

Resource Book for Farmers

FOR MOUNTAINS AND PEOPLE

Climate-Resilient Practices for Sustainability of Large Cardamom Production Systems in Nepal



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The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalaya – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalisation and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.



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Climate-Resilient Practices for Sustainability of Large Cardamom Production Systems in Nepal

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Acronyms and Abbreviations

ECDF	Environment Conservation and Development Forum
ICIMOD	International Centre for Integrated Mountain Development
KKKS	Kalimpong Krishak Kalyan Sangathan
SALT	Sloping Agriculture Land Technology
TMII	The Mountain Institute India
VDC	Village Development Committee

Executive Summary

This Farmers Resource Book is based on a series of field consultations with large cardamom growers, field observations, focus group discussions, and surveys conducted in the large cardamom farming areas of Sikkim and the Kalimpong region of West Bengal, India, and Taplejung District, Nepal. A large amount of available literature was reviewed to relate and validate the information.

This Farmers Resource Book is a ready-made guide for large cardamom farmers to learn, share, and exchange knowledge and experiences for reviving and expanding large cardamom cultivation in Nepal and elsewhere.

It is envisaged that the cultivation of large cardamom, adopting appropriate climate-resilient practices and management procedures, will bring a significant change in the sustainability of agro-ecologically sound large cardamom-based traditional farming systems. This change will contribute immensely to the improvement of livelihoods of the marginal farmers in Nepal and in other countries where large cardamom is growing.



1. Introduction to Large Cardamom

Importance of Large Cardamom

- Large cardamom is a high-value, low-volume, non-perishable, less labour intensive cash crop.
- Agroforestry system provides fodder, fuelwood, timber, and medicinal plants.
- Nepal, India, and Bhutan are the major producers of large cardamom for global market demand.
- Agroforestry systems act as recharge areas for springs and streams.
- Large cardamom uses marginal and sloppy lands where other crops can't grow.
- Large cardamom plantations help maintain good human health and a clean environment.
- Large cardamom provides local employment to women and elderly people in particular.



Constraints in Large Cardamom Farming

Aging (15 – 18) years plantation stands

- Old unmanaged bushes, rhizomes exposed above the ground, vulnerable to drought, disease, and environmental stresses
- Increasing acidity of soil due to old alder trees in the advancing age (> 16-year stand)
- Limited availability of organic carbon, soil organic matter, total nitrogen, total phosphorus, and available phosphorus
- Low nitrogen-transformation rates; declining soil nutrient pool sizes
- Highly nutrient exhaustive, weak and less productive stand



Impacts of climate change

<ul style="list-style-type: none"> Decrease in yield ↓ 	<ul style="list-style-type: none"> Changes in crop phenology ↑↓ 	<ul style="list-style-type: none"> Loss of crops ↑ 	<ul style="list-style-type: none"> Increase in production costs ↑
<ul style="list-style-type: none"> Burns leaves Emergence of diseases Increases water requirement 	<ul style="list-style-type: none"> Alters flowering and fruiting Damages to the flowers 	<ul style="list-style-type: none"> Increase outbreaks of disease and pests attack Damages to the large cardamom bushes and flowers 	<ul style="list-style-type: none"> Increases costs of irrigation
<ul style="list-style-type: none"> Temperatures are increasing ↑ 	<ul style="list-style-type: none"> Rainfall is erratic, unseasonal, and uneven ↑↓ 	<ul style="list-style-type: none"> Incidences of pests and diseases are increasing ↑ 	<ul style="list-style-type: none"> Water sources are disappearing ↓

Lack of access to market information

- Lack of infrastructure for access to market
- Lack of information flow about the value chain, and current market prices (local, national, international)
- Below premium prices due to lack of organized market

Lack of good management practices

- Lack of good management practices on disease and pest, soil fertility, shade, and irrigation
- Lack of farmers-centric extension services and support
- Low awareness level, lack of training and capacity-building activities

Reviving Old Large Cardamom Stands



Clear the land, harvest old trees, and uproot old large cardamom bushes.

Plough the field and apply manure.



Plant suitable shade species.



Make compost pits, and use weeds, litter, and slash biomass to make compost.



Keep cows, oxen, or buffaloes in the field to maintain fertile soil conditions.



Initiate large cardamom plantation, intercrop with legumes, cereals etc. fruits etc.



Grow seasonal crops such as maize, buckwheat, ginger millet, fruits, and beans, pulses or other legumes. Continue this for at least 2 years.



Establish proper irrigation facilities.

Coping with Climate Variations and Impacts

- Produce enough manure and apply in the large cardamom field.
- Establish irrigation facility, using sprinklers/drip system or bringing water from springs/streams/rivers in a channel.
- Plant disease- and pest-tolerant varieties of large cardamom.
- Monitor and manage diseases/pests regularly in large cardamom and surrounding agriculture farms.
- Plant both nitrogen-fixing and other suitable shade species.

Bad practices

- Planting diseased or infected material
- Overcrowding of large cardamom bushes or shade trees
- Ploughing or tillage after plantation
- Flooded irrigation
- Burning of litter
- Lack of disease/pest management and proper irrigation in large cardamom stands
- Plantation in an open land without incorporating shade trees

Remember

Do not keep old large cardamom plantations; they are unproductive. Harvest shade trees and grow cereals or legumes or carry out agriculture for two to three years in the same land. Convert into a large cardamom plantation after three years.

2. Selection of Plantation Sites and Varieties

Elevation, Slope, and Aspect



- Grows from humid subtropical belts at 400 m to warm temperate agro-climatic belts up to 2,300 m elevations.
- Grows in well-drained flat fields to steep slopes (45°) under trees or moist conditions, or along streams/river basins.
- Northwest and southwest facing aspects are suitable, as well as under hill shade or sparse shade conditions.
- 1,200–1,800 masl is the best suited elevation for large cardamom cultivation.

Rainfall and Temperature

- Grows well in lower altitudes receiving 1,700–2,500 millimetres (mm) rainfall per annum, and in higher altitudes receiving rainfall from 2,500 to 4,000 mm per annum.
- Grows well in areas with well-distributed rainfall spread around 250 days per year.
- Exhibits slow growth during dry season and can withstand 1°C temperatures during winter and 20–25°C during summer season. Direct heat or exposure to sunlight is very harmful.
- Highly susceptible to frostbite.
- Low intensity snowfall does not necessarily hamper the production potential.

Variety Selection Criteria

Farmers have to consider the following criteria while selecting the planting material.

- High yielding cultivars (>500 kg dry capsules/ha)
- Varieties that give 2-4 spikes per tiller
- High number of capsules per spike
- Large capsules, more seeds (50–70 seeds/capsule)
- Disease resistant/tolerant
- Pest resistant/tolerant
- Cultivars adaptive to desired agro-climatic situations
- Variety that grows well in low soil moisture condition

Varieties and Planting Conditions

There are a number of local varieties of large cardamom adaptive and suitable to the altitude ranging from 400 m to 2,300 m. They are *Seremna*, *Bharlange*, *Chibeysai*, *Dzongu Golsai*, *Ramla*, *Ramsai*, *Sawney*, *Jirmale*, and *Dammersai*.

Seremna

- Grows exceptionally well in the altitude ranging from 1,200 to 1,800 masl
- Minor pests and diseases can be managed in the farm easily
- Regular management (manure/irrigation) can extend plantation life up to 15–20 years
- Well known for its high yield potential and tolerance to diseases
- The normal plant height ranges from 1.5 to 2.0 m, productive tillers bear 2–3 spikes, each spike bears 10–15 capsules, and each capsule contains 65–75 seeds
- Can be identified by its green tillers/leaves



Bharlange

- Plant height is up to 2.4 m
- Grows well in the mid and high agro-climatic ranges (> 1,500 m)
- The fruit bearing tillers and spike ratio are relatively high.
- Flowering starts from May in mid altitudes and from June until late July in high altitudes.
- Capsules are large and slightly elongated, yield performance is very high
- Big and bold capsules hold 50–70 seeds



Chibeysai

- Farmers can select well suited local variety *Chibeysai* on mid altitudes (1,300–1,800 m)
- The production potential is very high
- A single fruit bearing tiller bears 2–4 spikes with each spike bearing 10–12 capsules
- Market potential is also very high



Dzongu Golsai

- This variety was initially developed by the Lepcha tribe of Dzongu, in North Sikkim in India, thus the name Dzongu
- This variety is adaptive to low elevations (< 1,000 m)
- Capsules are big and bold with 50–70 seeds
- Flowering starts from May, capsules can be harvested by September
- It is considered as disease tolerant local cultivar
- The tillers are similar to that of Ramsai



Ramla

- The plant looks similar to that of *Ramsai* with the same height and vigour
- The leaves are broad and slightly elongated
- Flowering starts from the onset of monsoon and the capsules are ready to harvest from late October
- The plant has maroonish tillers
- Capsules are dark pink in colour with 30–40 seeds



Ramsai

- Flowering starts from May and can be harvested during September–October
- Plant height ranges from 1.5 to 2 m with large number of tillers
- Cultivation range is 1,200–1,600 m, can be cultivated in steep slopes as well
- *Ramsai* has smaller capsules compared to other varieties with each capsule bearing 25–40 seeds
- The plant has narrow leaves with maroonish tillers
- Grows well in the altitude ranging from 1,500 to 2,100 m and in sloppy lands too



Sawney

- Plants are 1.5–2.0 m tall, robust in nature
- This variety is highly susceptible to diseases and pests
- Can be widely grown in low elevations (900–1,500 m)
- Flowering starts with onset of rains (late March to May), harvesting follows during September–October
- Farmers should select this variety only if they can manage pests and diseases
- Leaves are ovate and broad with maroonish tillers
- Capsules are smaller than *Bharlange*, contain 35–50 seeds



Jirmale

- The stem and leaves are green with robust tillering.
- The variety is draft and can withstand dry conditions as compared to other varieties.
- Harvesting of this variety follows during | July–August.
- In an average 22–37 capsules in one spike and in one capsule contains up to 56 seeds
- It is considered a disease-tolerant variety.
- *Jirmale* is known as drought-resistant variety.



Dammersai

- Tasty fruit and fetches high price.
- The stem is light red and green.
- It can be harvested within September–October.
- This is a dwarf variety with fewer tillers.
- This variety can be cultivated at an elevation of 700–1,200 m
- Capsules are big in size and contain more and weighty seeds.

Planting Season

- Best planting season starts from early May (*Jeth mahina*) soon after the first monsoon shower.
- Planting should be carried out up to June (*Asar Mahina*).



Planting Material

- Bring planting material from a healthy nursery and plant them immediately in the pits already prepared by you.
- Take extreme care to avoid damage of leaves, pseudo-stem, rhizome, new shoots, or root.
- Keep material in a moist place before plantation.

Always remember

- Do not keep planting material under the sun or in a dry place.
- Avoid damage during transportation.
- Do not keep planting material for several days once uprooted for transplantation.

Remember

- Do not plant large cardamom during July–August, post monsoon season, or winter. The performance of the plant will be weak.
- Prepare plantation stands during April.
- A sapling planted in May will bear five to six new shoots next year.

3. Propagation of Large Cardamom

Seed Propagation

Primary nursery

- Collect seeds from well-maintained, best performing and diseases free cultivars.
- Isolate big and well-matured capsules from the well-fruited spikes and separate seeds.
- Wash seeds either with water or mixed with sand and gently rub to remove mucilage.
- Dry seeds under the sun for a few days.
- Prepare seed beds (15–25 cm height, 1 m width) during December.
- Sow seeds in February, observe germination in June.
- Cover seeds with thin layer of soil, cover beds with ferns, rice straw, or twigs of *siris* (*Albizia* spp.) tree.
- Add manure and irrigate regularly.

Methods for raising large cardamom seedlings in primary nursery



Secondary nursery

- Establish a secondary nursery by making seed beds of considerable length
- Transplant saplings brought from primary nursery in 1 x 1 m distance in a row in May. Put well-decomposed manure, mixed with soil
- Irrigate them regularly during dry seasons
- Grow useful plants such as Titeypati (*Artemisia vulgaris*), soybean, and legumes that provide partial shade for large cardamom
- Transplant them in the second year as they will be ready for field planting



Propagation through Suckers

Nepal's Ministry of Agriculture Development discourages large cardamom propagation through suckers. Instead, it suggests seeds and tissue culture methods of propagation. Farmers using the suckers for propagation should take these precautions:

- Select suckers from high yielding, disease-free plantations.
- Select tillers with 2–3 immature buds for planting.
- Apply well-decomposed manure and irrigate regularly during dry seasons.

Do not

- Select suckers from diseased plants or plantations, or from low yielding, weak plants
- Select a variety not suitable to your farm or elevation
- Keep uprooted suckers for long

What farmers should avoid

- Do not develop a nursery close to the farm infested by diseases and pests.
- Avoid water logging within the plantations.
- Do not use un-decomposed manure, and direct apply of poultry waste or goat dung as manure. They might spoil the large cardamom bush.

Tissue Culture

This is a best method for propagation of large cardamom. Seedlings are produced in laboratory using tissue culture method to produce a healthy seedling. This is a very safe method for disease transfer and multiply the best cultivar widely.

4. Land Preparation and Plantation Management

Pit Making and Spacing

- Plough the field.
- Develop small-size pits (30 x 30 cm) on contours keeping a distance of 1.5 x 1.5 m apart. Exception: Closer spacing (1.3 x 1.3 m) is advised for *Seremna*.
- Prepare pits one and a half months in advance. Fill them with mulch mixed with manure.

Plantation Methods

- Plant saplings (suckers) in the pits up to the collar region.
- Use sticks to support them to avoid logging under heavy rain or wind.
- Use manure, initiate timely watering, and manage appropriate shade and soil moisture.
- Monitor pests and diseases regularly.
- Raise nursery regularly in a small plot for gap filling.

Development of Soil Base and Mulching

- Fields with deep, well-drained soils with loamy texture and pH 4.5–6.0 are best suited for large cardamom plantation.
- Soil rich in organic matter and inter-planting of nitrogen-fixing species such as *Alnus nepalensis*, *Albizia* spp., or some legumes will enrich soil base with nitrogen and phosphorus.
- Make compost manure or vermi-compost or farmyard manures and use for soil fertility maintenance.
- Terrace the land slightly to avoid nutrient loss and soil erosion.
- Use dried twigs, leaf litter, weeds, or similar for mulching.

Always remember

- Do not step around the sapling with your foot after plantation to tighten the soil. It will spoil the tender roots or buds.
- Do not plant saplings within weeds or under bushes.

Five things farmers must remember for plantation management

- Shade and plant canopy cover management
- Insect/pests and disease management
- Phytosanitation, irrigation, and manure management
- Inter-culture operations, soil fertility maintenance
- Protection from cattle grazing, wild animals, and frost or snow

What farmers should avoid

- Tillage all over or ploughing in sloppy land for plantation (will result in soil/nutrient loss)
- Grazing of farm animals in and around the large cardamom orchard
- Damage to the plant during fodder collection
- Tillage in the farm (will disturb the roots of the plant)
- Deep planting

Gap Filling

- Remove unproductive, old, or diseased bushes or those damaged by wind, heavy rains, snow, and frost or by wild animals.
- Fill the gaps with new good planting material (during May–June) to keep an adequate number of bushes.
- Use healthy planting material from a disease-tolerant, highly productive variety.
- Fill the gaps of best-suited shade species.
- Monitor the plantation stands.

Re-plantation Scheme

- Carry out thinning of shade trees after 10 years if they are in large numbers.
- Re-plant shade species and quality large cardamom saplings.
- Maintain an agroforestry rotation cycle of 15 years for optimum yield and ecosystem reconstruction.
- Alder increases soil acidification more after 15 years, so harvest them between 15-20 years of stand age.
- Old and matured stands are nutrient exhaustive, so recycling is important.
- Manage stands with partial shade to understorey large cardamom.



SALT/Terracing

- Sloping agriculture land technology (SALT), a low-input technology, can be applied to improve slope lands into productive zones
- Sloppy wastelands or old large cardamom plantation stands can be converted into terraces to improve the fertility and stabilize soils
- Grow a combination of suitable species (both nitrogen fixing and non-nitrogen fixing) or other fast-growing and high-biomass leguminous trees or shrubs, and intercrop large cardamom with legumes
- An old large cardamom farm converted into terraces. Farmers initially grow agricultural crops such as maize, pulses, and soybeans.
- Now they established large cardamom farms and intercrop with beans and other vegetable crops. They also planted important shade tree species.



Weed Management

- Carry out weeding and clearing of litter over the large cardamom clumps before flowering to maintain the growth of the plant.
- Tree leaf litter or weeds during flowering will damage large cardamom flowers, which may rot.
- Also carry out weeding before harvesting.



5. Water Management

Critical Stages of Irrigation

- Farmers should understand the critical stages of irrigation to maintain healthy plants and optimum growth.
- Irrigate the large cardamom stands or nurseries during dry seasons until the first monsoon showers.
- Irrigate twice a week (3–4 hours a day).

Water Harvesting and Management Techniques

- Develop small water-harvesting dig-out ponds at suitable locations in your farm to arrest rainwater during monsoon
- Also store water brought from nearby sources
- Develop many storage pits throughout the plantation stands to collect rainwater and to increase soil moisture
- Regularly repair and rebuild the existing traditional irrigation system (*kulo*) or water supply pipes

Ways to Manage Irrigation

- Establish a proper irrigation facility.
- Drip irrigation or sprinkler irrigation is easiest.
- Hose, sprinkler, or flood irrigation supplied through channels can also be adopted.

Always remember

- Overwatering through pipes or from channels may cause mudslides or landslides, or wash away soil nutrients.
- Try to maintain soil moisture continuously so choose the appropriate irrigation method that helps to maintain soil moisture depending upon your situation. For example, drip irrigation or sprinkler or channel irrigation.



- Stream, spring, or river water should be tapped for irrigation.
- Develop proper drainage through diversion channels in the farm to avoid soil erosion and nutrient loss.
- Regular irrigation during lean seasons will retain soil moisture content and augment decomposition of litter.

What farmers should avoid

- Irrigation by flooding and constant flow of water through the large cardamom. This method will leach away nutrients or wash away fertile soil, or expose the large cardamom roots above the soil.
- Big volume of stream water from the channel (*kula-ko-pani*). This method will lead to mudslides/landslides or excessive soil erosion and land degradation.



6. Soil and Nutrient Management

Manure Production



Livestock is a constant source of manure in a traditional farm, apart from a good source of income. Keep cattle for manure production.



Keep livestock at the new fields where you plan to develop large cardamom plantations. This will enrich the soil fertility and soil organic matter.



Keep cattle within the large cardamom farms, preferably at the top of the plantations. This will enrich the stand and reduce labour for transfer of manure during the time of application.



Grow different species of fodder such as broom grass and fodder trees within and outside large cardamom farms.

Vermi-composting

- Learn to make composts or vermi-composting in your own farm.
- Seek assistance and training from extension agencies and request for supply of worms.
- Vermicomposting supplements production of livestock manure.



Bio-composting

- Make bio-composting pits in the large cardamom farm.
- Collect weeds, climbers, twigs, and leaves or leaf litter and mix them with cow/buffalo dung.
- Collect exotic weeds such as *Kalikhhar* (*Eupatorium adenophorum*), English lahara (*Michenia micrantha*), or Kande phul (*Lantana camara*) for bio-composting.
- Reshuffle the compost biomass regularly in the pit.
- Store composts in a suitable place and use them during the appropriate season.



Preparation of Effective Microorganisms

- Learn to prepare effective microorganisms.
- Seek training on preparation of composts with effective microorganisms.
- Apply appropriate doses of manure before flowering and after harvesting.

Green Manuring

- Green manuring helps supplement nutrients and increase organic matter
- Grow legumes or other nitrogen-fixing or non-nitrogen-fixing species (*Flemingia microphylla*, *Adhatoda vasica*, *Artemisia vulgaris*, *Walsura trijuga*, *Sesbania* spp., *Sapium* spp., *Albizia* spp., *Alnus nepalensis*, and *Eupatorium* spp.) along the terrace edges
- Fast-growing nitrogen-fixing will increase the soil fertility



Manure Application

- Apply 8–10 kg of manure (after harvest and before flowering) around the large cardamom bush.
- Cover with crop residue immediately after the harvest so that the plant gets enough nutrients during the lean period.
- Slashed weeds can be used as mulching material to cover manure to avoid drying.



What should not be done?

- Minor tilling or digging of soil in and around the large cardamom bushes. This will damage the growing roots under the soil.
- Disturbing plants during flowering
- Regular visits during flowering. This will disturb pollinator species.



7. Disease Management

Chirkey Disease

- Chirkey disease is transmitted by corn aphids (*Rophalosiphum maidis*), which is one of the prevalent insect vectors.
- Disease spreads within and to adjacent plantations due to use of contaminated field implements (knife or sickle used for weeding).
- Young emerged leaves have a mosaic appearance with discrete pale green to yellow longitudinal stripes running parallel to each other.
- Gradually infection spreads to the mature leaves, the bush, or the plantation. Consequently, photosynthetic activity of the leaf area declines while infection continues to reduce flowering and fruit yield.
- Insects help to spread the disease over the stands so need to control insects through different measures like using bio-pesticides.



Foorkey Disease

- Foorkey disease can be identified in bushes with large numbers of thin stunted shoots coming out from the rhizome part.
- The leaves become small, pale green, and slightly curled.
- The stunted shoots do not grow, and the remaining tillers gradually become pale yellow and drastically reduce flowering and fruiting.
- Inflorescences eventually become stunted, and do not flower.
- Sometimes spikes remain flowerless or fruitless, with no seed formation in capsule.
- The disease is caused by a virus, transmitted through a vector banana black aphid (*Pentalonia nigronervosa* and *Micromyzus kalimpongensis*). The virus can survive inside the aphid for a long time. Therefore, it is not good to plant banana nearby large cardamom stands.
- Either burn or decompose it under the soil or destroy all infested plants through other means.
- The virus is also transmitted through infected rhizomes of the split suckers from one plantation to another.
- The disease is not transmitted mechanically through sap.





Fungal Blight

- Fungal blight progresses during pre-monsoon in April–May and increases rapidly during the peak monsoon.
- Spikes of the diseased clump show elongated lesions and lack fruit setting.
- With time leaves dry out, giving a burnt appearance. Eventually the infected clump and plant dry.

Management

- Visit plantations/infested plants; observe minutely the rhizome plant once you see pale leaves.
- Uproot infested plant, isolate, dry and burn.
- Carry out soil testing to understand the soil ph. Soil below ph level 4 has high chance of soil borne diseases and needs soil ph improvement.
- Ensure proper water management to reduce infestation of fungal disease.



Phoma Leaf Spot Disease

- This disease is caused by *Phoma hedericola*. The entire leaf area shows water soaked lesions, round in shape, that coalesce and become yellowish and eventually dry out.
- The disease appears mostly during winter and advances during rainy season.
- It spreads rapidly during continuous rain resulting into severe damage of large cardamom bushes.

Management:

- Separate the infected plant parts, and dry and burn.
- Manage through phytosanitation and application of bio-agents.

Leaf Streak Disease

- This disease is caused by *Pestalotiopsis royenae*. Numerous translucent streaks are seen on young leaves along the vein.
- It appears throughout the year and results in considerable damage of leaves of large cardamom.
- The most susceptible large cardamom variety is *Golsai*.
- The first infection is initiated from the emerging folded leaves.

Management:

- Indian Large cardamom Research Institute Sikkim recommends the application of three rounds of 0.2% copper oxychloride or 1% Bordeaux mixture at 15-day intervals to control the disease.

Moulds

- Aphids excrete several species of black-coloured fungi or moulds that grow on honeydew.
- Moulds cover large cardamom leaf, and its black growth can block sunlight and interfere with photosynthesis.
- Respiration is reduced through the physical closure of stomatas by the mould's growth.
- Low or no rainfall promotes accumulation of sooty materials causing wilting.

Management:

- Irrigate the field regularly.
- Destroy mould wherever it appears on the plant.
- Destroy the aphids wherever they appear on the plant or associated plants.



Clump Rot

- Clump rot is caused by fungi like *Pythium* sp., *Cephalosporium* sp. and *Rhizoctonia* sp.
- It is generally observed during summer and in winter until the onset of monsoon.
- The infected plants show yellowing of leaves and stem followed by wilting. The rhizome gradually dies and decays.

Management:

- Remove the infected plant, and dry and burn.



8. Pest Management

Leaf Caterpillar

- Leaf caterpillar (*Artana chorista*) initially feeds on chlorophyll content of leaf lamina from under surface.
- The infested portion looks like white paper.
- The leaf defoliates, leaving the midrib part.
- Infestation can be observed during the onset of monsoon (May–June) and October–March.

Management:

- Inspect the infested plant, and destroy caterpillars.
- Sprinkle bio-pesticides (cow urine with tobacco leaf juice) on the infected plants.

Shoot Fly

- Shoot fly (*Merochlorops dimorphus*) damages the emerging shoots, then tip of the young shoot becomes brown and later whole shoot dries up.
- Infestation can be observed throughout the year, and is severe during rainy season, when new tillers start growing.

Management:

- Inspect the infested plants, isolate, and kill.

Stem Borer

- Incidence is observed mostly during March–November
- Farmers should constantly monitor the infested plant, destroy stem borer at different times to stop its life cycle
- The larvae (*Glyphipteris* sp.) bore into the pseudo-stem above the collar region, feed on the central part causing dead heart
- Minute observation shows frass materials (excreta) outside the holes



Seremna variety is more susceptible to stem borer, but can be managed in the farm without any inputs.



White Grub

White grubs (*Holotrichus* sp.) cause damage to the base of the pseudo-stem and the rhizome part, the plants look yellow.

- Newly hatched grubs emerge during June–August and continue up to October–December
- Collect adult beetles during the emergence period and kill them
- The larvae are fat, whitish or cream-coloured grubs which measure about 38 mm when fully grown
- Larvae feed on plant roots and organic matter in the soil
- The rhizome part eventually decays and dries, the pseudo-stem and leaves become pale and dry
- Mature grubs are found in 0–6 inch soil, move deeper when the soil is very dry



Aphids

- Both adult aphids and nymphs cause damage to large cardamom crops by transmitting viral disease.
- Incidence is severe during the summer at lower altitudes (< 1,000 m), and is sometimes noticed during winter and pre-monsoon season.
- Lack of rainfall promotes the growth, and increases the incidence of moulds.
- Increasing temperature might be favourable for the growth of aphids resulting into incidence of viral diseases (*Chirkey, Foorkey*).

Management:

- Regularly irrigate the plant and destroy the aphids wherever they appear on the plant or on the associated plants.

Capsule Borer

- During capsule maturity, larvae bore the fresh capsules and damage the seeds
- Observe such capsules in the farm during the fruiting stage, and isolate them to control the infestation
- Holes are prominently seen, as a result
- Pupation of the larvae takes place in the capsule, and the adult emerges from the hole after maturity
- These capsules do not contain seeds. Many of them eventually decay after maturity



As management, clear leaves, twigs, or weeds that cover the fruit-bearing bushes to prevent different types of insects infecting the spikes.

Lace Wing Bug

- The incidence of lace wing bug (*Stephanitis typica*) was first recorded in 1997 by the Spices Board India.
- The incidence has been observed in and around 1,300–1,700 m.
- It is a sucking pest; incidence is higher in less open conditions where shade is very sparse.
- Crop damage is greater during pre-monsoon and monsoon.

Management:

- Apply cow urine mixed with tobacco leaf extract regularly.

Other Pests

- Some fruit-eating animals such as monkeys, mice, porcupines, civets, *Kala*, and squirrels damage large cardamom bushes, fruits, and buds.
- Climatic variation (increasing dry periods, erratic rainfall, temperature rise) favours spread of pests. Plants become susceptible to other diseases, pests, or environmental stress conditions.

Management:

- The infected plant parts should be destroyed; otherwise, it acts as breeding ground for pests/diseases.
- Phytosanitation is important to manage pests/diseases, maintain optimum plant population per unit area, and guard farms to prevent wild animals.

Planting Insect Repelling/Attracting Species

- Some species attract the insects which are harmful to large cardamom; they either feed on the nectar or collect pollens.
- Grow aromatic plants such as marigold or other flowering plants, which act as biological control to insects that are harmful to large cardamom.
- Design agriculture crop rotation to grow non-host crops to pests/insects. The rotations will substantially suppress harmful pests/insects.



Marigold planted in the large cardamom plantation, a climate smart practice

Alternative Methods of Pest Management

- Regularly manage pests for plant growth, vigour, and productivity.
- Raise flowering plants/compatible cash crops along the field border by arranging shorter plants towards the main crop and taller plants towards the border to attract natural enemies and to avoid immigrating pest populations.
- Select plants that are appropriate companion plants which could be trap-crops and pest-repellent crops. Grow flowering plants, the parasitoids and predators (natural enemies) number also will increase due to availability of nectar, pollen, and insects. The major predators include a wide variety of spiders, ladybird beetles, long-horned grasshoppers, and earwigs.

Do not

Do not uproot important weeds such as *Tridax procumbens*, *Ageratum* sp., and *Alternanthera* sp. that are growing in the large cardamom plantation. They serve as nectar sources to the insects and pests.

Understanding Prey or Predator Insects in the Field

- Predator insects are mostly farmers' friends which feed on pests.
- The concept of an "insect zoo" can be helpful to enhance farmers' skill in identifying beneficial and harmful insects.
- Collect unfamiliar or unknown predators from the field to observe and study with scientists.
- Place the predator in a plastic bottle together with parts of the plant and some known insect pests. Observe activities. Determine whether the test insect is a pest (feeds on plant) or a predator (feeds on other insects).
- Regular observation of insects and pests will help identify pests and predators and thus to reduce pests and save predators.



Harish Chandra Silwal

Farmers discussing crop management techniques

Field-based Ecological Engineering for Pest Management

Field-based ecological engineering is a simple method of pest management and control of soil-borne and other diseases. Apply this method to increase the beneficial microbial population and enhance soil fertility.

The following activities are suggested:

- Design crop rotations with leguminous plants to enhance nitrogen content.
- Cover the soils year-round with living vegetation and/or crop residue by mulching to reduce moisture loss.
- Add organic matter such as farmyard manure, vermi-compost, or crop residue to enhance below ground biodiversity of beneficial microbes and insects.
- Apply a balanced dose of nutrients using manures (bio-composts/vermi-composts) or bio-fertilizers based on the soil test report.
- Apply *Trichoderma harzianum/viride* and *Pseudomonas fluorescens* for treatment of seed/seedling/planting materials in the nurseries and field application.

Crop Management Strategies

Some skilled and knowledgeable farmers should visit a large cardamom field (newly established and old plantations elsewhere) to observe plants closely. Choose a small plot (5 m x 5 m) or 15–20 large cardamom bushes and record the following observations:

There are several natural enemies in the large cardamom field which could play a significant role in controlling foliar insect pests. The diversity of natural enemies contributes significantly to management of insect pests both below and above ground. They require food in the form of pollen and nectar, alternate hosts when primary hosts are not present, and shelter, overwintering sites, and moderate microclimate.

Field observation for managing large cardamom crops in the field

SN	Attribute	Field observations
1	Plant	Plant height, number of aerial tillers, crop stage, deficiency symptoms
2	Pests	Number of pests at different places
3	Natural enemies	Number of parasitoids and predators
4	Diseases	Visible disease symptoms and severity on leaves and stems
5	Rats	Number of plants affected by rats
6	Weeds	Observe weeds in the field and their intensity
7	Water	Water condition
8	Weather	Impacts of weather



Farmer's Field School for Community Study, Problem Identification, and Management

Farmer's Field School (FFS) is an informal education programme for identifying problems and finding solutions on their own initiatives and learnings. In the FFS approach a group of farmers gets together in one of their own fields to learn about their crops and things that affect them. They learn how to farm better and how to control insects and pests by observing, analysing, and trying out new ideas on their own fields. Farmers should meet regularly, carrying out the following activities:

- Collect plant parts with disease symptoms. Find a shady place to sit as a group in a small circle for drawing and discussion.
- Identify the pests, defenders (beneficial insects), and diseases on the plant. Each group will then analyze the field situation in detail and present their observations and analysis.



- Next, make a drawing of a plant that shows the field situation, weather condition, water level, and disease symptoms.
- Draw the pests on one side of the plant and defenders on the other side and write the number of each pest. Indicate the plant part where the pests/defenders were found. Try to show the interaction between pests and defenders.
- In small groups, discuss the field situation and make a crop management recommendation.
- Regroup and have a member of each small group present their analysis in front of all participants.
- Led by a facilitator (someone who asks guiding questions and makes sure everyone is actively involved), discuss the recommendation and formulate a common conclusion. The whole group should support the decision on what field management is required.
- Make sure the required activities (based on the decision) will be carried out.
- Keep the drawing for comparison in the following weeks.



Illustrations for monitoring pests on large cardamom leaves

Collecting Field Information and Recording Methods

Record field data in a notebook and a drawing on a chart to document what has happened. This practice helps with making an analysis and drawing conclusions.

After the field visit, sit together and discuss and record the following essential observations:

- Immediate crop management aspects that are important now and in the seasons to come
- Any pest or disease outbreak observed or any disease/pests that need immediate management attention
- Beneficial insects and harmful pests
- Changes in the field compared to the last visit.
- Balance between the field pests and beneficial insects.
- Plant health and any required inputs (gap filling, manure, irrigation, etc.)
- Insects and pests you could identify and those you could not
- Necessary management practices to improve the current situation of the crop
- When to conduct management practices and who should be involved
- Effectiveness of shade trees or other associated species, and how can they be better managed
- Problems that might emerge in the near future or in the coming season (good/bad weather situations, emergence of pests or diseases, etc.) and solutions (actions to solve the problems)

Finally, summarise the observations in two sections—problems and solutions—for better management of the large cardamom plantation.

Data to be recorded by the group of farmers

SN	Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Plant growth												
2	Plant height												
3	Number of leaves												
4	Crop situation												
5	Plant health												
6	Pests, diseases, weeds												
7	Natural enemies												
8	Soil condition												
9	Irrigation												
10	Weather conditions												
11	Input costs												
12	Seeds												
13	Fertilizer												
14	Bio-pesticides												
15	Labour												
16	Harvest												
17	Yield (kg/acre or kg/ <i>ropani</i>)												
18	Price of produce (NPR/ kg)												

9. Harvesting and Post-Harvest Management of Large Cardamom Stands

A Week before Harvesting

- Slash the fruit bearing tillers without disturbing other non-bearing tillers
- Clear the litter, leaves, twigs, and weeds over the spikes bearing the capsules
- Slash weeds, bushes (*buta-buti*), or other plants by using a sickle (*hansiya/kachiya*)
- Spread the litter uniformly on the floor without covering the fruit bearing spikes



Harvesting

- Bushes that grow profusely with a large number of tillers require thinning in order to find enough space for fruiting next year.
- Observe the mature capsules and seeds for harvesting.
- At maturity, spikes bearing tillers and new tillers are arranged very compactly. Use a double-edged knife to trim down the new shoots of new tillers that will bear fruit next year.
- Harvesting requires skilled labour. Train workers how to manage the tiller density and use knives.
- Identify the dark seeds during maturity; the mucilage becomes sweet in taste.
- Taste the seeds. You should feel a mild burning sensation in the throat.





Use of Knives

- Learn skills to use the knife (*Churi*).
- Use long and short knives according to the size of the bushes.
- Trim down only the spike-bearing tillers.
- Do not trim the emerging tiller. It will fruit next year.
- Thin if the new shoots are profuse and compact.

Harvesting the Spikes Bearing Capsules

- During harvesting, examine the capsules in the spikes to understand the seed maturity.
- Once the capsules are maroon in colour and fully matured you can start harvesting.
- Large cardamom maturity starts from the lower elevations to higher.
- Harvesting will start from the end of September in lower elevations and until the first week of November in high altitudes depending on the time of maturity.



Identifying Fruit Maturity



- Closely examine the capsule maturity in several spikes
- Observe the fully ripened capsules



- Harvest spikes when the capsules turn fully mature and maroon in colour
- Harvest the spikes immediately once matured; otherwise, animal paste civet cat (kala) will feed on capsules
- Taste the mucilage part — it should be sweet — and the seeds — you should feel a mild burning sensation in the throat
- Identify the dark seeds during maturity

Post-Harvest Curing

Curing is crucial for maintaining capsule quality. You will need a covered area to store fuelwood, a kiln, and a shed. Large cardamom drying is the most important part of large cardamom processing. Colour and oil retention is maintained by proper drying process.



Keep harvested spikes in a dry, shady place and separate capsules from the spikes manually.



Collect fuelwood one year in advance and keep it in a shaded area.



1. Design a kiln that requires less fuelwood to ensure the best quality product (maroon colour of capsules with essential oil content).
2. Construct a shed over the kiln. Use locally available material such as stones, bamboo, and wooden poles.
3. Repair the shed every year. Make sure the roof is watertight; rain will spoil the drying capsules.
4. Constantly monitor fire hazards.



Constant fire flames without smoke are beneficial.

What should be avoided?

- Stocking of spikes or capsules for more than two days before curing.
- Improper postharvest handling, storage, and processing techniques.
- Wet fuelwood. The smoke it creates will discolour the capsules.
- Excessive heat with high flames. This will burn the jacket of the capsules, charring the capsules.

Post-Curing Grading

- Remove the tails (*kainchi-cut*), or segregate into big (*thulo-danu*) and small (*sanu-danu*) capsules.
- Gently reshuffle the freshly dried capsules to remove dust or to clean them.
- Remember capsule cleaning, grading, temperature and relative humidity control, safe storage, safe transportation, and safe handling at destination.
- Use good packaging materials.
- Avoid dampness, wetness, and decay.



Post-Curing Storage

- Store in a well-ventilated room; it should have a dry and clean wooden surface.
- Capsules can be stored for months to years until a high market price is confirmed.
- Package capsules in jute bags, which are easily available.
- Monitor the storage room for fungal attack and moisture/wetness to prevent decay.



What should be avoided?

- Dampness in the storage room, moisture, wet floors
- Jute bags attached to the walls, which will absorb moisture and spoil the capsules

Transportation precautions

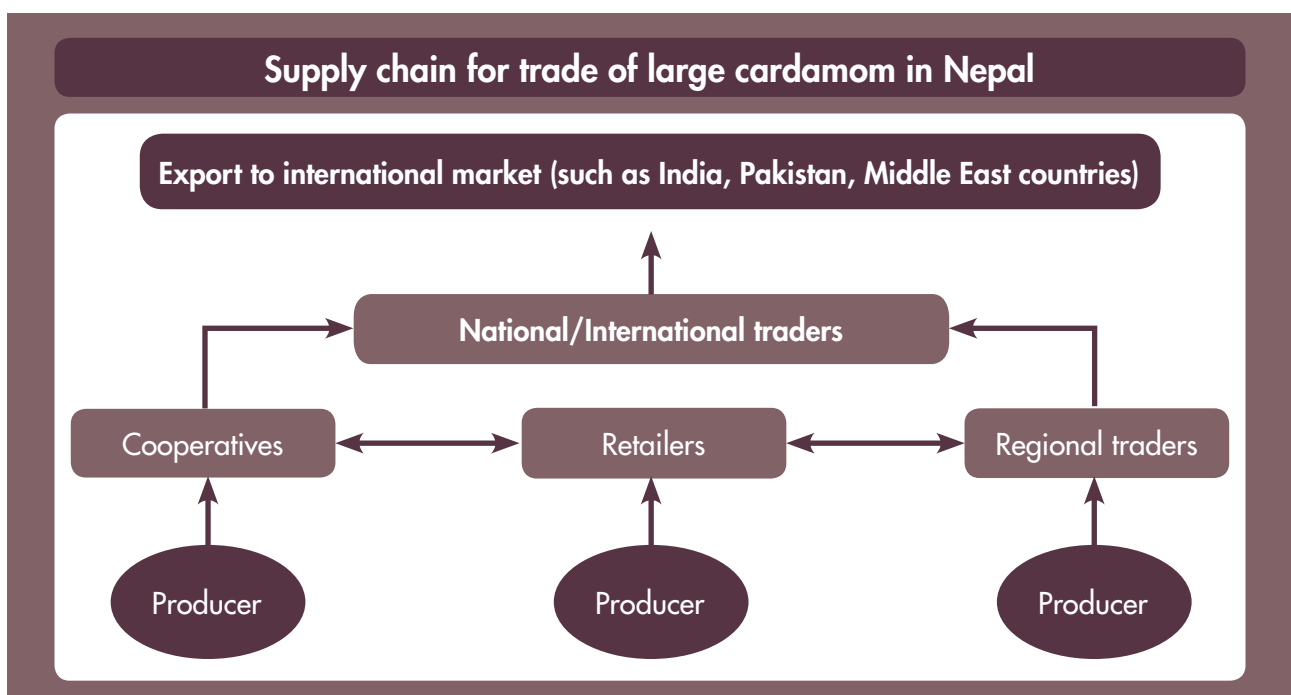
- During loading or unloading from carrier trucks or taxis, handle the sacks carefully to avoid damage to large cardamom products.
- During transportation, cover the sacks with polythene to protect against rain or water.
- Do not keep anything on top of the sacks.

Market Delivery

- Establish links to the nearest market traders, retailers, or regional traders. Use mobile phones to understand day-to-day rates of large cardamom.

Market Channels

Understand the value chain of large cardamom marketing and trade, and monitor fluctuating prices. For premium price fixing with farmers, the extension service providers can organize auctions of large cardamom at a suitable place where farmers and traders can negotiate prices.



Collective Marketing through Cooperatives

- Establish a cooperative system of large cardamom growers.
- Cooperatives enhance people’s participation, promote market oriented production systems, increase bargaining power, and supplement existing service delivery system, provide credit and mobilize savings.
- Co-operative marketing will shorten the marketing channel (Producer – Local traders/Regional traders (Wholesalers/Middleman-Retailer)/National traders/International traders – Consumer).
- Establish revolving fund for the members they can utilize whenever in need at low interest rates.

Stand Management after Harvesting



- Put 8–10 kg of well-decomposed compost at the base of the large cardamom bushes after the harvest
- Chop the slashed (harvested fruit bearing) into pieces and spread them around the bushes to speed up decomposition
- Irrigate the stand during the dry period



Post-Harvest Mulching with Harvested Tillers

- Collect weeds from within or from surrounding places and use them as mulching material for the bushes. They will decompose and provide soil organic matter as well as maintain soil moisture.
- Use a sickle to collect the weeds. Uprooting them will disturb large cardamom roots.



Avoid

- Collecting harvested tillers and keeping the floor devoid of mulch. The soil moisture level will be lost and the soil becomes dry.
- Covering the inflorescence or fruits with the litter. The flowers or the fruit will decompose.

10. Shade Management

Large cardamom is a shade-loving plant and grows well within 50% to 60% shade conditions.



- Grow nitrogen-fixing species (such as *Alnus nepalensis* or *Albizia* spp.), preferred fruit trees, fodder, or timber trees
- Manage sparse shade for large cardamom



- Besides other functions, shade trees protect large cardamom leaves from sun-burn
- Grow titeypati (*Artemisia vulgaris*), bilaune (*Maesa indica*), or a variety of suitable species on the edges

Things to avoid

Exposure of the plantation directly to the sunlight throughout the day. Direct sun exposure is highly detrimental to large cardamom and causes sunburn to the leaves and drastically reduces the understorey and soil moisture content.



11. Other Promising Livelihood Activities with Large Cardamom-Based Farming

Beekeeping for Pollination, Economic, and Ecological Services

- Bumblebees and honeybees are major pollinators of large cardamom.
- Beekeeping can enhance the pollination in large cardamom. Beekeeping can generate income.
- Beekeeping will conserve pollinator species.
- Beekeeping also has social, religious and spiritual, health and medicinal and environmental importance.

Activities

- Learn and understand the role of pollinator species and their services in increasing the productivity of large cardamom.
- Initiate beekeeping in your household or farm.



Beekeeping is a traditional practice in Furumbu VDC, Taplejung District

Kiwi Cultivation as Shade-Giving Vine Fruit



Kiwi cultivation at Udai Dahal's farm at Yaphrek, Phurumbu VDC 8

- Initiate kiwi (*Actinidia chinensis*) cultivation around the large cardamom plantation wherever suitable.
- This high-value crop can improve livelihoods by providing a source of cash income.
- It can be a viable option to diversify livelihood options in addition to large cardamom.
- The unused terraces and edges of the large cardamom farms or in other open agriculture lands can be converted into kiwi cultivation.

Production of Legumes and Other Potential Crops



Grow legumes (black gram, broad-bean, chickpea, cowpea, field pea, grass pea, horse gram, lentil, mung bean, *Phaseolus vulgaris*, pigeon pea, rice bean, soybean) in agriculture farms or intercrop with large cardamom.



- They increase the soil nutrient base
- Cultivate cereals and pseudo-cereals, vegetables, fruits and nuts, medicinal or aromatic plants, roots and tubers, and multipurpose trees on available land



- Intercrop large cardamom with fruit trees such as mandarin orange, as suited to land and climate

Mushroom Cultivation on Large Cardamom Plantation Floors

- Integrate shitake mushroom cultivation to diversify livelihood options
- It can be cultivated throughout the year under natural environmental conditions
- *Shitake* is a low-cost, high-value mushroom and can be cultivated on large cardamom forest floors without any inputs



- Bring cultivation technology to the farm
- Take training on mushroom cultivation



- Learn value-added measures like drying and packaging



Large Cardamom Nursery for Selling Plantation Material

- Develop a large cardamom nursery in your farm.
- Planting materials can be sold in the second year.
- Collect mother seeds from disease resistant or tolerant varieties that are adaptive to large cardamom growing elevations.
- The demand for planting material is very high and current supply has not been able to meet the demand in Nepal.
- Use saplings for gap filling, and eventually convert the nursery into a productive stand.



A large cardamom nursery in Hee-Gaon, West Sikkim

Annexure

Annex 1: **Calendar events for large cardamom crop cultivation**

Activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Manure application												
Irrigation												
Weeding												
Gap filling (new suckers)												
Slashing fruit-bearing tillers												
Disease/pest monitoring												
Mulching												
Harvesting												
Drying												
Drainage												
Land and soil management												
Fuelwood stocking												

Annex 2: Summary of suggestions for climate-resilient practices

Activities	Climate-resilient practices
Manure application	Use well-decomposed dung. Sort out any manure that contains white grubs.
Irrigation	Carry out sprinkler or drip irrigation during dry periods at frequent intervals (minimum twice a week).
Weeding	Weed before large cardamom flowering and before harvesting. Use weeds as mulch around the bushes.
Intercropping	Intercrop nitrogen-fixing pulses or beans, or nitrogen-fixing fodder trees such as <i>siris</i> or <i>phaledo</i> to enrich the soil nutrient base.
Shade trees	Plant <i>Alnus nepalensis</i> , <i>Albizia</i> spp., <i>Artemisia</i> spp., and other preferred shade species.
Slashing fruit-bearing tillers	Take extreme care when slashing the fruit bearing tiller before harvesting. Trim the slashed tillers with leaves and spread them around the bushes.
Weed growing	In high altitudes, grow weeds during winter to prevent frostbite to the new shoots that will fruit next year.
Harvesting	Skilful harvesting is crucial to ensure good fruiting next year. Carefully cut apart the spike bearing tillers and the spikes without disturbing the newly advancing shoots.
Disease monitoring	Monitor disease and pests throughout the year. They may appear on rhizomes, pseudo-stems, and leaves at different times/months/seasons. Isolate or manage diseased plants to prevent spread to healthy plants.
Mulching	Mulch slashed pseudo-stem, weeds, or leftover fodder residue with dungs. Mulching will provide additional nutrients to the plants after decomposition while also protecting the base of the bushes from frostbite or snow.
Green manuring	Plant leguminous trees or shrubs in the large cardamom plantation. Green manure species act as live fences, hedge plants, and insect repellents. Titepati (<i>Artemisia vulgaris</i>), Ankhitare (<i>Walsura trijuga</i>), Dhaincha (<i>Sesbania</i> sp.), Khirro (<i>Sapium insigna</i>), Sancai (<i>Crotalaria juncea</i>), ipil ipil (<i>Leucena leucocephala</i>), and Rahar dal (<i>Cajanas cajan</i>) are preferred species. Farmers' friends can also select such preferred species as per their choice.
Drying	Large cardamom drying is the most important part of large cardamom processing. Colour and oil retention are maintained by proper drying process. Use dry fuelwood of hardwood (<i>khara daura</i>) species such as <i>chilauney</i> , <i>phalanth</i> , <i>book</i> , or <i>katus</i> that will provide enough heat. Monitor the fire flames constantly and reshuffle capsules to ensure uniform moisture content.
Post-harvest storage	If market value is low, store the produce until prices rise. Store it in a well-ventilated, moisture-free room, as dampness attracts fungus (<i>dhundi</i>) that will spoil the capsules and result in lower bargaining power with traders.

Annex 3: Annual calendar events for large cardamom plantation

Activities	Year 1	Year 2	Year 3
Land preparation	Dec–Feb	–	–
Pit digging and filling with composts/manure	Dec–Feb		
Plantation of shed species	April–June	Gap filling, April–June	Gap filling if required
Plantation of suckers	May–June	Gap filling, May–June	Gap filling, May–June
Intercropping of vegetables or other suitable crops	May–December	May–September	Intercropping can be done only on terrace rises and not between the large cardamom bushes
Manure application	September–October	October–November after the use of knife	October–November after harvest and April before flowering
Irrigation	Dry periods	Dry periods	Dry periods
Weeding	April, before flowering	Before flowering (April) and before harvesting (July–August)	Before flowering (April) and before harvesting (July–August)
Use of knife	–	During harvesting time, August–October	During harvesting

Note: From fourth year onwards, farmers continue third year activities.

Source: For more detail information, please also see: Sharma, G., Joshi, S.R., Gurung, M.B., Chiwal, H.C. (2017). *Package of practice for promoting climate-resilient large cardamom value chain in Nepal*. ICIMOD manual 2017/3. Kathmandu: ICIMOD



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