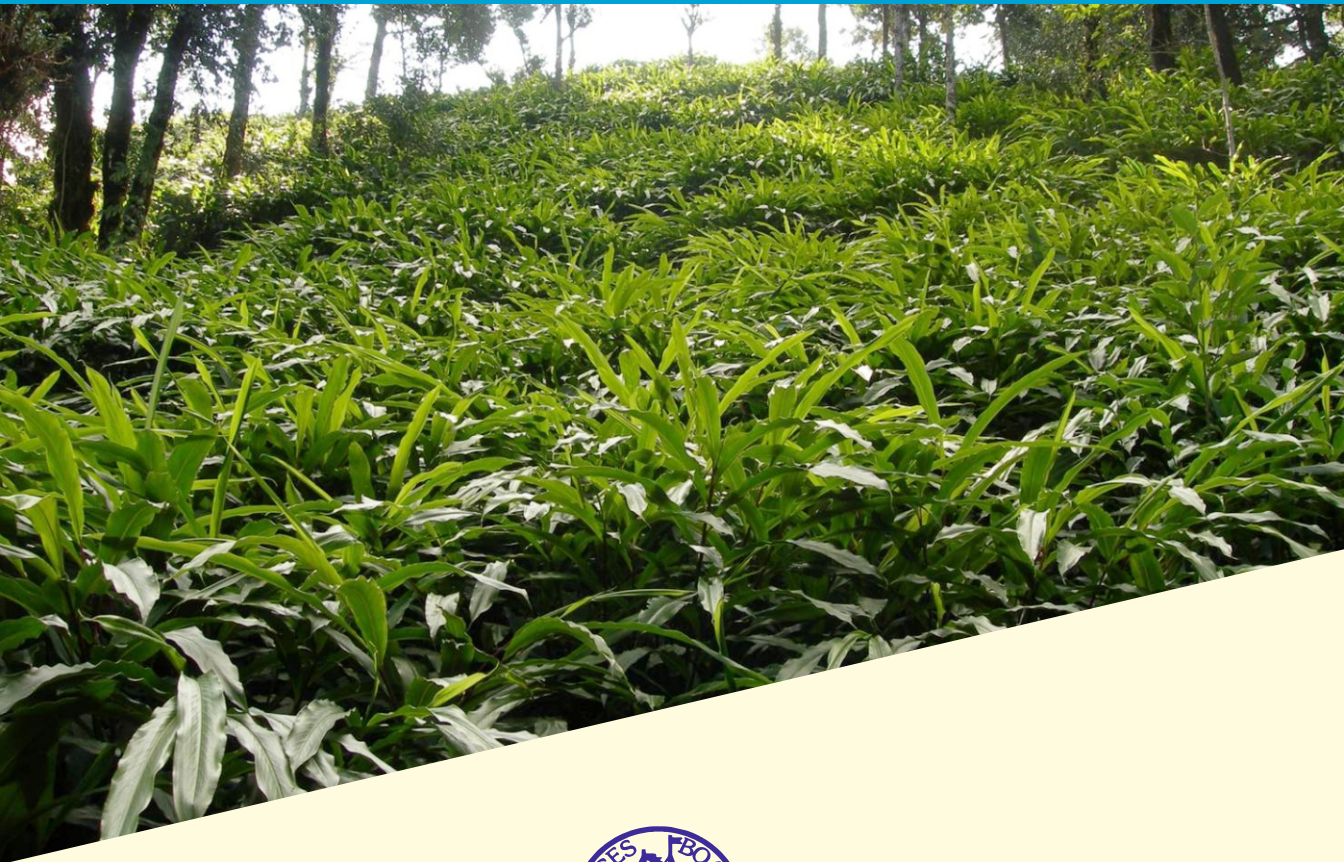


LARGE CARDAMOM GUIDE



स्पाइसेस बोर्ड
भारत

SPICES BOARD

Ministry of Commerce & Industry
Government of India

Sugandha Bhavan, P. B. No. 2277

Palarivattom P.O., Kochi 682 025, Kerala

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(*Amomum subulatum* Roxb.)



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LARGE CARDAMOM GUIDE

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Dated: *9/05/2023*

MESSAGE

It's a matter of pride that Indian Cardamom Research Institute(Spices Board), Regional Research Station, Sikkim is bringing out the 7th edition of Large Cardamom Guide. The Regional Research Station (RRS) of Indian Cardamom Research Institute (ICRI) has its legacy in Large Cardamom Research as it is the only research institute having a mandate exclusively on Large Cardamom.

It's noteworthy to mention that ICRI RRS has released two varieties of Large Cardamom, viz, ICRI Sikkim 1 & 2 and also standardised various aspects on Large cardamom production, crop protection and post-harvest technologies. The Large Cardamom Guide 2023 is an attempt to provide the updated information on various Good Agricultural Practices of organic large cardamom cultivation for the benefit of farming community.

I believe that the book would be adequately informative for the cardamom farmers and will encourage them towards the production of one of the major agricultural cash crop in terms of cultivation, harvesting, processing, value additions and other aspects.

I appreciate the efforts taken by Spices Board and the Scientists of ICRI for bringing out this publication. I urge all my Large Cardamom farmer friends to make use of this reference book to its fullest potential for the sustainable cultivation of Large Cardamom.

Lok Nath Sharma



एस. के. तामंग / S. K. Tamang
प्रधान निदेशक-सह-सचिव
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MESSAGE

Large Cardamom which originated in the Sikkim Himalayas is the main spice crop of Sikkim and other north eastern states. The crop is grown organically and hence its demand is increasing every year. Now-a-days, there are various challenges in Large Cardamom cultivation due to various environmental and biological factors. All these hinder the crop productivity to reach its fullest potential. I am happy that Indian Cardamom Research Institute is releasing the 7th edition of Large Cardamom Guide for the benefit of farming community. This booklet has extensively covered all the important aspects of Large Cardamom cultivation. Detailed illustrations are given in the guide to properly identify various problems and the corrective measures to be adopted.

I profusely appreciate Spices Board and the Scientists of ICRI RRS for their excellent research works and releasing the booklet. The booklet will be a valuable treasure for the farmers and other stake holders of Large Cardamom.

(S.K.Tamang)

Principal Director cum
Secretary
Horticulture Department
Govt. of Sikkim





SPICES BOARD

Ministry of Commerce & Industry Government of India
Sugandha Bhavan, P. B. No. 2277
Palarivattom P.O., Kochi 682 025, Kerala

स्पाइसेस बोर्ड

(वाणिज्य एवं उद्योग मंत्रालय, भारत सरकार
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पालरिवट्टम पी.ओ. कोचिन-682 025
भारत

**D. SATHIYAN, IFS
SECRETARY**



FOREWORD

Large Cardamom (*Amomum subulatum* Roxb.) is a important spice crop grown in the Sub-Himalayan states of Sikkim, Arunachal Pradesh, Nagaland, Manipur, certain pockets of Meghalaya, Uttarakhand and in Darjeeling & Kalimpong districts of West Bengal. The crop has its origin in Sikkim and later its cultivation expanded to the other North Eastern states. Spices Board has its been extending all necessary support in promoting cultivation of the crop. The Regional Research Station (RRS) of Indian Cardamom Research Institute (ICRI), Spices Board in Sikkim has always taken a pivotal role in research and development of Large Cardamom. The 7th edition of the Large cardamom Guide (organic) is a testimony to the continuous striving of excellence by ICRI. I congratulate the Director and all the scientists of ICRI RRS Sikkim for publishing the Large Cardamom Guide. I believe that the Guide will immensely benefit farmers in adopting Good Agricultural Practices for sustainable livelihood and socio-economic development.

Kochi
August, 08, 2023

Shri D. Sathiyam IFS
secretary
Spices Board
Ministry of Commerce & Industry
Kochi- 682025
Kerala



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PREFACE

The Research Station for Large Cardamom in Sikkim was established in 1987 as the third Regional Station of the Indian Cardamom Research Institute (ICRI), Spices Board. This station was established exclusively for Large Cardamom research. The research findings are extended to the farming community through various extension programmes of Spices Board like spices clinics, field visits, training programmes and seminars in the Large Cardamom growing areas. The Large Cardamom Guide 2023 is the 7th edition in the series which covers good agricultural practices for organic cultivation of Large Cardamom. Of late, the Large Cardamom plantations are facing challenges due to various biotic and abiotic stresses. The current edition of the Large Cardamom Guide is a detailed pictorial guide that helps the farmers to identify various issues in Large Cardamom cultivation and the recommended remedial measures. I Congratulate the scientists of ICRI Regional Research Station, Sikkim for their devotion and persistence in updating and publishing the guide in a timely manner.

Kochi
August, 08, 2023

Dr. A. B. Rema Shree
Director (Research & Finance)
Spices Board
Kochi-682025
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LARGE CARDAMOM

(*Amomum subulatum* Roxb.)

INTRODUCTION

Large cardamom (*Amomum subulatum* Roxb.), a member of the family, *Zingiberaceae* under the order *Scitaminae* is the main cash crop cultivated in the sub-Himalayan state of Sikkim, Arunachal Pradesh, Nagaland, Kalimpong and Darjeeling Districts of West Bengal. Naturally, it was growing wild in forest ecosystem which was subsequently domesticated in the sub- Himalayan region, at altitudes ranging from 600 to 2200 m above mean sea level. It is a shade loving plant (sciophyte) grown in areas with an annual rainfall ranging from 2000 -3500 mm. It is locally known as *bada elaichi* in Hindi and *alainchi* in Nepali. Large cardamom is known to be one of the oldest spices used by the mankind. In India, it has references of use in Ayurvedic preparations as early as 6th Century BC as mentioned by Sushruta. It is also used in Unani medicines like Arq Elaichi and Anushdaroo-E-Sada. The seeds of large cardamom contain about 2-3 per cent essential oil, a powerful flavoring agent and are used mainly as spice. Large cardamom has tremendous potential as natural products with flavour and fragrance has a high demand in food industry, perfumeries, medicines etc. It possesses carminative, stomachic, diuretic and cardiac stimulant properties and also a remedy for sore throat and respiratory trouble. It is used as flavoring agent in fried rice, meat & meat-based preparations besides in ice creams, colas, biscuits liquors, sweets, sel roti (traditional sweet rice bread), masalas etc.

Area and Distribution

Apart from Sikkim, West Bengal, Arunachal Pradesh and Nagaland, the crop is also cultivated in Manipur, Meghalaya, Assam and Uttarakhand. Nepal, Bhutan and Myanmar are the other countries where large cardamom is mainly cultivated. Sikkim is the largest producer and constitutes the major share of Indian and world market followed by Arunachal Pradesh, Nagaland and West Bengal.

The total area in India under the crop is 44701 ha with a production of 8803 MT with an average productivity of 196.93 kg/ha during 2021-22.

Botany

This semi perennial rhizomatous herb has subterranean rhizomes bearing about 11-15 circular scales along the cross section which are formed after shedding of the leaves. At maturity, rhizomes bears leafy stem with about 13-15 leaves, whereas the lower or basal scales form the roots. The leafy stem is formed by long sheath like structure encircling one another. Many such rhizomatous leafy sheaths of about 30 to 70 numbers form a clump which is considered a “single plant”. The rhizomes mature in about 10-12 months of their emergence where vegetative buds are formed on the middle scales. The flower buds originate on the middle and upper scales. Usually, each rhizome bears one pseudostem with about 1-3 flower buds or spikes. The rhizomes usually become dry after bearing the fruits or capsules. The height of the robust leafy stem (pseudostem) ranges between 1.0 and 2.5 m. The leaves are arranged distichously (slightly alternate) and are simple, linear, lanceolate with dark green leaf blade, glabrous on both sides with a prominent midrib. The inflorescence is a dense spike on a short peduncle (3-5 cm) with an axis (3-6 cm) bearing about 45-50 flower buds arranged in an acro-petal sequence. The flowers are medianly zygomorphic, bisexual, epigynous and bracteate. The yellowish perianth (3+3) is differentiated into calyx, corolla and anther crest. All the cultivars and varieties of large cardamom belong to *Amomum subulatum* Roxburgh. Out of the total 150 species of *Amomum* that occur in the tropics, only 8 species are considered native of Eastern sub-Himalayan region viz., *A. subulatum* Roxb., *A. costatum* Benth., *A. linguiformae* Benth., *A. paucifloram* Baker., *A. corynostachyum* Baker., *A. dealbatum* Roxb. (*A. sericeum* Roxb.), *A. kingie* Roxb. and *A. aromaticum* Roxb. Cultivated large cardamom (*Amomum subulatum* Roxb.) along with the occurrence of seven wild species makes this plant native to Sikkim.

The flowering season begins early in the lower altitudes with a peak during March-April, while it is late in the higher altitudes with a peak period during June-

July. The fruit is a trilocular, many seeded capsule. The capsule wall is echinated having reddish-brown to dark-pinkish to maroon colour. The seeds are di-angular, whitish when immature and become dark-greyish towards maturity. Usually, the capsules formed at the basal portion of the spike are bigger and bolder than middle and top portion.

Climate

Large cardamom, a shade loving plant (sciophyte), has its natural habitat in the humid subtropical semi-evergreen forests of mountainous sub-Himalayan region. It grows well in the altitudes of 600-2200 m AMSL receiving annual rainfall of 2000-3500 mm apportioned over 200 days. Cloudy conditions prevail for most of the monsoon period. 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 ranging from 6^oC (December-January) to 30^oC (June-July) accompanied by constant high relative humidity. Continuous rain during flowering is detrimental as it hampers the foraging activities of pollinating bees and leads to poor capsule setting and development of barren spikes. Plants remain dormant during severe winter and it can withstand up to 2^oC, but frost and hailstorm are injurious to the crop.

Soil

Large cardamom is generally grown in forest loamy soils having a depth of few centimeters to several inches. Colour of large cardamom soil ranges from brownish yellow to very dark greyish brown. Texture varies from sandy, sandy loam, silty loam to clay. In general, large cardamom soils are acidic in nature and majority of soils have pH ranging from 5.0 to 5.5 with more than one per cent organic carbon content. On an average, these soils have high available Nitrogen and medium levels of Phosphorus and Potassium. Plants cannot withstand water-logged conditions; hence, adequate drainage is very important for better stand of the crop especially when planted in non-sloppy or terraced lands.



Large cardamom plantation under forest ecosystem



A mature large cardamom plant (clump)



Large cardamom – Inflorescence (spikes), bloom and bearing tillers with capsules on spikes



Fresh capsules



Dried capsules (Large cardamom of commerce)

CULTIVARS AND VARIETIES

There are mainly six popular cultivars of large cardamom viz., *Ramsey*, *Ramla*, *Sawney*, *Varlangey*, *Seremna* and *Dzongu Golsey*. Several others types which are not so popular include *Chivey*, *Ramnag*, *Madhusey*, *Seto Golsey*, *Koprings*, *Rato Sawney*, *Hario Sawney* and *Mongney*.

1. *Ramsey*: It is well suited to high altitudes (>1515 m AMSL) and can be cultivated even in steep slopes. The cultivar is identified by the maroonish colour of the tiller and narrow leaves. Plants are 1.5 to 2.0 m tall, robust with large number of tillers. Flowering starts in May and crop becomes ready for harvest by October- November. Capsules are small with around 25 - 40 seeds.



a



b



c

***Ramsey*: a. clump, b. flower and c. capsules**

2. *Ramla*: Plants are 1.5 to 2.0 m tall and vigorous like *Ramsey*. Colour of tillers resembles that of *Ramsey* and the leaves are broad and long. Capsules are dark pinkish in colour with 30 - 40 seeds. Cultivation is restricted to a few high altitude areas (>1515 m AMSL) in North Sikkim. Flowering commences in May and the crop is generally ready for harvest in October.



a



b



c

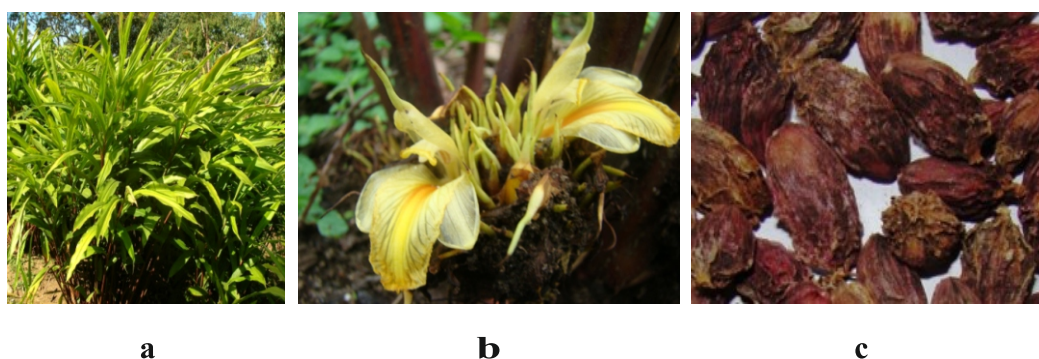
***Ramla*: a. clump, b. flower and c. capsules**

3. Sawney: It is a widely adapted cultivar, which is most suited to medium (975 – 1515 m AMSL) and high (> 1515 m AMSL) altitude areas. Plants are 1.5 to 2.0 m tall, robust in nature, leaves are ovate and broad and the colour of tiller is maroonish. Capsules are big and bold with 35 - 50 seeds. Flowering starts from March to May and harvest begins in September - October, sometimes extends up to November in high altitude areas.



***Sawney*: a. clump, b. flower and c. capsules**

4. Varlangey: It is suited to grow in mid and high altitude (>975 m AMSL) areas. Its yield performance is exceptionally high at higher altitudes (>1515 m AMSL). Plant height is 1.5 - 2.5 m, robust and resembles *Ramsey* having narrow leaves with wavy margins. The ratio of productive tiller to spike is relatively high in this cultivar. On an average, 2 - 3 spikes per productive tiller are recorded and the capsules are bold with 50 - 70 seeds. Flowering starts in May at medium altitudes and during June - July at high altitudes. Consequently, in high altitudes, harvesting is delayed up to the end of November.



***Varlangey*: a. clump, b. flower and c. capsules**

5. *Seremna*: The cultivar is known for its location specificity. It is grown in Hee-Gaon area of West Sikkim at low altitudes (<975 m AMSL) and has high yield potential. Plants are 1.5 to 2.0 m tall; tillers are green and leaves are mostly drooping type, hence named as '*Seremna*'. On an average, 2-3 spikes in each productive tiller with an average of 10 capsules in each spike and 65-70 seeds per capsules are recorded. Now-a-days, the cultivar is becoming popular in other locations also.



a

b

c

***Seremna*: a. clump, b. flower and c. capsules**

6. *Dzongu Golsey*: The cultivar is mostly confined to Dzongu area of North Sikkim and suitable to grow in areas below 975 m AMSL. The plant height is 1.0 to 1.5 m and not as robust like other cultivars. Unlike *Ramsey* and *Sawney*, the tillers are green and the leaves are narrow and erect. Capsules are bold and big containing 50-70 seeds. Flowering starts in March and harvesting is done in September - October.



a

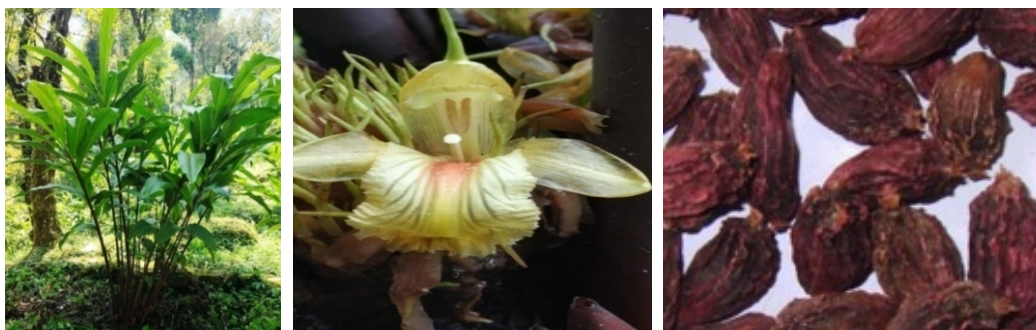
b

c

***Dzongu Golsey*: a. clump, b. flower and c. capsules**

High yielding Varieties: Indian Cardamom Research Institute, Regional Research Station, Spices Board, Tadong released two high yielding varieties during 2004. These two varieties viz., ICRI Sikkim 1 and ICRI Sikkim 2 are selections from the cultivar *Sawney*.

1. ICRI Sikkim 1: This variety is well suited for 1500 to 1650 m AMSL altitudes. Plants are robust with maroon tillers and leaves are ovate and broad. In a 5 year old plant, sixty per cent of spikes were found to bear 14 capsules per spike. The capsules are bold and maroon. Eighty per cent of capsules have a size of 2.2 cm (length) x 2.0 cm (dia.) with 35-50 nos. of seeds. Average yield recorded is around 840 kg/ha.



a

b

c

ICRI Sikkim 1: a. clump, b. flower and c. capsules

2. ICRI Sikkim 2: This variety is suited to 975 -1500 m AMSL altitudes. Plants are robust in nature and leaves are ovate and broad. Tillers are deep maroon in colour. In a 5 year old plant, sixty per cent of spikes were found to bear 15 capsules per spike. Capsules are also maroon in colour, bold and seventy per cent capsules are more than 2.7 cm in length and 2.2 cm in diameter with an average of 45 seeds. Average yield is around 898 kg/ha.



a

b

c

ICRI Sikkim 2: a. clump, b. flower and c. capsules

PROPAGATION

The propagation of large cardamom is mainly done through seeds or suckers. Tissue culture techniques are also available but are not popular.

Propagation through seeds enables production of large number of seedlings. Viral diseases are not transmitted through seeds and therefore, the seedlings are free from viral diseases. Due to cross-pollination, plants raised through seeds exhibit variation in their characteristics from their parents.

On the other hand, producing planting material through suckers ensures true to the type/parents. Plants with high productivity can be raised by collecting planting materials from high yielding, disease free mother plants. These techniques produce suckers ready for field planting in the next season itself. But there are

chances of transmission of viral diseases if suckers are taken from diseased plantation.

Tissue culture technique though produces true to type and large number of plants; it requires expertise and high investment and hence it is not so popular till date.

I. Propagation through seeds

Seeds are collected from high yielding and well-maintained plantation free from diseases. Well matured capsules from bottom and middle portion of the spikes are selected for extraction of seeds. After de-husking, seeds are mixed and rubbed with fine 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.



Spikes, capsules, de-husked capsules and seeds

I a. Primary Nursery

Seeds are generally sown in September - October. Seed beds are prepared in well-drained soil dug to a depth of 30 cm and left for weathering. Raised beds with around 30 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. In Sikkim condition, germination of seeds commences after 5-6 months of sowing. Acid treatment (seeds soaked in 25% Nitric acid for 10 minutes) or soaking of seeds in 25% cow dung slurry for 5 days increases the percentage of germination. When germination is noticed the mulch materials are 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 beds / nursery.



Raised seed beds and germinated seedlings ready to transplant

I b. Secondary Nursery

Secondary nurseries can be prepared in poly bags or on raised secondary beds.

I b.i. Poly bag nursery: Polythene bags of size 15 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 containing soil, sand and cow dung in the ratio of 4:1:1. The bags filled with the mixture are arranged in rows of one meter width and in convenient length under shade. 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.



Poly bag nursery

I b.ii. Raised secondary beds: Beds of around 30 cm in height and 10 m 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 April-May at spacing of 15 cm. The inter space is mulched with chopped rice straw or dry leaves. Over head shade is erected for providing cover and the soil is kept moist with irrigation. The seedlings on attaining height of 45-60 cm with 2-3 tillers are planted in the main field during June - July of the subsequent year.



Secondary nursery

II. Propagation through suckers

The suckers collected from high yielding disease-free, elite plantations having one mature tiller with one or 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 3 consecutive years.
- One mature tiller with one or two immature tillers or vegetative buds is used as planting unit.

Site of nursery

- The nursery should be around 500 meters 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 consisting of 45 cm (1½ ft.) width and 30 cm (1 ft.) depth with convenient length has to be made across the slopes of the field.
- Top soil 15 cm (½ ft.) to be kept separately from the trench on the upper side.
- Lower 15cm portion of soil in the trench to be forked thoroughly
- Dried leaves to be applied as layer in the trench.
- The trench has to be filled with top soil mixed with cow dung compost.
- Spacing of 30 cm between two trenches to be maintained.
- The planting units has to be planted at a spacing of 45 cm (1 ½ ft.) and provide support to plants by staking.



Preparation of trenches



Planting in trenches

Planting season

- Last week of May to June. Wherever irrigation can be ensured or an early rainfall is received, planting can be done during April-May.
- Mulch the plants with dried leaves / grass around the base so as to prevent soil erosion.

Maintenance

- Thick mulching with dry leaf / grass may be applied at the base of plant and watering may be done during November to March depending on the soil moisture condition.

- Well decomposed cattle manure may be applied.
- The plot may be maintained with 50 per cent shade under shade trees or using agro shade net.
- The disease and pest incidence to be monitored from time to time and necessary management practices to be adopted.
- On an average, five planting units could be obtained from a single plant.



Large cardamom sucker nursery

PLANTATION ESTABLISHMENT AND MANAGEMENT

Selection of site

Large cardamom grows well in forest loamy soils on terrains with gentle to medium slopes. Luxuriant growth is observed when perennial water sources are located nearby plantation. However, water logged condition is detrimental to the plants and hence adequate drainage is required. It performs well under partial shade (50 per cent) and the shade tree, *Alnus nepalensis* (Himalayan alder or *Utis* in Nepali) - large cardamom agro-forestry system is an ideal system for sustainable cultivation in Sikkim Himalayan region.

Soil type: Deep, well drained, loamy textured soil rich in Organic matter and Nitrogen, medium level of potassium and phosphorous, with a pH of 5.0 to 5.5 are ideal for large cardamom.

Land preparation

The land selected for planting should be cleared of all the under growth, weeds etc. before the onset of monsoon. 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 center of the pits. Wider spacing of 1.8 m x 1.8 m is recommended for robust cultivars like *Ramla*, *Ramsey*, *Sawney*, and *Varlangey*



Land preparation for planting

etc., while closer spacing of 1.2 m x 1.2 m is advised for non-robust cultivars like *Dzongu Golsey*, *Seremna* etc. Pits are left open for weathering for a fortnight and

then filled with top soil mixed with cow dung compost/FYM @ 2-3 kg per pit. Mix *Trichoderma* @50-60g with cow dung compost/FYM @ 2-3 kg per pit. Pit making and filling operation should be completed in the third week of May before the onset of pre-monsoon showers.

Planting

Planting is done during June-July in Sikkim and Darjeeling. In Arunachal Pradesh, planting is done in the month of May when there is enough moisture in the



Planting Unit



Planting and staking of suckers



Planting upto collar region



Deep planting: delayed tiller emergence

soil. A mature tiller with 2-3 immature tillers/vegetative buds is used as planting unit. Quality planting material has to be raised in the nurseries or collected from certified nurseries for better production. Suckers/seedlings are planted by scooping a little soil from the centre of the pits and planted up to collar zone. Staking of newly planted suckers is needed to prevent lodging due to heavy rain and wind. Planting to the collar region ensures proper emergence of tillers and deep planting should be avoided as it hinders/delays the tiller emergence.

Organic nutrient management

Maintaining optimum soil fertility is one of the most important aspects for a good plantation. For producing about 100 kg dry large cardamom, the robust cultivars require (in kg) 10.33 N: 1.95 P: 26.24 K: 19.10 Ca and 11.9 Mg; whereas non robust cultivars like, *Dzongu Golsay* removes only about 5.74 :0.99 :3.54 of NPK and 9.18 Ca and 5.86 Mg respectively.

Soils with pH ranging from 5-5.5 are ideal for the growth of large cardamom. Soil needs to be tested for its pH and for very acidic soils lime/dolomite application is warranted. The quantity of lime / dolomite for soil application has to be determined based on the soil tests only.

In organic large cardamom cultivation, disease-free crop residues are recycled in the plantation and FYM / Organic materials etc are applied for meeting the nutrient requirement. Application of well -decomposed cattle manure/compost/organic products @ 5 kg/plant at least twice a year i.e., in April-May and October- November is recommended. Vermicompost, having favourable impact on soil physical properties and a good source of nutrients, may also be applied @ 1 kg/clump in two equal doses in combination with FYM. Application of mustard cake @ 500 g / plant at least once in two years during April – May is beneficial. Before applying manure, remove the mulch/organic matter from the plant base to expose the soil. The soil has to be mildly forked as a circular band (15cm width) from a distance of 30–45 cm away from the base of the clump. Manure should be applied along the circular band, mix with soil and cover with mulch to avoid wash off by rain water.

Large cardamom soils are deficient in the micro nutrient Boron. The Boron plays a significant role in pollen development and influences the productivity. Application of Borax as foliar application @ 0.5% (5g/litre) + soil application @ 2.5 kg/ha is recommended for correcting Boron deficiency and increasing productivity.



Plant base cleaned before application and application of manure at plant base

Soil base making and mulching

If the land is not terraced, soil base may be made by cutting top soil from the upper half and to be placed on the lower half followed by mulching. Mulching at the plant base with easily degradable organic materials is good for conserving both moisture and soil. The mulching can be done after harvest and cessation of rains during October-December. Dried organic matter, leaves, weeds etc, can be used as mulching materials. Among different moisture conservation practices surface mulching is effective for retaining higher soil moisture content. Soil moisture can also be conserved by filling biomass in trenches made across the slope in plantations.



Mulching at plant base

Weed management

Weeds compete with crop for nutrients, water and sometimes act as alternate host for diseases and insect pests causing damage to the crop. Hence, weeding is an important cultural operation to be carried out for atleast three rounds / year during the initial two to three years. Later when plant is fully grown and occupies more space, then two rounds of weeding is sufficient. First round of weeding to be done during April- May to facilitate the movement of pollinators and the next round, just before harvest during September - October. Clean weeding is not advisable in hilly terrain as it may lead to soil erosion. Around the plant base weeds are pulled out by hand and the inter-space needs only slash weeding with sickle. The thrashed materials can be used for making compost or disease-free weed material can be used as mulch.



Manual weeding around plant base



Slash weeding (sickle) in interspaces

Water management

Large cardamom plants cannot thrive under water stressed or drought condition. Yield performance is better in plantations where irrigation is given during dry winter. Moreover, blight disease incidence was more prevalent in plants weakened due to water stress. Watering during November - March is essential to maintain sustainable yield in the plantation. Depending on the availability of water sources, hose / sprinkler / flood irrigation through small channels is advised once in every 15 days based on the soil moisture status. Wherever, water scarcity is prevalent, construction of water tanks (Jalkund) and rainwater harvesting is suggested.

Pits may be dug in the middle of four plants of nearby rows before rainy season. This helps in percolation of water during rainy season which can support the water requirement of the crop to a certain extent. *In-situ* soil moisture conservation practices like surface mulching helps to conserve higher moisture content in soil.



Water tank (Jalkund)



Pits made between four plants

Shade management

Large cardamom is a shade-loving crop. It is noticed that dense shade or less shade hinders optimum crop growth and production. It grows well under a shade level of 60 - 70 per cent of full day light interception to a shade level of about 30 per cent full day light interception.

Adequate shade (50%) also protects the crop to some extent from damage due to hail as well as frost. Under dense shade, blight disease incidence will be high. Under less shade or planting large cardamom in open field without any shade resulted in with varying response as over-exposure to direct sunlight causes yellowing of leaves to reduced life span of crop. Therefore, it is very much important to maintain optimum shade through shade regulation. The lopping of branches of the shade trees to remove excess shade is very important and should be done before the onset of the monsoon during May - June. Judicious shade management is very important for optimum plant growth, timely flowering and for obtaining better yield. In areas with insufficient shade, planting of saplings of shade trees belonging to different species should be done during June–July. The most common shade trees are *Utis* (600– 2000 m AMSL); *Chilaune* (550–1515 m AMSL); *Panisaj* (400–1000 m AMSL); *Pipli* (900–2000 m AMSL); *Malato* (670–1515 m AMSL); *Asarey* (850–2000 m AMSL); *Karane* (1500–2400 m AMSL); *Bilaune* (670–1515 m AMSL) etc. *Artemisia* sp. can be used as a temporary shade for new plantations. Depending on the altitude, planting of shade tree saplings in a row with a distance of 9 -10 m is ideal. While planting the saplings, the course and direction of the sun movement and the slope of the hill are generally considered. Usually, the tree rows are run along the southwest direction inside the plantation.

INSECT PESTS AND MANAGEMENT

There are as many as 23 insect pests found associated with large cardamom and the entire pests do not cause economic damage to the plant. Among the insect pests, leaf eating caterpillar (*Artona chorista* Jordon), Shoot fly, (*Merochlorops dimorphus* Cherian) and White grub (*Holotrichias* pp.) are considered as important pests. Capsule borer and nematodes are emerging as important pests, while incidence of stem borer (*Glyphipterix* spp.) has been coming down. Aphids are responsible for transmitting viral diseases viz., *Chirke* and *Foorkey*.

LEAF EATING CATERPILLAR: Leaf caterpillar *Artona chorista* Jordon (Lepidoptera: Zygaenidae) is a major defoliator of large cardamom plants causing noticeable damage to the crop. The adult is a moth, black and its size ranges from 10–15 mm. The male moth can easily be distinguished from female with its bushy antennae, white bands on the abdomen and smaller size.



Leaf caterpillar and its damage

Period of occurrence

Although the leaf caterpillars remain in the field throughout the year, their infestation is mostly observed from June to July and October–March.

Nature of damage

The leaf caterpillars are highly host specific and monophagous. Caterpillars are gregarious in nature (60-200 caterpillars/leaf) and feed on chlorophyll content underneath the leaf leaving transparent epidermis and veins (skeletonization). The damaged portion of the leaf becomes brownish and the infested leaf can easily be identified from a distance. The mature larvae completely defoliate the plant leaving only the midrib of the leaves. Removal of chlorophyll and defoliation of the plant by the caterpillar affects the yield indirectly.

Management

a) **Cultural:** The caterpillars are gregarious in nature, sluggish and they feed underneath the cardamom leaves. During June-July and October - December, the infested leaf can easily be collected along with the larvae and destroyed. When an outbreak is observed in a locality, the cardamom farmers as a group may engage in manual collection and destruction of caterpillars so that the incidence can be totally managed within few years.

b) **Biological:** Some natural enemies are reported to kill the caterpillars and pupae, however, so far no commercial exploitation of these natural enemies are carried out to control the pest. *Cotesia* sp. and *Dolichogenodea* sp. are two hymenopteran endolarval parasitoids parasitized upon *A. chorista*. Two larval-pupal parasitoids, *Medina* sp. and *Bactromyza* (F. Tachinidae) sp. were also recorded in natural condition. These natural enemies kill the caterpillars and pupae of the pest and reduce the pest population considerably in the field.

c) **Biorational/ biopesticides:** Application of Neem Kernel Aqueous Extract (NKAE) @ 5% + 1% surfactant can deter the pest from feeding. The NKAE has to be applied on both sides of the leaves at 15 days interval during September to November and last week of May to July.

2. Shoot fly Two species of shoot fly has been identified so far in damaging large cardamom. These two are *Merochlorops dimorphus* Cherian (Diptera:

Chloropidae) and *Bradysia* sp. (Diptera: Sciaridae). However, *M. dimorphus* is most prevalent in large cardamom growing tract of Sikkim and Darjeeling. The adult fly *M. dimorphs* is 5–6 mm in size and brownish yellow in colour. In the main field, more damage is recorded at higher altitudes than in the lower altitude.

Period of occurrence

Although the shoot fly is found throughout the year but severe incidence of the pest noticed during February to August. Higher incidence is recorded in new plantations within 3 years of planting.

Nature of damage

The tip of the shoot becomes brown and later whole shoot dries up. Low to moderate damage by shoot fly is recorded in large cardamom plantation in Sikkim and West Bengal. Single, pale glossy white maggot bores the young shoot and feeds on the central core of pseudostem from the top to the bottom resulting in its death. In general, young shoots up to one foot length are infested by shoot fly and incidence was as high as 56 per cent of new shoots.



Shoot fly infestation symptoms

Management:

- a) **Cultural:** For managing this pest, infested young shoots should be removed at ground level and destroyed. Adult shoot fly can be trapped using fish meal bait and then destroyed.
- b) **Biorational / biopesticides:** Application of neem seed kernel extract 5 ml per litre during new shoot emergence at monthly interval reduces the pest problem.

3. Stem borer

Stem borer *Glyphepterix* sp. (Glyphiperidae: Lepidoptera) is also an important pest reported from all the cardamom growing tracts.

Period of occurrence

Stem borer incidence is noticed throughout the year. But during four periods, December-January, March-April, May-June and September-October their abundance is more. The incidence of stem borer is more in low elevations than in higher elevations.

Nature of damage

The larvae feed on the central portion of the shoot which results in drying of the central leaf of the plant and this symptom is known as dead heart. Infestation of this pest is also indicated by the presence of entry holes plugged with excreta. Damage up to 19.50 per cent is reported due to its infestation.



Stem borer larvae and frass material after infestation

Management

a) Cultural: For managing this pest, infested shoots to be removed at ground level and destroyed.

b) Biorational / biopesticides: Application of neem seed kernel extract 5 ml per litre during new shoot emergence at monthly interval reduces the pest problem.

4. White-grubs

In Sikkim, four species of white grubs (*Holotrichia* spp., Coleoptera: Melolothidae) are reported. Among these *H. seticolis* identified as major one, while another species named as *H. sikkimensis* is also found to cause damage. The young grubs are white translucent whereas mature grubs are pale coloured and 'C' or semi-circular shaped. Adults are dark brown dorsally, yellowish ventrally, forewing thick (elytra), hind wings membranous, crepuscular to nocturnal in habit. As large cardamom being cultivated under natural forest ecosystems, the incidence of white grub is more or less available in all the plantations.



Yellowing of leaves in white grub infested plant, grub larvae and adult beetle

Period of occurrence

The adults emerge in large numbers on receipt of summer showers during April-May. Larval stage of this pest is causing damage to the crop. The grubs are active in their second and third instar larval stages and remains very active during rainy seasons (July-October) and feed on organic matter until they come in contact with living roots of plants.

Nature of damage

White grub is a polyphagous and it feeds on the feeder roots and newly formed rhizomes. The infested plant shows yellowing of leaves and withering symptoms. In severe infestation, pseudostem may be cut at the basal region by third and fourth instar grubs.

Management

a) Cultural: For managing this pest, community wise collection and killing of adult beetle during dusk to night period (6.00 - 7.30 pm) in the month of May to early July from their preferred host tree. Place light traps @ 1 trap/ha during May to early July also reduces the adult beetle to some extent.

b) Biorational / biopesticides: Drenching of root zone with neem seed kernel extract 5 ml per litre water at monthly interval reduces the pest problem. Soil drench with *Metarrhizium anisopliae* (1×10^8 CFUg⁻¹) @ 10.0 g per litre or NKA 5% + 1.0 % surfactant or *Beauveria bassiana* (1×10^9 CFUg⁻¹) @ 10.0 g per litre of water at monthly intervals can also effectively manage the pest.

5. Aphids

In large cardamom, aphids cause more damage as a vector of viral diseases rather than as a pest. The aphids are associated with the transmission of viral diseases (*Foorkey* and *Chirke*) of large cardamom. The major species associated with large cardamom are:

1. *Pentalonia nigronervosa* f. *caladii* (Goot) (Hemiptera: Aphididae)
2. *Micromyzus kalimpongensis* (Hemiptera: Aphididae)
3. *Rhopalosiphum maidis* (Fitch) (Hemiptera: Aphididae)
4. *Rhopalosiphum padi* (Lin.) (Hemiptera: Aphididae).

Period of occurrence

The aphid population is recorded high during summer months at lower altitudes.

Nature of damage

P. nigronervosa f. *caladii* and *M. Kalimpongensis* are known to be as vectors of 'foorkey' or virus yellow disease. The aphids colonize at the base (rhizome) of the clump and if population is more, they move to aerial portion of the clump. They remain mostly to exposed rhizomes and dried leaf sheaths and they suck the sap from the pseudostem.

Maize aphids, *Rhopalosiphum maidis* and *R. Padi* are found to be on the lower surface of the leaves of large cardamom, congregating near the mid-rib and veins. These aphids are known to be the vector of another viral disease, mosaic streak or 'chirke'.

a) Cultural: The removal and destruction of diseased plants is helpful in control of further spread of disease and in reduction of aphid population. It is necessary to keep vigil on infestation of these aphids on their most important alternate hosts like Banana and Canna for *P. Nigronervosa* and maize for *R. maidis* and *R. padi*. If infestation is noticed, alternate hosts also to be removed and destroy to minimize the chances of spread of these pests.

b) Biorational / biopesticides: Spraying of Neem oil (Azadirachtin 0.15%EC) 1500 ppm @ 3 ml per litre formulations at 15 -20 days interval provides effective control.

6. Capsule borer: (*Jamides alecto* Lycaenidae : Lepidoptera)

The infestation of capsule borer is in increasing trend in large cardamom growing tracts and gaining importance as it causes damage to the economical part of the plant *i.e.*, the capsule. With increase in infestation, it may attain the status of a major pest within few years. Capsule borer, is identified as *Jamides* sp. belonging to Lepidoptera

Period of occurrence

The adult butterfly appears in the cardamom fields from March - April

onwards in lower elevations whereas seen upto mid-September in higher elevation. Its incidence coincides with the onset of flowering to developmental phase of the capsule.

Nature & extent of damage:

Out of the various stages in life cycle, larvae alone cause damage to the crop by eating away developing seeds of the capsules by boring a hole on it. In laboratory studies, it was observed that a single larvae feed around 7-9 capsules during its larval phase. In surveys, the extent of damage recorded was upto 33.9%.



**Adult capsule borer
(*Jamides* sp.)**



**Larvae feeding inside
capsule**



Capsule with hole

Management

As it is an emerging pest, so far, no management practice is adopted. Moreover, applications of any biorational / biopesticides also deter the movement of bumble bees, the major pollinator of large cardamom. However, it was observed that infestation used to be more in unattended and neglected plantation, so phytosanitation is one of the important aspects to be taken care to reduce the infestation.

7. Nematodes

Nematodes are important pest causing damage to the crop. In large cardamom root knot nematode, *Meloidogyne incognita*, was only reported earlier infecting seedlings/plants in nurseries and plantations causing considerable damage. The affected seedlings/plants show stunted growth, the leaves become narrow and are arranged in a rosette fashion due to reduction in internodal length. Root system shows excessive branching with galls. However, recent studies revealed that apart from *Meloidogyne incognita*, the association of other nematodes like *Helicotylenchus* spp., *Hoplolaimus* sp., *Tylenchorhynchus annulatus*, *Pratylenchus* sp. and *Criconeema* spp. are found in large cardamom soils. The nematodes, *Meloidogyne incognita* and *Pratylenchus* sp. are seen associated with cardamom roots. Further studies are under progress to prove its pathogenicity.



Foliar symptoms of nematode infestation

General Management Practices

Deep digging and exposing the soil to sun (solarization) before preparation for nursery reduces the nematode population. Use of the same site continuously for raising nursery to be avoided. Farmers are encouraged to change nursery sites every year and to raise seedlings in polybags containing healthy potting mixture. This practice not only reduces nematode incidence but also prevents movement of nematode through soil from one location to another.

Use of yellow sticky trap for monitoring soft bodied flying insects

In general, soft bodied flying insect pests *viz.*, aphids, white flies, leaf miners etc. used to get attracted and glued to yellow sticky traps. Yellow sticky traps are used to monitor pest population build up which in turn help us to undertake timely management measures. These traps can be installed by peeling off the protective coating and by hanging it 2-3 inches above plant canopy. The flying insects get trapped and their population can be monitored. When the trap is full it needs to be replaced.



Yellow sticky trap

Pollinators of large cardamom

The bumble bees, *Bombus breviceps* and *B. haemorrhoidalis* have been recorded as important pollinators of large cardamom in all the altitudes. These bumble bees are called locally as *Bhomora* (Nepali), *Boom boom Taka* (Bhutia), *Tungboom* (Lepcha) in Sikkim and Tai- Taga (Galo), Ngonia, Tong, Taga (Nyishi) in Arunachal Pradesh. In Nagaland it is known as *Timipfi* (Tenyidie), *Teshukhwi* (Chokri), *Tshumikhuzho* (Khezha), *Mehdi* (Sangtam) and *Lemthunao* (Chang).



Bombus haemorrhoidalis



Bombus breviceps



Nest of Bumble bee in soil

Foraging activity of bumble bees is maximum during morning hours (4.00 am to 9.00 am) on clear days and their activity becomes less or even nil during heavy rains. It is also known that rock bee (*Apis dorsata*) plays a positive role in capsule setting. It is observed that for optimum capsule and seed set a minimum 50 visits by the pollinators are required. A well-set spike appears like a small pineapple. When the capsules get mature, the seeds are turned into blackish colour.

Decline of bumble bee population throughout the world is a cause of concern now. Bumble bees construct nest in the soil. During farm operations, care should be taken not to disturb the nests in the soil and also their natural habitat. Maintenance of natural vegetation as well as micro-climate of the bumble bee nests in the plantation bears significant importance. Flowering plants need to be grown in the plantation throughout the year to maintain continuous supply of their food.

DISEASES AND THEIR MANAGEMENT

Major threat to large cardamom is the widespread occurrence of fungal and viral diseases causing considerable damage and consequent crop loss in devastating proportions. Diseases affecting large cardamom and their management are dealt herewith in detail.

1. Blight (*Colletotrichum gloeosporioides*)

Colletotrichum blight has devastated the large cardamom plantation and is the cause of concern for severe crop loss and decline in plant population in the recent past.

Causal organism:

Blight is caused by *Colletotrichum gloeosporioides* and its perfect state is *Glomerella cingulata*. Lesions on leaf and sheath carry black dots and are rough in its texture. These dots are identified as perithecia of the pathogen.

Epidemiology

The disease appears generally with the advent of the pre-monsoon showers in April-May and progresses rapidly during the rainy season. However, in some areas the incidence starts during winter months (January-March).

Symptoms

Water-soaked lesions appear either at margins or tips or any other point on the leaves which rapidly enlarge, coalesce and cover major portion or the entire leaf lamina giving a blighted appearance. The advancing lesions are blackish brown in color and margins give a yellow halo. In some cases, the entire lamina becomes yellowish and blighted. The affected area becomes necrotic and dry up.



a



b



c



d

Blight Symptoms: a. Water-soaked lesions on leaves, b. lesions on pseudostem, c. breaking of pseudostem at the point of infection and d. severely affected plantation

Leaf sheath covering the pseudostem show blackish brown discoloration which extends up to rhizomes and subsequently turn into greyish or blackish patches with brown margins. Gradually, the pseudostem becomes brittle and breaks in the middle or at the collar regions. In most cases, the lesions on the pseudostem become necrotic as a result the entire leaves dry out giving a burnt appearance. Later, the pseudostem lodges at the point of necrotic lesion. As a whole, the entire plantation looks dried up.

The disease mostly affects the bearing tillers of the clump while the new tillers remain apparently healthy. However, later in the season, in some cases, the young emerging leaves of the new tillers in the diseased clump show pale yellow discoloration in the inter-veinal areas. Sometimes the emerging leaves are whitish in colour and droop without opening properly. Slight yellowing and narrowing of emerging leaves are also noticed and, in some cases, the pseudostem break open longitudinally in the middle and the young leaves emerge through the opening. Examination of the rhizomes of such tillers showed brown lesion with air space in the middle.

The spike from the diseased clump exhibits elongated appearance in comparison to the spike from the healthy clump and this is mainly due to lack of fruit setting. However, in other cases, flowering and seed-setting takes place but the seeds do not mature and remain whitish or light brown instead of natural black. Generally, the roots are not infected. In the cultivar *Varlangey* the newly formed tillers in the diseased clump show pale yellowing and rosetting of leaves giving a stunted appearance as compared to the healthy plants.

Collateral hosts:

Fourteen species of plants belonging to various families showed symptoms similar to *Colletotrichum* blight. Some of them are marigold, *Amomum dealbatum*(*Churumpa*), canna, wild colocasia, ornamental basil, *Alnus nepalensis* etc.

Management:

- No cultivar is found to be resistant to the disease. A holistic approach is required for disease management as the problem is related to environmental, soil and plant health.
- Diseased leaves, tillers and other plant parts which are cut during harvesting season should never be spread in the plantation. Strictly adopt phytosanitary measures like removal of diseased plants/plant parts and bury them away from the plantations. The infected material may serve as inoculum for the next season and hence to be composted for destructing the pathogenic propagules. Addition of EM (effective microorganism) solution or cow dung slurry in the composting pit will enhance the composting process.
- Destroy alternate host plants like marigold, *Amomum dealbatum* (cherumpa), canna, wild colocasia, ornamental basil etc.
- Regulate shade trees to provide not more than 50 per cent shade.

Chemical control (fungicides approved by NPOP for restricted usage in organic cultivation):

- Pretreatment of suckers with Copper Oxychloride @ 0.3% (300g in 100 litres water) for 30 minutes before planting in nursery/field.
- Application of 1% Bordeaux mixture after harvest and also as prophylactic sprays before onset of monsoon (April/May) and after monsoon (September/October).
- Foliar spray and soil drench with Copper Oxychloride 50WP @ 0.3% (300g in 100 litres water) during monsoon at 20-25 days interval.

Biological control

- Pre-treatment of suckers with bioagents like *Pseudomonas fluorescens* or *Bacillus subtilis* @ 5 litres in 100 litres water for 30 minutes before planting.

- Application of bioagents like *Pseudomonas fluorescens* or *Bacillus subtilis* as foliar spray and as soil drench after harvest, before onset of monsoon and during monsoon months. Mix 3-5 litres of bioagents in 100 litres of water and apply @ 3-4 litres/clump.
- Apply *Trichoderma* mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg) in soil @ 2kg/clump. This will reduce soil inoculum of pathogen.

General

Copper fungicides may be applied only when the disease pressure is high. Once disease pressure comes down, bioagents can be applied. It should be noted that after using Bordeaux mixture/COC, bioagents should be applied only after 15 days interval and never mix bioagents with copper fungicides.

Care must be given to provide adequate plant health. In highly acidic soils, liming has to be done to attain optimum soil pH. Apply recommended dosage of manure every year. Insufficient/lack of irrigation during winter leads to weakening and collapse of the plants. Plants grown in moisture deficient stress are more susceptible to blight disease and hence, providing irrigation during winter months is essential. Severely infected gardens and traditional plots may be temporarily (3-4 years) converted to other crops (crop rotation). Wherever possible, planting in new ideal locations is to be adopted.

2. *Phoma* leaf spot disease

Leaf spot caused by *Phomas* p. was found to be of serious concern in the seedling nurseries in Arunachal Pradesh and field plants in Sikkim.



***Phoma* : Initial and advanced symptoms on leaves**

Epidemiology

Rapid spread during continuous rain and consequent damage indicates its potential to devastate. In Sikkim, the disease was found to occur during late winter and peak rainy periods.

Management

- Field phyto-sanitation by removal and destruction of disease affected plants or plant parts
- Provide adequate drainage.
- Spray 1% Bordeaux mixture at 20-25 days interval during rainy days based on disease severity. Or
- Spray *Pseudomonas fluorescens* or *Bacillus subtilis* as @ 3Litre/100 Litre water

Leaf streak disease (*Pestalotiopsis royenae*)

It is prevalent round the year and results in considerable damage to foliage in the cultivar *Dzongu Golsey*.

Symptoms

The disease symptom is seen as numerous translucent streaks on young leaves along the veins. The infection starts in emerging folded leaves which results in spread of the disease to the adjacent folds. When these leaves open, many translucent streaks are noticed on the leaf blade.



Leaf streak disease

Management

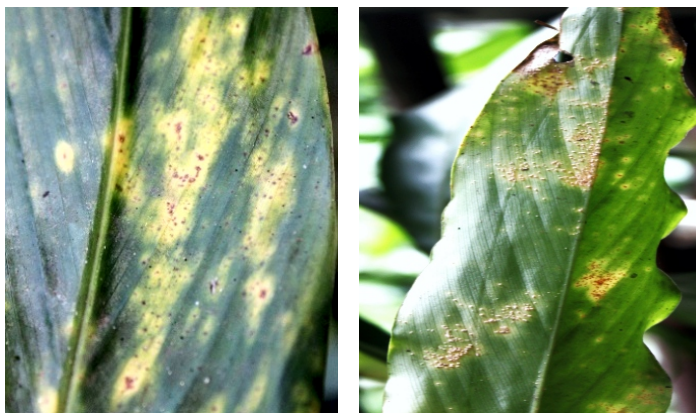
- Removal and destruction of severely affected plant parts
- Three rounds of 0.2 per cent Copper oxychloride (i.e, 200 g in 100 lit water) or 1% Bordeaux mixture at 15 days interval can control disease.

3. Leaf Rust (*Phakospora elettariae*)

The disease mainly affects older leaves. It is prevalent throughout the year, but higher incidence is noticed during rainy months.

Symptoms

Leaf rust is often seen on lower leaves as numerous whitish to brown powdery pustules (uredosori) on the under surface of the leaves. The uredosori are seen surrounded by chlorotic haloes and on the upper side of the leaves the symptom appear as yellow necrotic patches. In severe cases the uredosori are found covering the entire leaf blade and cause premature drying of leaves



Rust: Symptoms on upper and lower sides of leaf

Management

- One or two rounds of 1% Bordeaux mixture at 15 days interval can control the disease

4. Wilt/dry rot disease

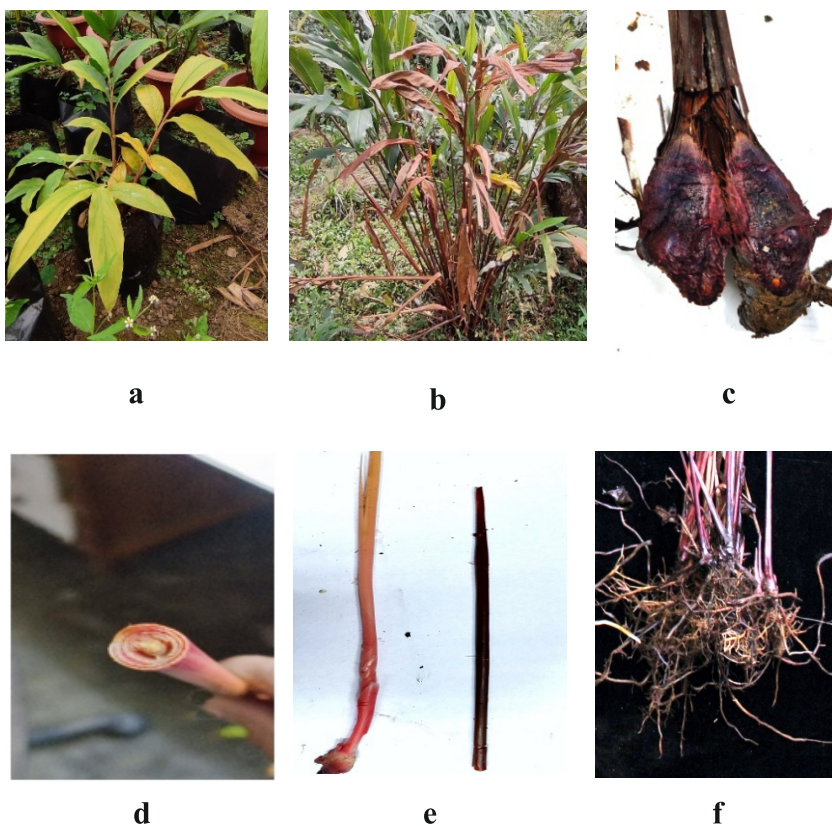
Wilting of plants can be due to various biotic and abiotic factors. The wilt/dry rot disease due to pathogenic fungus *Fusarium oxysporum* Schlecht has been reported in the large cardamom nurseries and plantations of Sikkim. The disease is seen more frequently in drought prone/open areas. The recent surveys revealed that the incidence of the disease is gradually increasing in all the areas. Moreover, the period of disease occurrence is extended till June as against February which was reported earlier.

Symptoms:

In case of wilt symptoms, initially, yellowing of leaves from base upwards is noticed. The yellowing may start from the margin and eventually spreads to the entire lamina. Later the leaves wilt, becomes dry and turns brown/black. The entire leaves may collapse at the petiole leaving the pseudostem standing. Loosening of leaf sheath and splitting at the base of pseudostem is also noticed (Plate 5a & b).

Dry rot symptoms can be seen by longitudinally opening the rhizome which reveals the discoloured / rotten area. Almost the whole rhizome may be invaded by the pathogen. The inner whorls of the pseudostem just above affected rhizome look brown and shrivelled. The central core of pseudostem turns brown and decay. Later, the pseudostem lodges from the base. The roots show blackening and the bark peel off easily. Finally, the whole clump dries up (Plate 5c to f).

In nurseries, the wilt incidence was observed during February-June while in plantations, it was noticed during October to June.



(a) Yellowing of leaves, (b) wilting and drying of leaves, (c) rotten rhizome (d) lodging of infected pseudostem (e) healthy & rotten central core of pseudostem and (f) rotten roots

Management

As it is an emerging problem, exclusive studies on management of *Fusarium* wilt/dry rot in large cardamom is under progress. Factors like acidic nature of soil, poor fertility status and poor plantation management predisposes large cardamom plants to soil borne diseases like wilt/dry rot.

- Correction of acidic soil by applying lime.
- Diseased plant materials to be properly disposed
- Provide adequate shade in the plantation.
- Provide irrigation during winter
- Apply recommended organic manures
- Pre-treatment of suckers with bioagents like *Pseudomonas fluorescens* or *Bacillus subtilis* @ 5 litres in 100 litres water for 30 minutes before planting.
- Apply *Trichoderma* mixed with FYM (1-2 kg/100kg) and neem cake (1kg/100kg) in soil @ 2kg/clump. This will reduce soil inoculum of pathogen.

6. Chirke disease

The disease is caused by virus (Large Cardamom Chirke Virus), transmitted through aphid vector and also mechanically through plant sap. The corn aphid *Rhopalosiphum maidis* is one of the prevalent insect-vectors of the disease. Primary spread of the disease from one area to another is through infected rhizome and further spread within the field takes place by contaminated farm implements and aphids.

Symptoms

- The disease is characterized by mosaic appearance on leaves.
- The symptom is more prominent on young emerged leaves where discrete pale green to yellow longitudinal stripes running parallel to each other can be seen.
- The typical symptoms are masked on mature leaves.
- The flowering is greatly reduced which results in gradual reduction of yield over the years.



Mosaic symptoms of *Chirke* on young leaves Aphid, *Rophalosiphum maidis*

7. Foorkey disease

The causal agent of the disease is a virus (Cardamom Bushy Dwarf Virus) which is not transmitted mechanically through plant sap but through insect vector, viz., banana black aphid (*Pentalonia nigronervosa*) and *Micromyzus kalimpongensis*. It is transmitted in a persistent manner, means the virus can survive inside the aphid for a long time after feeding on infected plants. The virus also spread primarily through infected rhizomes.

Symptoms

- The affected plants produce many stunted shoots which fail to produce flowers.
- The leaves become small, lightly curled and pale green in colour. Sometimes, slightly broadened leaves resembling betel leaf is also seen.
- The inflorescence becomes stunted and sterile.



Foorkey affected large cardamom



Aphid, *Pentalonia nigronervosa*

Management of viral diseases

Plants affected with viral diseases cannot be cured. Early identification of the diseased plants and its destruction can reduce the further spread. Hence, from an environmentally safe and economically viable perspective, the following measures would be adopted for effective management of viral diseases.

- Monitor the plantation every month particularly during rainy season and carefully identify the diseased plants.
- The diseased plants may be uprooted and destroyed as and when they are seen. They should be taken to an isolated place, chopped into small pieces and buried in pits for quick decomposition. As an alternative, mass uprooting and burning of infected plants at the village / area level could be taken up for eradication of the disease.
- Never collect planting materials from an infected garden or apparently healthy plants from severely infected gardens.
- Establish nursery about 500 m away from main plantation in order to avoid aphid colonization
- Spraying of Neem oil (Azadirachtin 0.15%EC) 1500 ppm @ 3 ml per litre at 15 -20 days interval provides effective control of aphids.
- Maintain clean clumps by removing old tillers with loosened leaf sheath so that aphids will not colonize.

During plantation monitoring, especially prior to harvesting, the plantation must be inspected carefully for identification of diseased plants. These plants may be uprooted and destroyed on priority. The knife and other implements used for the purpose should not be used on healthy plants since disease could be transmitted through sap. Dip the implements in hot water for half an hour for killing the inoculum before going to the healthy plants for harvesting or cleaning.

INTEGRATED PEST AND DISEASE MANAGEMENT (IPM) SCHEDULE FOR ORGANIC LARGE CARDAMOM PRODUCTION

Month	Operation	Target pests / pollinators
January-December (Throughout the year)	<ul style="list-style-type: none"> • Monitoring of plantations at 15 days interval to identify <i>Chirke</i> and <i>foorkey</i> infected plants for removal and destruction by deep burying outside the plantation. • Thrashing and phyto-sanitation. (Depending on pest incidence) 	<ul style="list-style-type: none"> • Aphids and viral diseases (<i>chirke</i> and <i>foorkey</i>) (To make large cardamom plantation virus and pest free)
March – May	<ul style="list-style-type: none"> • Weeding in large cardamom plantations during flowering period will facilitate foraging of pollinators. • Phyto-sanitation by collecting blight infected leaves, caterpillar infested leaves and destroy them by deep burying outside the plantation. • Foliar application of Bordeaux mixture (1.0%) and application of copper oxychloride (0.3%) as drenching in plantations after phyto-sanitation. • Or Application of bio-control agents and botanicals as basal drenching and foliar spray (Two to three applications at monthly intervals) 	<ul style="list-style-type: none"> • Pollination by bumble bees/ honey bees and conservation of bumble bee nests in the soil. • <i>Colletotrichum</i> blight • Leaf caterpillar (<i>A. chorista</i>),
June – July	<ul style="list-style-type: none"> • Phyto-sanitation by collecting blight infected leaves, caterpillar infested leaves, uprooting of viral infected plants and destroy them by deep burying outside the plantation. • Application of bio-control agents and botanicals as basal drenching and foliar spray (Two to three applications at monthly intervals) 	<ul style="list-style-type: none"> • <i>Colletotrichum</i> blight • Leaf caterpillar (<i>A. chorista</i>), • Viral diseases (<i>chirke</i> and <i>foorkey</i>)

August December	<ul style="list-style-type: none"> • Weeding, covering of spike with dried leaves and small branches of trees • Trashing and phyto-sanitation. Application of bio-control agents and botanicals as basal drenching and foliar spray. • Foliar application of Bordeaux mixture (1.0%) and application of copper oxychloride (0.3%) as drenching in plantations after phyto- sanitation (Post monsoon). 	<ul style="list-style-type: none"> • Mammalian pests • <i>Colletotrichum</i> blight, • Leaf caterpillar(<i>A. chorista</i>), • Viral diseases (<i>chirke</i> and <i>foorkey</i>)
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Preparation of Bordeaux mixture

Dissolve 1 kg of Copper sulphate in 50 liters of water. In another vessel, slake one kg of quicklime by adding small quantities of water preferably warm water (1–1.25 kg of lime can be taken). When slaking is over, make up to fifty liters by adding water and stir well to get a uniform suspension of lime. Transfer the lime suspension thus prepared through a sieve and keep separately. Add 50 liters of the Copper sulphate solution to the 50 liters of lime solution with constant stirring. To test the correctness of the mixture, dip the edge of a brightened iron knife for a minute in the mixture. If the knife remains bright, the mixture is correctly prepared. If the knife turns rusty brown or if its brightness is lost, add more lime suspension, correctly prepared Bordeaux mixture will turn red litmus to blue and turmeric powder to orange red in colour.

Precautions: For dissolving Copper sulphate or preparing Bordeaux mixture, use copper, wooden or earthenware or plastic pots or drums. Use fresh quicklime. Bordeaux mixture should be passed through a sieve before transferring to the sprayers. Spraying of Bordeaux mixture should be done on the same day of preparation.

Preparation of low cost fish meal traps (bait):

Fish meal trap/ bait to trap shoot flies can be prepared at farm itself.

Materials required

- » Dried fish or fish waste (not used for consumption)
- » Plastic bottle or a container with perforations on the upper side (for entry of insects)
- » Soap/ kerosene /insecticides (wherever permitted)

Method of preparation

Mix dried fish/fish waste in water; allow it to ferment for few days until it emits putrid smell. Fill the perforated bottle/container to half level either with concentrated soap water or kerosene or insecticide mixed water. Place the fermented fish meal in small polythene bags and hang it inside the plastic bottle/container without touching the liquid inside. The bottles may be hanged just above the canopy level of the plants. The scent emitted by fish meal/bait will attract the flies which enter through the perforations in the bottle. The trapped flies later fall into the solution which kills them. The solution with died insects to be discarded and fermented fish meal/bait to be replaced at an interval of 14-15 days.

Preparation of Neem Seed Kernel Extract (NSKE)

Neem Seed Kernel extract can be prepared at farms itself.

Materials required

For preparation of 100 liters of 5% NSKE solution, following materials are required

Neem seed kernels (well dried) – 5 kg
Water (reasonably good quality) – 100 litres
Detergent/ soap – 200g

Method of preparation

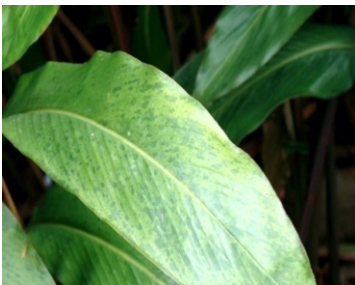
Take required quantity of Neem seed kernels (5 kg) and grind it to powder form. Soak the powder for overnight in 10 lit of water. On the following day, stir the mixture properly and filter using muslin cloth and then make up the solution to 100 lit by adding water. Add 200g detergent/soap in the solution and mix well and spray the plants using a sprayer.

ABIOTIC DISORDERS

1. Frost Injury

During winter, the large cardamom grown in high altitudes (>1500 m AMSL) become prone to damages due to cold weather. This happens during December-February when the temperature reaches below 6° C. The frosting appears as slight yellowing on lamina which later turns pale brown and dry out. Freezing and thawing of leaves due to diurnal variation in temperature hasten up the process of browning. The entire plant looks like affected by firing debris at the base.

Sometimes, tiny pin prick like water-soaked spots appears on the lamina. As the cold weather continues, these spots enlarge and coalesce to form a large patch. The affected tissues become dead, turn brown and later colonized by saprophytic fungi. In open areas, the effect of frost is very severe that the entire garden looks burnt up.



Frost -Water-soaked spots



Frost-Brown dead tissues



Severe frost damage on plants in open areas

2. Hail Stones

Hail is a form of precipitation consisting of solid ice that forms inside thunderstorm updrafts. Hail stones happen during summer showers in March-April. In large cardamom, hail stones cause tearing off of leaf lamina parallel to the veins. The photosynthetic activity of the plants is greatly reduced, the affected tissue dries off and through the wounds saprophytic/parasitic fungal colonization happens. During the ensuing rainy season, severe physical damage is noticed on hailstone affected leaves.



Tearing off of leaves due to hailstones



Drying of torn leaves and colonization by fungi

3. Sun Scorch

Scorching of leaves is noticed in large cardamom grown especially in open areas and during summer. The symptoms include yellowing, browning and drying of lamina especially on the newly unfurled leaf. The under surface of affected area appears as if it is varnished. Chlorosis and bleaching also appears and the leaf gets parched later.



Sun scorched plants in open area



Yellowing and browning of leaf due to sun scorch

Management of abiotic stress

Large cardamom is a shade loving crop, traditionally grown under forest trees. Of late, the crop has been cultivated in open and terraced lands. The exposed plants are more vulnerable to extreme weather conditions. The effect of sun scorch, hail stones and frost damage in plants grown under shade trees are minimum or negligible. Hence recommended shade (50%) must be ensured to protect the plants from abiotic stress. In sucker and seedling nurseries, agro shade net (50%) has to be provided to protect the plants. Once the detrimental environmental conditions are over, the totally damaged tissues may be selectively removed. The plants must be irrigated and light manured to promote new growth. Spraying of bioagents will help in checking the flare up of fungi invading through wounds.



Frost damage on plants without shade



Healthy plants under shade in a frost hit area

HARVESTING

Plants raised from seedlings takes 3 years from planting to produce fruits. In sucker raised plants, it takes 2 years from planting to start yielding. Indication of time of harvest is when the seeds of top most capsules in a spike turn brown. At this stage, bearing tillers are cut at a height of 30 – 40 cm from ground and left for another 10 – 15 days for capsules to attain full maturity. The spikes are harvested by using special knives known as “Cardamom-knife” (*Elaichi chhuri*). The harvested spikes are heaped and capsules are separated manually, preferably on the same day. At any circumstances, the capsule separation from spikes should not be delayed for more than two days as capsules starts rotting and turn blackish.



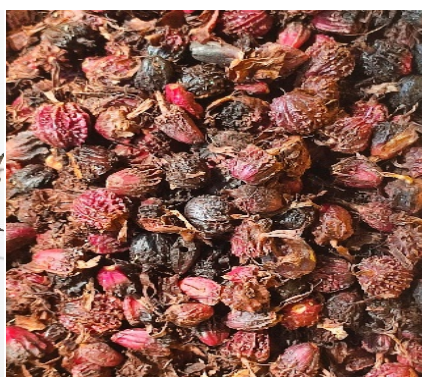
Cutting of bearing tillers



Elaichi chhuri



Mature Spikes



Mature Capsules separated from spikes

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.

Cultivar	Harvesting time (in general)
<i>Ramsey</i>	October–November
<i>Ramla</i>	October–November
<i>Sawney</i>	August–October (November in high altitude)
<i>Varlangey</i>	October–December
<i>Seremna</i>	August–October
<i>Dzongu Golsey</i>	September–October

POST HARVEST PROCESSES

CURING

The fresh capsules are fleshy with almost 85 per cent moisture content. Hence their keeping quality is poor and is highly perishable. They are cured or dried to bring down the moisture to 10-12 per cent so as to prolong the shelf life.

Cardamom is cured (i.e., dehydration of the capsules over low sustained heat) in a curing furnace, the heat invariably coming from burning of wood fuel. Traditionally, locally made furnace, the “*Bhatti*”, are used to cure cardamom. Here, the capsules are spread on a wire mesh kept on stone mud structure and heated by burning wood from the bottom. The capsules are thus exposed to direct heat and smoke in local *bhattis*.

After drying, the capsules on the wire mesh are rubbed so as to remove the tails (calyx) to some extent. The cardamom cured in local *Bhattis* loses its natural pink/maroon colour and they turn blackish with a smoky aroma.



Fresh Capsules



Local bhatti



Local bhatti cured cardamom

ICRI modified Bhatti:

Improved curing devices are presently available for processing cardamom with superior quality. Indian Cardamom Research Institute, Regional Research Station, Gangtok developed improved curing technology known as ICRI Improved Bhatti where cardamom is cured through indirect heating. In improved Bhatti, a drum is kept as furnace in the lower firing chamber where the wood is fed as fuel. From the furnace, a set of flue pipes is fitted which carries smoke laden heat beneath the wire mesh (curing chamber) which later escapes through an outlet. Here

cardamom is dried by indirect heating at 50-55°C. Curing is done till moisture content of the produce is brought down to 10 -12 per cent and it gives metallic sound while shuffling. The cardamom cured in modified *Bhattis* retains its natural aroma and colour and is highly preferred in the market.

The system is available in two capacities that can process 200kg and 400 kg of fresh capsules. The cost is estimated to be Rs. 62,500/- (200 kg) and 92,500/- (400 kg). Spices Board, Ministry of Commerce, Government of India is promoting the ICRI improved Bhatti among farmers through subsidized promotional scheme as “ICRI Modified Bhatti”.



ICRI modified bhatti



Flue pipe with furnace



Curing of cardamom in ICRI modified bhatti



ICRI bhatti cured cardamom

In large cardamom drying, new improved driers are being used now a days which run either on electricity / diesel or both (hybrid). Cardamom cured in improved driers are found to retain good colour and aroma.



Dellmarc Electric Drier



Dryer run on Electricity/diesel or both

POLISHING

Polishing is done immediately after curing the capsules to provide a smooth texture and also to remove the calyx to some extent. The polishing can be carried out using cardamom polishing machine.



Cardamom polishing machine

TAIL CUTTING (Kanchi Cut)

The complete removal of calyx (tail) from large cardamom capsules manually using scissors (“*kanchi*” in Nepali) is known as tail cutting or kanchi cutting. The tail cut (kanchi cut) grade used to fetch higher price in the market.

At farmers' level tail cutting or polishing are not practiced. These processes are mainly done at Traders level to improve the marketability of the produce.



**a. Cardamom capsules with tails (calyx) b. Tail cutting (kanchi cut)
c. Cardamom after tail removal (kanchi cut grade)**

GRADING, PACKAGING AND STORAGE

Traditionally, the traders used to grade the capsules as *chhota dana* and *bada dana*. Traders use different sieves to grade their produce for better marketability. Indian Cardamom Research Institute, Regional Station, has standardized five grades for large cardamom capsules based on capsule size (dia).

ICRI RRS specified grades of large cardamom capsules in comparison with traders grades.

Sl. No.	Capsule Dia. (cm)	Bulk Density (g/l)	Grades developed by ICRI RRS Tadong	Grade Name as per traders in Sikkim	Grade Name as per traders in Siliguri (West Bengal)
1	>1.5	367.5	Boda dana (A) / Grade I	Badadana	Extra Bold hand pick (T.O SCHOOTER)
2.	1.4-1.5	354.2	Bada dana / Grade II	Goldana	Medium bold tail cut (7 STAR)
3.	1.3-1.4	344.2	Medium dana / Grade III	Medium dana	Medium tail cut (BSS JJ)
4.	1.2-1.3	334.9	Chota dana / Grade IV	Chhota dana	Chhota tail cut (KENSTAR)
5.	<1.2	326.0	Pan Elaichi	Pan grade	Pan variety or Pan dana tail cut (PAN)

Diameter of sieve hole and percentage of capsules percolated / retained on sieves

Diameter of sieve hole (cm)	Percentage of capsule percolated through sieve	Percentage of capsules retained on sieve
1.5	83.8	16.2
1.4	64.3	35.7
1.3	46.3	53.7
1.2	27.9	72.1



**Grading sieves developed
by ICRI RRS, Tadong**



Grading at a trader's godown

PACKAGING AND STORAGE

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

The godowns where large cardamom capsules are stored should be free from storing any chemicals/paints/kerosene as exposure of the same leads to deterioration in quality of stored cardamom . The godowns should maintain proper ventilation and hygiene to keep the produce intact for a long time.



**Packaging in polythene
lined gunny bag**



Storage in godown

MARKETING

In the Large Cardamom producing states, no regulated markets are available. Farmers sell dried cardamom to the local traders / dealers in primary (assembling) markets and from there it goes mostly to the secondary markets followed by various terminal (consumption) markets. In order to streamline the marketing of large cardamom, Spices Board had made it mandatory to obtain trader license issued by the Board and also to submit trade returns periodically. Spices Board conducts Buyer Seller Meets to establish direct market Linkage between farmers / FPOs and Institutional Buyers / Processors / Exporters and also to eliminate the middlemen in the supply chain.

The primary (assembling) markets in the major cardamom producing states

Primary assembling markets of large cardamom		
Sl.no.	State	Preliminary Markets
1	Sikkim	Mangan, Dikchu, Gangtok, Rongli, Singtam, Ravangla, Jorethang, Geyzing, Dentam
2	West Bengal	Kalimpong, Lava, Pedong, Bindhu, Todey, Sukhia Pokri
3	Arunachal Pradesh	Itanagar, Naharlagun
4	Nagaland	Dimapur

The secondary markets for large cardamom in Assam and West Bengal

Secondary markets of large cardamom		
Sl.No.	State	Secondary Markets
1	Assam	Tinsukia, Guwahati
2	West Bengal	Siliguri, Kolkata

The terminal (consumption) markets for large cardamom are Delhi, Kanpur, Lucknow, Varanasi, Mumbai, Hyderabad, Amritsar, Jaipur, Nagpur, etc.

QUALITY AND USES OF LARGE CARDAMOM

QUALITY

In market, the quality of large cardamom is governed by its external appearance. The colour, size, shape, texture and flavour of the capsules determine its quality. In general, pinkish/maroonish bolder capsules with many seeds fetches higher market price.

The taste and aroma of capsules are determined by the presence of various aromatic compounds. The large cardamom constitutes around 2-3% of essential oil. The essential oil contains the volatile principles such as 1,8 cineole (75-85%), α - bisabolene (3-6%), α -terpinene (4-8%), α -terpineol + α – terpenyl acetate (3-6%) and also the β -myrcene, nerolidol, pinene, thujene etc., are known in traces. Cineole contributes to the pungency while α - terpenyl acetate towards pleasant aroma

USES

Large cardamom is mainly used as spice and also for medicinal purpose. As a spice, it is used as whole or in ground form. It is mainly used as a flavouring agent in pulav, briyani, rice preparations and also used in sweets like laddu, burfi, etc. Large cardamom is one of the important ingredients in garam masala, meat masala, curry masala and other food preparations.

It is also used in flavouring beverages viz. tea, coffee, buttermilk, etc. Seeds of large cardamom with silver coatings are also used as mouth fresheners.

Large cardamom is used in preparation of certain ayurvedic medicines for cold, cough, digestion and other stomach ailments. It is used as a fragrant adjunct to

other stimulants, which are bitter and pungent. The 1,8 cineole in large cardamom is reported to have antioxidant, anti-inflammatory and antimicrobial properties.

Large cardamom husk is widely used for preparation of dhoop sticks and agarbathi. During harvest, pseudo-stems are removed from plants and it gets accumulated in the plantation. Oflate, the pseudo-stem fibres are used in weaving table mats, bags, folders, etc. Thus, value addition of large cardamom waste pseudo-stem has opened new avenues of livelihood for the farmers.



Scientifically cured large cardamom in gift packs



A weaving unit in North Sikkim making mats from large cardamom pseudo-stem fibres

CROP CALENDAR

Month	Activities
January February	<p>Nursery</p> <ul style="list-style-type: none"> • Regular watering may be done in secondary/sucker nursery based on available soil moisture in nursery. • In primary nursery if 25% germination is observed, the mulch has to remove immediately and shade pandal has to erect. • If any symptoms of disease/pest infestation noticed it may be controlled immediately. • Need based weeding. <p>Plantation</p> <ul style="list-style-type: none"> • After harvest of the crop, the dried leaves and shoot may be dumped in pit instead of using as mulching material. • The base of the plants may be mulched with forest leaves. • Viral disease (<i>Chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting / burial at regular intervals. • Leaf caterpillar / stem borer infested plant parts may be collected and destroyed mechanically. • Regular watering may be done based on available soil moisture in plantation.
March – April	<p>Nursery</p> <ul style="list-style-type: none"> • Regular watering may be done in secondary / sucker nursery based on available soil moisture in nursery. • Decomposed or powdered cattle manure / organic manure may be applied in the nurseries for healthy growth of suckers. • Disease / pest infested suckers may be removed and destroyed. • One round of weeding followed by forking of soil at plant base.

<p>March – April</p>	<p>Plantation</p> <ul style="list-style-type: none"> • Irrigation may be done based on available soil moisture in plantation. • <i>Colletotrichum</i> blight and viral disease (<i>Chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals. • Prophylactic spray and drench of <i>Pseudomonas fluorescens</i> (3-5 lt. in 100 lt water) during April last week after removing blight infected plants (Phytosanitation). • Regular inspections may be carried out to observe shoot fly/stem borer incidence if any, may be hand-picked and destroyed mechanically. • One round of weeding may be done for easy movement of bumble bee and honey bee for pollination.
<p>May– June</p>	<p>Nursery</p> <ul style="list-style-type: none"> • Disease & pest affected plant parts may be removed and destroyed. • New site for secondary / sucker nursery has to prepare and planting may be completed. • One year old sucker nursery seedlings ready for planting in main field. <p>Plantation</p> <ul style="list-style-type: none"> • Decomposed cattle manure/organic manure may be applied in the plantation if not applied earlier for sustained production. • <i>Colletotrichum</i> blight and viral disease (<i>Chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting/burial at regular intervals. • Prophylactic spray and drench of <i>Pseudomonas fluorescens</i> 3-5 lt. in 100 lt water – 1st week of May after removing blight infected plants if not applied earlier. • Spray and drench the plants with copper oxychloride 50% WP @ 1 Kg in 300-400 l of water/acre. • Regular inspections may be carried out to observe caterpillar / stem borer/shoot fly incidence if any, may be hand-picked and destroyed mechanically.

<p>May– June</p>	<ul style="list-style-type: none"> • All the aged /diseased / un productive cardamom plants may be uprooted and removed. Line marking, opening pits and filled with top soil/compost/cow dung so that timely replanting / gap filling operation can be taken soon after getting rains. • Suitable native shade tree saplings may be used for planting where shade is less and where shade is more it may be regulated by loping the excess shade. • Bordeaux mixture 1% as prophylactic spray during onset of monsoon.
<p>July – August</p>	<p>Nursery</p> <ul style="list-style-type: none"> • Disease / pest affected suckers may be removed and destroyed. • Weeding may be carried out if necessary. <p>Plantation</p> <ul style="list-style-type: none"> • Replanting / gap filling operation may be completed within 1st fortnight of July if not done earlier. • <i>Colletotrichum</i> blight and viral disease (<i>Chirke</i> and <i>foorkey</i>) infected plants may be uprooted and destroyed by burial at regular intervals. • Spray and drench of <i>Pseudomonas fluorescens</i> 3-5 lt. in 100 lt water in August after removing the blight affected plants. • Spray and drench the soil with copper oxychloride 50% WP @ 1 Kg in 300-400 l of water / acre. • Regular inspections may be carried out to observe caterpillar/stem borer/shoot fly incidence if any, may be hand picked and destroyed mechanically. • Bhatti (ICRI modified) may be constructed before harvest. • In lower elevation capsule start maturing and one round of weeding and threshing may be done. • Harvesting may be carried out based on maturity in August last.

<p>September - October</p>	<p>Nursery:</p> <ul style="list-style-type: none"> • Over head pandal may be raised for the nursery opened during May- June. • Nursery bed may be mulched properly with dried forest leaves. • Disease/pest infested suckers may be removed and destroyed. • Necessary weeding may be carried out. • Seed bed/primary nursery bed may be prepared for raising nursery and seed may be sown. <p>Plantation</p> <ul style="list-style-type: none"> • <i>Colletotrichum</i> blight and viral disease (<i>Chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals. • Spray/ drench of <i>Pseudomonas fluorescens</i> 3-5 lit. in 100 lit water in September if not applied in August after removing the blight affected plants/plant parts. • Regular inspections may be carried out to observe caterpillar/stem borer/shoot fly incidence if any, may be hand picked and destroyed mechanically. • Capsule start maturing in higher elevation and one round of weeding and threshing may be done if not carried out earlier. • Farmers may repair their bhatti for curing cardamom. • Harvesting may be done when capsules are fully matured and curing can be carried out immediately. • Second round of application of dried or powdered cattle manure/organic manure may be carried out in the plantation to boost up the production.
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November-December	<p>Nursery</p> <ul style="list-style-type: none"> • Nursery bed may be mulched properly with dried forest leaves. • Irrigate the nursery based on available soil moisture. • Disease/pest infested suckers/plant parts may be removed and destroyed. • Seed sowing and mulching has to complete immediately within 1st week of November in the seed bed/primary nursery bed and regular watering may be done based on soil moisture. <p>Plantation</p> <ul style="list-style-type: none"> • Harvesting has to be completed in higher elevation based on maturity and curing may be carried out immediately. • After harvest of the crop, the dried leaves and shoot may be dumped in pit for composting instead of using as mulching material. • The base of the plants may be mulched with forest leaves. • Viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals. • Leaf caterpillar/stem borer infestation may be collected and destroyed mechanically. • Regular watering may be done based on available soil moisture in plantation.
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ACKNOWLEDGMENT

We place our sincere gratitude to all our scientists, officers and staff who had contributed immensely for the research and development of Large Cardamom since inception. The whole hearted support rendered by the Govt. functionaries, farming fraternity, cardamom traders, exporters etc. is gratefully acknowledged.





स्पाइसेस बोर्ड
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