulped mechanically. Boiled berries pass through motorized fruit pulping machine.

3. **Bleaching:** The boiled berries are washed thoroughly by using bleaching powder or any bleaching agent.

4. **Drying:** The cleaned berries are sun dried for 3-5 days on cement floor or mats till they become white and the moisture gets reduced to 10-15%.

White Pepper is also manufactured from black pepper with the help of Decorticating machine.



BLACK PEPPER VINES



BLACK PEPPER

CARDAMOM

- Small/Lesser Cardamom: *Elettaria cardamomum* (Malabar cardamom)
- Large Cardamom: *Amomum subulatum* (Native to Eastern Himalaya)
- Bengal Cardamom: *Amomum aromaticum*

-Family: Zingiberaceae

-Origin: Western Ghats of South India (Kerala)

-Useful Plant Part: Fruit and Seeds

Out of the above species, most popular species occupying a premier position is Small Cardamom. Large Cardamom is mainly cultivated in Darjeeling, Assam, Himalayas, Nepal, Bhutan, Thailand, and Indonesia.

Bengal cardamom is grown in Northern Bengal.





Small Cardamom [True cardamom/Green cardamom]

Small Cardamom is popularly known as the **Queen of Spices** and also **Green Gold**. It is one of the ancient species of India and is also one of the most valued species of the world. It is next only to Black Pepper as the largest foreign exchange earner among various Indian spices.

Cultivation of Cardamom is mostly concentrated in the evergreen forests of Western Ghats in South India. Besides India, Cardamom is cultivated in Guatemala, Tanzania, Sri Lanka, Vietnam, Cambodia and New Guinea.

Among three cardamoms small one is the most popular species. India has the largest area (90% of the world area) and is also largest producer (70%).

Among the different spices, exported from India cardamom **ranks second** after Black Pepper. Nearly 40% of the production is exported to more than 60 countries.

Importance/Uses:

Cardamom is used for flavouring and seasoning various food stuffs, confectioneries, beverages, and liquors. In Arab countries, beverage cardamom flavoured coffee is called '**Gawa**'. It is generally offered to guests at social and religious functions. In Sri Lanka cardamom is used in manufacturing liquors.

The essential oil of cardamom is used for medicinal purposes both in allelopathy and in Ayurveda. It is used as powerful aromatic stimulant, carminative, stomachic and diuretic. Cardamom seeds are chewed to prevent the bad breath, indigestion, Nausea and Vomiting. Some well known uses of small cardamom includes:

- 1. Cooking:** Small cardamom is a staple ingredient in many South Asian, Middle Eastern, and Scandinavian cuisines. It is commonly used in dishes such as biryani, curries, rice puddings, and gingerbread cookies. The seeds are often ground into a powder and added to recipes for an aromatic and flavourful enhancement.

- 2. Medicinal purposes:** Traditional medicine systems, such as Ayurveda and Unani, have long used small cardamom for its therapeutic properties. It is believed to aid digestion, relieve respiratory ailments, and boost immunity.

- 3. Perfumery:** Small cardamom is a key ingredient in many perfumes and fragrances due to its distinct, warm, and spicy aroma. The essential oil extracted from the seeds is used in the production of perfumes, soaps, and other personal care products.

- 4. Beverages:** Small cardamom is a popular flavouring agent in various beverages, such as coffee, tea, and traditional Indian drinks like masala chai. The spice imparts a warm, aromatic, and slightly sweet flavour to these beverages.

Botany:

Cardamom is a herbaceous perennial plant. A fully grown plant is about 2-4 m height. The real stem of the plant is the underground rhizome. The aerial pseudostem is made up of leaf sheaths. Leaves are lanceolate with dark green colour. It has shallow root system. Inflorescence is a long panicle with racemose clusters arising from the underground stem but comes up above the soil. Flowers are bisexual, pale white, flowers fragrant. **Fruit is trilocular capsule.**

Varieties:

Based on the size of the fruit, two varieties are broadly recognized in Cardamom.

- a. *Elettaria cardamomum* var. *major* : comprises of all wild indigenous type
- b. *E. cardamomum* var. *minor* : comprises of all cultivated types.
(Mysore type, Malabar type and Vazhukka type)

Improved Varieties:

- a. **Coorg cardamom Malabar selection – 1** (CCS – 1) (Malaba type)
Released by National Cardamom Research Station (NCRS). Appangala.
- b. **Mudigere -1**(Malabar type):
Released by Regional Agricultural Research Station, Mudigree, Karnataka.
- c. **ICRI -1** (malabar type):
Released by Indian Cardamom Research Institute, Myladumpara.
- d. **ICRI -2** (mysore type):
Released by Indian Cardamom Research Institute, Myladumpara.
- e. **PV –1**(malabar type): Released by Cardamom Research Station, Pampadumpara.
- f. **SKP–14**(malabar type): Released by ICRI Regional station, Saklespur, Karnataka.

Climate:

Small cardamom is a humid tropical plant. It is grown under natural conditions of ever green forests at an elevation from 600 to 1500 m above MSL. The plant prefers temperature of 10 to 35⁰ C and a well distributed rainfall of 1500 mm/annum. Summer showers are essential during summer. e. February – April for panicle initiation. It does not stand drought and is highly sensitive to winds. Under exposed conditions, the plant does not attain its full vegetative growth because of sun scorching. It grows luxuriantly under shade. Shade trees besides providing shade create a congenial micro climate in the plantation. It keeps the surrounding humid and cool. *Moderate shade, high humidity, cool surroundings, well distributed rainfall and wind less areas are very essential for the satisfactory performance of Cardamom.*

Soils:

Grows best on well drained humus rich forest soils. Water logging and excessive soil moisture conditions are detrimental. Moisture level should be 40 to 50% of the field capacity of the soil. **An ideal site is a sloppy land with good drainage.** In India cardamom is grown on red, deep and good textured laterite forest soils having plenty of humus. Ideal pH is 5.0 to 6.5.

Propagation:

Cardamom can be propagated by seeds, rhizomes and suckers. Out of which seed propagation is most preferred because of certain advantages over vegetative propagation.

By Seed:

Propagation by seeds prevents spread of **khatte disease**. This is the most common method. The main disadvantage is that the progeny is highly variable with no uniformity in the yield.

By Rhizomes:

Planting material of rhizomes is collected by uprooting 2 to 2.5 year old clumps. These materials are noted for their high yields. The advantage of this material is greater uniformity and earlier bearing habit compared to seedlings. One of the very serious disadvantages is that *Cardamom*

Mosaic Disease spreads through rhizomes. Plantations raised by vegetative means are short lived. Getting adequate plant material is another difficulty. If rhizomes are used for propagation continuously, the plants tend to lose their vigour after a few generations. Due to these limitations seedlings mostly used by farmers.

Nursery site and Planting:

Seedlings are normally raised in primary and secondary nurseries. The nursery site should be selected on gentle sloppy lands, having an easy access to a water source. Raised beds are prepared after digging the land to a depth of 30-45 cm. The beds of 1 m width and of convenient length raised to a height of about 30 cm are prepared. A fine layer of humus rich forest soil is spread over the beds. Seeds are to be collected from well ripe capsules. Immediately after harvesting, the husk is removed and seeds are washed repeatedly in water for removing the mucilaginous coating. After draining the water the beds are to be mixed with wood ash and dried in shade for a day. In order to ensure uniform and early germination, seeds should be sown immediately after extraction. One kg of capsules may produce 5000 seedlings.

Sowing may be taken up during November – January and is done in rows. Deep sowing should be avoided for better and quick germination. Seeds are mulched to a thickness of 2 cm with paddy straw or any locally available material and are watered regularly. The germination commences in about 30 days and may continue to a month or two. After germination the mulch is removed.

Seed rate: 10 g/m² of nursery bed area.

An overhead pandal with a height of 2 m is quite desirable. Materials like coir mat, coconut leaves or tree species which do not shed their leaves easily may be used but the coir mat is preferred as it allows uniformly filtered light.

Generally, in Kerala and Tamil Nadu the seedlings are transplanted to the secondary nursery when they attain 4 – 6 leaf stage. The beds are prepared in the same manner as that of primary nursery. Seedlings are transplanted in the secondary nursery in March – May at a spacing of 20 x 20 cm and mulched immediately. Beds are to be covered with an overhead pandal and should be watered regularly. Recently instead of secondary nursery beds, the seedlings are also raised in poly bags containing rich forest soil.

Raid clonal multiplication technique developed by Cardamom Research Centre, Appangala:

Cardamom is propagated mainly through seeds and also through suckers each consisting of at least one old and a young aerial shoot. The suckers are commonly used for gap filling but suckers may not be available in larger numbers.

Therefore rapid clonal multiplication technique evolved by NRCA, Cardamom Research Centre, Appangala is proved to be quick, reliable and economic for production of large number of quality planting materials. The site selected for this method should have a gentle slope and must be nearer to the water source. Trenches of 45 cm width, 45 cm depth and of any convenient length may be taken across the slope or along the contour at 1-8 m apart. The top 20 cm depth soil is excavated separately and heaped on the upper side of the trench. The lower 25 soil is excavated and heaped on lower side of the trenches all along the line.

Planting:

The best season of planting seedlings/suckers is just after monsoon showers. They are planted in the pits up to collar region for better growth. Cloudy days with light drizzle are ideal for planting.

Shade and shade regulation:

Cardamom is a shade loving (Pseophyte). Shade help to regulate soil moisture as well as temperature and provides congenial micro climate for cardamom growth. Shade protects plants from sun-scorching, rains and winds. Shade trees provide mulch material through fallen leaves on the surface and prevent soil erosion through their root system. Excess shade is also quite detrimental and shade has to be regulated so as to provide 50-60% filtered sunlight.

Some of the common shade trees are *Diospyros ebenum*, *D.elongi*, *Mimusopselangi*, *Artocarpus fraxinifolius*, and *Cedrella toona*.

Manuring:

Cardamom is a surface feeder and its growing areas are usually subjected to heavy rain fall conditions. The top soil is subjected to frequent leaching, resulting in the loss of nutrients. Even though there is annual replenishment of nutrients through the incorporation of fallen leaves of shade trees and cardamom plants. Therefore, manuring is very essential.

Under irrigated conditions – 75 kg N; 75 kg P and 150 kg K per ha.

Under rainfed conditions – 30 kg N; 60 kg P and 30 kg K per ha.

Organic manures may be applied at the rate of 5 kg per plant.

Irrigation:

Cardamom is generally raised as rainfed crop. However, it responds well to irrigation. It is necessary to irrigate the crop during dry periods to get increased yields.

Harvesting:

Only ripe capsules are harvested at 25-30 days interval, the harvesting is completed in 5-6 pickings. In most of the areas the peak period of harvest is during October – November.

Processing:

The commercial product of Cardamom is the dried capsules. At the time of harvesting the capsules are juicy and fleshy, so they must be cured before marketing.

a. Bleaching: Green colour of the cardamom capsules plays a vital role in the market. Green colour of the capsules can be preserved by **alkali treatment**. So freshly harvested cardamom capsules are soaked in **2% washing soda** (Na_2CO_3) solution for 10 minutes.

b. Drying: After bleaching, the capsules are dried either by sun drying or in fuel kilns and electric driers. The capsules are sun dried for 3-5 days. These capsules gets bleached and if does not store well. Hence, now a days capsules are dried artificially in which drying is incomplete and the green colour remains in electrical drier in capsules are dried at 45 – 50⁰ C for 18 hours.

c. Fuel kilns: Temperature is set at 50 – 60⁰ Cover night. The capsules kept for drying are spread thinly and stirred frequently to ensure uniform drying. The dried capsules are rubbed with hands or coir mats or wire mesh and winnowed to remove foreign matter.

Storage: Processed material stored in black polythene lined gunny bags to retain green colour according to size, and colour, before marketing.

In conclusion, small cardamom is a highly valued spice with a rich history and numerous uses. Its cultivation involves a series of steps that ensure the production of high-quality spice, while its applications range from cooking and medicine to perfumery and beverages. The unique aroma and flavour of small cardamom have made it an indispensable ingredients in many culinary traditions around the world.

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LARGE CARDAMOM/Badi Elaichi

❖ *Amomum subulatum* Roxb.

Large cardamom is the main cash crop cultivated in sub-Himalayan state of Sikkim and Darjeeling district of West Bengal.

Large cardamom is known to be amongst the oldest spice used by the mankind.

Sikkim is the largest producer of large cardamom and contributes lion's share to the Indian and world market. Recently large cardamom cultivation has also started in Nagaland, Meghalaya, and Arunachal Pradesh.

Climate:

Large cardamom, a sciophyte, has its natural habitat in the humid subtropical semi-evergreen forests of mountainous sub-Himalayan region. The areas under large cardamom cultivation receive annual rainfall of 2000-3500 mm apportioned over 200 days. The lower altitudes of cooler zones (proximal to the snow-line) and higher reaches of the warmer zones are best suited for its growth. Large cardamom belts experience mean annual ambient temperature range of 6⁰C (December-January) and 30⁰C (June-July) accompanied by constant high relative humidity. Continuous rain during flowering is detrimental, as it hampers the foraging activity of pollinating bees, thus affecting the flowers and resulting in poor capsule setting and barren spikes. Plants remain dormant during severe winter and can withstand up to 2⁰C but frost and hailstorms are injurious to large cardamom.

Soils:

Large cardamom is generally grown in forest loamy soils having soil depth of few centimetres to several inches. In general, large cardamom soils are acidic in nature and mostly ranges between pH 5.0 to 5.5. On an average, these soils have high available N and medium P and K.

Steepness of the terrain reduces chances of water logging and water-logged conditions are not suitable for the plants, hence adequate drainage is quite essential for the better stand of the crop.

Cultivers/varieties:

There are mainly six popular cultivars of large cardamom.

- ✦ Ramsey,
- ✦ Ramla,
- ✦ Sawney,
- ✦ Varlangey,
- ✦ Seremna, and
- ✦ DzonguGolsey

There are two high yielding varieties released by Indian Cardamom Research Institute for cultivation in Sikkim and Darjeeling-ICRI SIKKIM 1 and ICRI SIKKIM 2.

Field preparation:

Large cardamom grows well in forest loamy soils with gentle to medium slopes. Luxuriant growth is observed close to perennial water sources. It performs well under partial shade (50%). *Alnus nepalensis* (Utis) is the most common shade tree and *Alnus*-large cardamom is the most appropriate agro-forestry system for sustainable production in region.

The land selected for planting is cleared of all the under growth, weeds etc. Old large cardamom plants, if any may also be removed. Pits of size 30 cm x 30 cm x 30 cm are prepared on contours at a spacing of 1.5 m x 1.5 m from the centre of the pits. Wider spacing of 1.8 m x 1.8 m is recommended for robust cultivars like Ramla, Ramsey, Sawney, Varlangey etc. Closer spacing 1.45 m x 1.45 m is recommended for non-robust cultivators like DzonguGolsey, Seremna etc. Pits are left open for

weathering for a fortnight and then filled with topsoil mixed with cow dung compost/FYM @ 1-2 kg/pit. Pit making and filling operation should be completed in the third week of May before the onset of pre-monsoon showers. Planting is done in June-July when there is enough moisture in the soil. A mature tiller with 2-3 immature tillers/vegetative buds is used as planting unit. Suckers/seedlings are planted by scooping a little soil from the centre of the pits and planted up to collar zone. Deep planting should be avoided. Staking is needed to avoid lodging under heavy rain and wind and mulching is done at the plant base.

Propagation:

Propagation of Large and Small cardamom is almost similar.

Propagation is done through seeds and suckers.

(i) Propagation through seeds:

Seeds are collected from high yielding and well-maintained plantations free from diseases. Well matured capsules from the bottom and middle position of the spikes are selected for collection of seeds. After de-husking seeds are mixed and rubbed with sand and then washed with water to remove the mucilage completely. Once the water is completely drained, the seeds are mixed with wood ash, dried in shade and sown in the primary nursery.

Primary nursery: Seeds are generally sown in September-October. Seed beds are prepared in well-drained soils dug to a depth of 30 cm and left for weathering. Raised beds with 15 to 25 cm height, 1 m width and convenient length, preferably 6 m are prepared. Well-decomposed cattle manure is mixed with the soil and the surface of the bed is made to fine tilth. About 80-100 g of seeds per bed is sown in lines across the bed at a distance of 10 cm. Seeds are covered with fine soil and mulch with rice straw / dry grass (10-15 cm thick). Watering is done at regular intervals to keep the surface of the bed moist. Germination of acid treated seeds commences after 25 to 30 days of sowing. When average germination is noticed the mulch material is removed. The inter-space between rows is then re-mulched with chopped rice straw. Shades are immediately erected by using bamboo mats / reed mats or agro-shade nets. The beds are watered regularly and weeding is done as and when required. When the seedlings attain 3 to 4 leaf stage they are transplanted to secondary bed / nursery.

Secondary nursery: Secondary nursery can be prepared in poly bags or in raised secondary beds.

a. Poly bag nursery: Polythene bags of size 15 cm x 15 cm with perforations at the base are used for planting the seedlings from the primary nursery beds. The bags are filled with potting mixture of soil, sand and cow dung in the ratio of 4:1:1. The bags filled with the mixture are arranged in row of one meter width and at convenient length under the shades. Seedlings with 3-4 leaves are planted in the poly bags in April-May and watered regularly. They become ready for field planting in 10 to 12 months.

b. Raised secondary beds: Beds of size 15 cm height and 10 cm width with convenient length are prepared and well-decomposed cattle manure is mixed with the soil and an even surface is formed. Seedlings with 3-4 leaves are transplanted to the beds in May-June at spacing of 15 cm between them. The inter-space is mulched with chopped rice straw / dry leaves. Overhead shade is erected for providing cover and the soil is kept moist with irrigation. The seedlings on attaining height of 45-60 cm tillers are planted in the main field during June-July of the subsequent year.

(ii) Propagation through suckers:

The suckers collected from high yielding, disease-free, elite plantations having minimum of one mature tiller with two immature tillers or vegetative buds is used as planting units.

Selection of planting material:

- ❖ High yielding disease-free plantations to be selected.
- ❖ The plantation should have high yield record *i.e.*, more than 800 kg/ha for at least three consecutive years.
- ❖ One mature tiller with two immature tiller or vegetative buds is used as planting units.

Site of nursery:

- The nursery should be about 500 m away from the main plantation to avoid occurrence of pests and diseases.
- The irrigation facility should be available.
- It should be easily accessible by road.

Preparation of trenches:

- ✚ The trenches should be of 45 cm width and 30 cm depth with convenient length and may be made across the slopes of the field.
- ✚ Top soil 15 cm to be kept separately from the trench on the upside.
- ✚ Lower side 15 cm soil to be forked thoroughly.
- ✚ Dried leaves to be first applied as layer in the trench.
- ✚ Then the trench is to be filled with top soil mixed with cow dung compost.
- ✚ Spacing of 30 cm is required in between two trenches.
- ✚ The planting units to be planted at spacing of 45 cm in between with proper staking.

Plantation season:

- Last week of May-June.

Planting:

Planting may be done in May-June-July when there is enough moisture in the soil. A mature tiller with 2-3 immature tillers / vegetative buds is used as planting unit. Suckers / Seedlings are planted by scooping a little soil from the centre of the pits and planted up to collar zone. Deep planting should be avoided. Staking is needed to avoid lodging from heavy rain and wind and mulching is done at the plant base.

Harvesting and threshing:

The indication of time of harvest is when the seeds of top most capsules turn brown. As soon as the said colour appears and to enhance maturity bearing tillers are cut at a height of 30-40 cm from the ground and left for another 10-15 days for full maturity. The spikes are harvested by using special knives known as "Cardamom-knife" (*Elaichi chhuri*).

Yield, storage and post-harvest operations:

Harvesting begins early in the lower altitudes, during August-September and is as late as November-December at higher altitudes. The average yields range from 100 to 400 kg/ha. The fruit is a trilobular, many seeded capsule. The capsule wall is echinate having reddish-brown to dark-pinkish in colour. The seeds are di-angular, whitish when immature and become dark-greyish towards maturity. Usually the capsules which are formed at the basal portion are bigger and bolder than others.

Curing:

The quality of large cardamom is governed by its external appearance, which is influenced by colour, uniformity of size, shape, consistency and texture, and flavour, which ascertains taste and odour, and is affected by composition of aromatic compounds. The essential oil contains the volatile principles such as 1:8 cineole (75-85%), α -bisabolene (3-6%), r -terpinene (4-8%), α -terpineol + α -terpinyl acetate (3-6%). Cineole contributes to the pungency while α -terpinylacetate towards pleasant aroma.

The harvested spikes are heaped and capsules separated and dried. The cured capsules are rubbed on wire mesh for cleaning and removal of calyx (tail).

The fresh capsules are fleshy with almost 85% moisture. The keeping quality is poor and is highly perishable. They are cured/dried to about 10-13% moisture on dry weight basis to prolong its shelf life. Cardamom is cured (*i.e.*, dehydration of the fruits over low sustained heat) in a curing furnace, the heat invariably coming from burning of wood fuel. Traditionally, locally made furnace, the “Bhatti”, crude and primitive in operation, is a stone-mud structure, where capsules are dried by direct heating.

For good market value, the retention of natural colour and flavour constituents is very important. One on hand, the highly volatile flavour constituents are easily lost because of direct heat and/or high temperature, while on the other conditions of the traditional curing chambers result in colour loss and oozing capsules. This necessitates adoption of an appropriate curing method / system involving indirect heating with an optimum temperature range of 50-55°C, rapid air circulation within and exhaustion of moist air from the drying unit. The unit must be easily maintained and portable to be in operation near or in the vicinity of the remote plantations. Spice Board, Ministry of Commerce, GOI has attempted for quite some time now with improved and scientific “curing centres” based on hot-air flue indirect heating system but the traditional *Bhatti* still survives.

ICAR improved Bhatti: Improved curing techniques are presently available in which cardamom is processed to give quality and appearance. One such method is ICAR Improved Bhatti Curing System developed by **Indian Cardamom Research Institute, Regional Station, Tadong**, where cardamom is dried through indirect heating. In this cardamom is dried by indirect heating at 45-50°C. Curing is done till moisture content of the produce is brought down to 10% and gives metallic sound while shuffling.

Packaging and marketing:

The properly dried capsules should be allowed to cool and then packed in polythene lined jute bags. The bags may be stored on wooden platform away from the sidewall to avoid absorption of moisture and thereby, avoid fungal growth on the stored produce.



Harvesting



Mature Capsules



LARGE CARDAMOM

Important Diseases:

- i. Phoma leaf spot disease caused *Phoma*
- ii. Leaf streak disease caused by *Pestalotiopsisroyenae*
- iii. Stem lodging and capsule rot-caused by *Fusarium oxysporum*
- iv. Chirke disease caused by *Large cardamom Cirke Virus*
- v. Blight-caused by *Colletotrichum goleosporioides*
- vi. Stem borer-causing worm: *Glyphipterix spp.*
- vii. Leaf caterpillar-*Atrachorista*



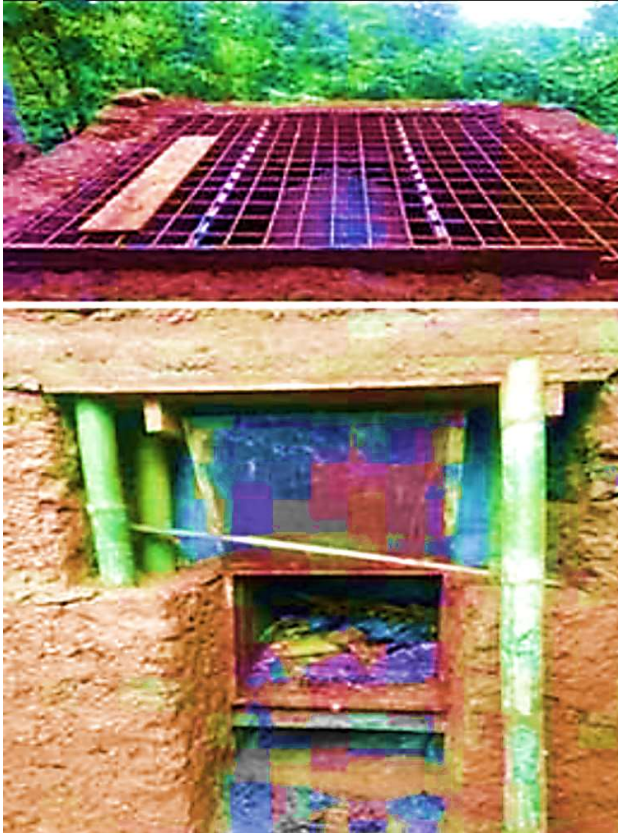
Furkey disease



Leaf streak disease



Leaf caterpillar



ICRI IMPROVED BHATTI

TRADITIONAL BHATTI

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THANK