# Sustainable Production Practices for Cardamom

## FARMERS' MANUAL


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This developPPP project aims to strengthen the production of cardamom (Kerala), Cumin and Dill seed (Rajasthan) turmeric (Tamil Nadu and Karnataka), Celery (Punjab and Haryana) by increasing the capacities of spice farmers and making the production practices economically, socially and environmentally more sustainable.

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As at December 2023

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# Sustainable Production Practices for Cardamom

December 2023

This handbook is published under the Enhancement of Smallholder Spice Farmers' Capacities in Sustainable Farming Project, a part of the Indo-German Biodiversity Programme. It aims to create awareness among farmers regarding the sustainable production of cardamom, ensuring the long-term viability of spice cultivation while minimising negative environmental and social impacts.

The project is funded through the develoPPP.de programme that the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH implements on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). GIZ India implements the project in cooperation with AVT McCormick Ingredients Pvt. Ltd. and McCormick Switzerland GmbH.

# Contents



# 1 Why Sustainable Agriculture Practices

# Why Sustainable Agriculture Practices

## Background and Need for Sustainable Agriculture Practices

Historically, our soils were fertile and capable of producing adequate crop yields because there was enough water, either as rainfall or as irrigation. With the advent of Green Revolution, food production has drastically increased due to enhanced crop yields as a result of widespread adoption of technologies such as mechanisation, new high-yielding and disease-resistant crop varieties, irrigation, and especially the use of mineral fertilisers. The overall NPK consumption in India grew 11.84 times from 1970-71 to 2018-19. The consumption of fertiliser products increased from 50.6 Mt in the year 2009 to 61.4 Mt in 2020. However, the productivity (kg food grain produced per unit of fertiliser nutrient used) exhibited a decline from 28 kg kg-1 in 1970-71 to 10 kg kg-1 in 2019-20. The overuse of mineral fertilisers accumulated mineral compounds in the soil which have been increasing the soil salinity and soil alkalinity, reducing the beneficial soil microorganisms.

Use of plant protection chemicals and weedicides has increased tremendously to control harmful insects, pests and weeds. The overuse of these agrochemicals for a longer duration impacts soil biodiversity and beneficial micro-organisms in agro-ecosystem negatively It also leads to development of resistance to certain pests and insects in the crops. The impact on overuse of pesticides depends upon the type of pesticide used, and dose applied, but it affects the nutrient content and quality of the produce. Ultimately, we have now reached a stage where several threats are emerging on food security, human and environmental health, maintenance of ecological balance, and conservation of the soil biodiversity.

## Major Challenges in Spices Cultivation

- Unseasonal rainfall and changes in the pattern of rainfall.
- Increased dependency of agriculture on agrochemicals.
- Overuse of mineral fertilisers over the last few decades, which has deteriorated the land and water in the agroecosystem.
- Overuse of chemical pesticides.
- Decreased productivity as well as reduced quality of the produce.
- Decreased availability of irrigation water.
- Loss of biodiversity in the agroecosystem.
- Reduced water quality due to contamination. of the water resources.
- Uncertain prices.

The current practices followed by the farmers are unsustainable, with regard to a) indiscriminate use of pesticides and improper dosages of fertilisers, b) improper methods in water irrigation, c) improper waste management, and d) inadequate post-harvest management and poor labour availability. In India, small and marginal farmers with less than 2 ha of land account for 86.2% of all farmers, but own just 47.3% of the arable land, according to provisional numbers from the 10th agriculture census 2015 - 2016.

Average land holding in the country has reduced from 1.16 ha in 2012-13 to 1.1 ha in 2015-16 and is expected to reduce further in the future, with 67% of the farmers owning land less than 1.0 ha. Small land holding and reduced yield due to climate change and insufficient knowledge about sustainable practices lead to decreased economic profitability and reduced production of quality produce. Unsustainable farm practices create additional pressure on global issues such as climate change, loss of biodiversity, land degradation, and pollution of soil and water. Thus, a major portion of

the development efforts needs to be directed towards small and marginal land holders, who are dominating the agriculture sector in our economy. Thus, the sustainable agriculture practices are playing a vital role in climate change adaptability and ensuring crop productivity with economic profitability. It is a method of cultivation which primarily aims at cultivating the land and raising crops in such a way, which keep the soil alive and in good health by use of farm wastes and other biological to crops for increased sustainable production in an eco-friendly pollution-free environment. More precisely, sustainable agriculture is based on managing the agro-ecosystem rather than relying on external farming inputs, such as pesticides, artificial fertilisers, additives, and genetically modified organisms. These technologies are very cost-effective as it involves the use of locally available materials for protection of crops without compromising yield. It involves simple and reliable techniques that can be adopted by small and marginal farmers to increase their yield and profitability.

## BUILDING SOIL STRUCTURE AND SOIL FERTILITY:

- Selection of crops and crop varieties.
- Crop rotation to enhance soil condition.
- Recycling of natural biomass by decomposition, to enhance soil organic carbon and soil microbial activities.
- Integrated Nutrient Management: Use of compost, vermicompost, green manures, Jeevamrut, biofertilisers as soil amendments for enhancing soil organic carbon and soil microbial activity to improve soil health and fertility.
- Intercropping, mixed cropping.
- Farming practices are carried out across the slopes to avoid soil erosion and land degradation.

## CONSERVING WATER AND MAINTAINING WATER QUALITY:

- Adoption of soil and water conservation measures like farm bunds, trenches, farming operations across the slopes, etc.
- Use of improved irrigation techniques to conserve water, like micro irrigation techniques.
- Use of minimal & recommended agrochemicals to avoid water contamination of subsurface water.
- Managing pests ecologically by using biopesticides and minimal usage of synthetic pesticides (Integrated pest and disease management).
- Preventive and curative crop protection measures to reduce pest attacks on crops.

**Preventive Measures:**

- Soil solarisation.
- Appropriate land preparation activities.
- Cultivation of green manures, application of neem cake, vermi-composting to make soil productive.
- Providing proper drainage in the field to avoid water stagnation.
- Crop rotation, intercropping, mixed cropping
- Cultivation of trap crops.
- Appropriate seed treatment with biological formulations, beneficial microbes and fungi which help in better germination and healthy growth of plants.
- Maintaining appropriate crop geometry to increase crop resistance for better growth and development of crops.
- Spraying of natural growth promotors like Jeevamrut, Panchgavya, Amritpani at 30, 60 and 90 days after sowing.

- Relying on natural predators by installing bird perches to reduce pest attacks naturally.

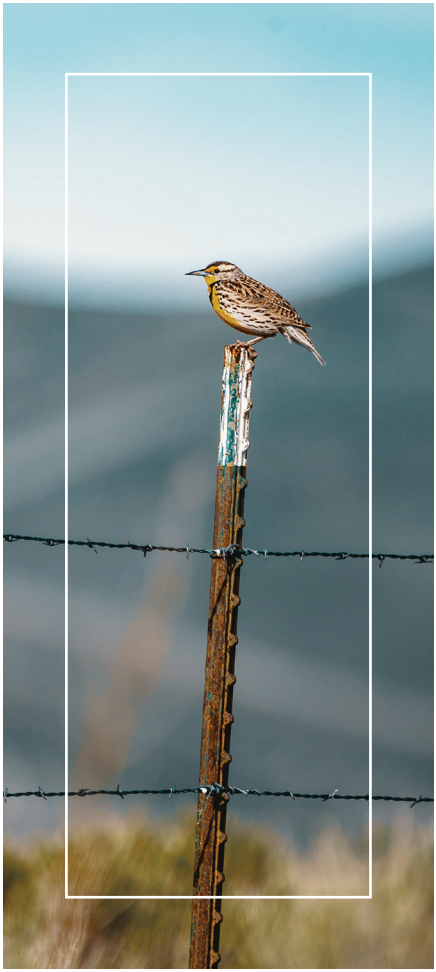
**Curative Measures:**

- Use of neem based biopesticides.
- Spraying biopesticides like Dashparni ark, Amrutpani.
- Minimal use of chemical pesticides: appropriate dosage, within permissible limits.

All these types of techniques are very cost effective and can be easily applied by small and marginal farmers to ensure their crop productivity with minimum inputs. All these techniques require natural ingredients which small and marginal farmers with small amount of livestock can effectively use.

## ENHANCING BIODIVERSITY IN THE FARM:

- Application of green manure, and organic manures will enhance soil biodiversity.
- Intercropping, mixed cropping.
- Use of trap crops and border crops
- Installation of bird perches, honeybee keepers, etc.
- Avoiding use of agrochemicals like mineral fertilisers, pesticides, etc.
- Integration of crop production system with livestock production, so that livestock wastes can be effectively used as manures.
- Integrated farming system is important for enhancing additional income for the farmers and also reduce the dependency and cost of cultivation of the crops.



# 2 Overview of Spice Production in India

# Overview of Spice Production in India

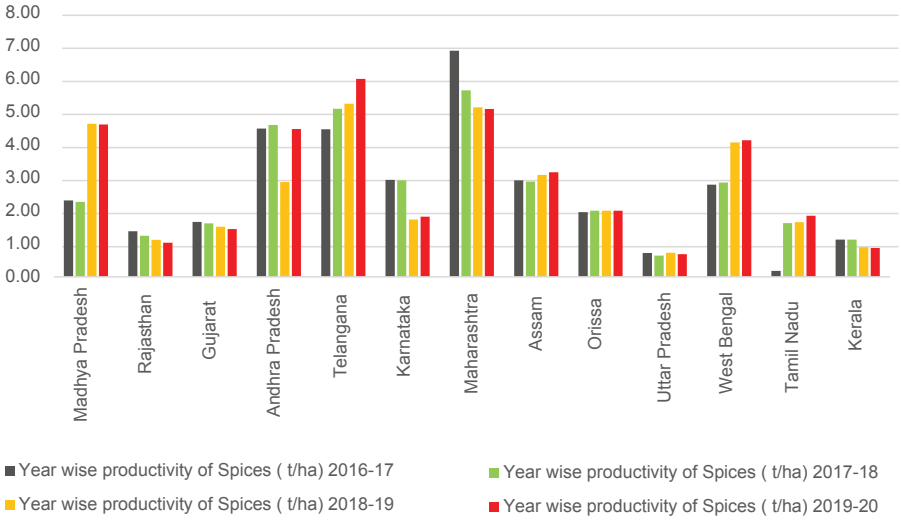
- Spices are seeds, fruits, roots, barks, or other plant substances used in different forms like fresh, dried and powdered. Spices are used to season and preserve food and as medicines, dyes, and perfumes.
- Spices have been highly valued as trade goods for thousands of years.
- The demand for spices has tremendously increased during the pandemic period due to its medicinal properties and its role in enhancing immunity. This can be clearly seen from the growing export of spices like turmeric, ginger, cumin, chilli etc.
- India is home to a wide variety of spices and holds a prominent position in world spice production. India is world's largest producer, consumer and exporter of spices as most of the states and union territories in India grow one or the other spices.

The demand for spices has tremendously increased during the pandemic period due to its medicinal properties and its role in enhancing immunity.

- India is unique in this regard as it is bestowed with wide variations in climatic conditions from tropical to subtropical, to temperate, which allow the growth of all spices splendidly in India.
- Traditionally, spices in India have been grown on small land holdings that support the rich culinary culture of India.
- Spices provide a prime source of livelihood to millions of smallholder farmers in India. About 85% of the spice production in India is led by small-scale producers, who typically have farm holdings of less than two hectares.
- In the year 2017-18, a total area of 39,600,000 hectares of land in India was under cultivation for different spices. India exported $2.6 billion worth of spices to different global markets during the same year, a growth of 6% from the preceding year.
- Though the production of spices is increasing across the country, the productivity of spices is decreasing in many states except for few states namely Madhya Pradesh, Telangana and West Bengal.

- Graph in Figure 1 shows the productivity of spices across different states in India. Decreased productivity is due to changing climatic conditions and increased occurrences of weather extremes (prolonged dry spells and flooding due to high intensity short duration rainfall), increased pest and disease incidences etc.

***Figure 1:*** *Graph showing state wise Spices productivity in India*



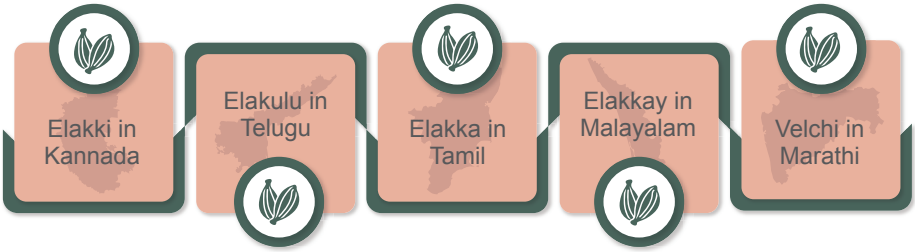

*Source: Spices Board of India*

- Thus, there is a need to develop sustainable spices supply to ensure crop productivity by creating awareness among farmers for developing sustainable agriculture practices
- Therefore, the need for developing FSA certified and Organically certified cultivation is becoming more important in India. Spices are primarily meant for export to western markets, where there is an increased consumer demand for ecologically certified products, but this market segment is also growing in India itself at an yearly rate of 25-30%.

# Cardamom Cultivation

## Introduction

- In India, Cardamom is popularly known as “ELAICHI”. It is a dried fruit of a perennial plant.
- Cardamom is locally known by different names in regional languages, namely:




- Cardamom *(Elettaria cardamomum)* the Queen of Spices enjoys a unique position in the international spices market.
- It is indigenous to the southern stretch of evergreen forests of Western Ghats.
- In India, cardamom is cultivated in the states of Kerala, Karnataka and Tamil Nadu.
- Kerala is the largest producer of small cardamom and constitutes a major share of the Indian and global market.
- Cardamom is generally known as the “Queen of Aromatic Spices”. This spice is also used for medicinal purposes.

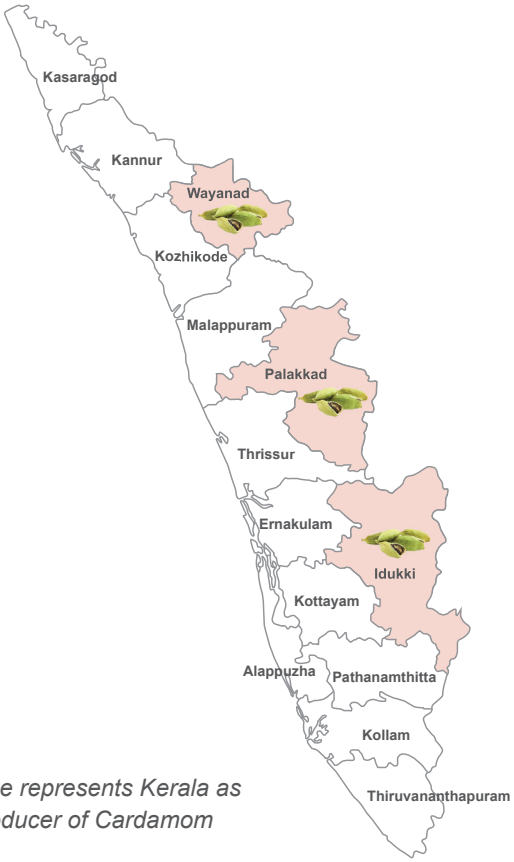
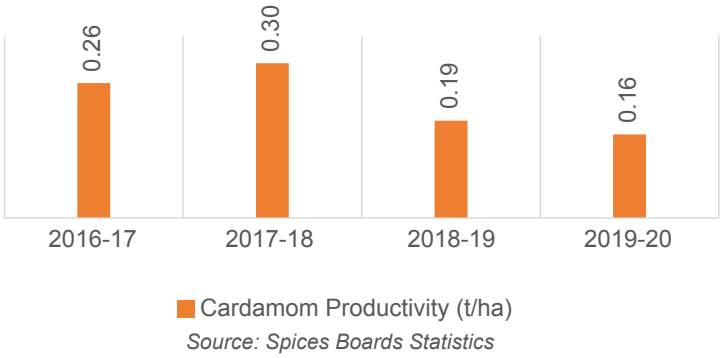



*Image represents Kerala as a producer of Cardamom*

Disclaimer: The geographical map used is for informational purposes only and does not constitute recognition of international boundaries or regions; GIZ makes no claims concerning the validity, accuracy or completeness of the maps nor assumes any liability resulting from the use of the information therein.

***Figure 2:*** *Graph showing the declining productivity of the Cardamom*




*Source: Spices Boards Statistics*

The above graph shows the declining productivity of Cardamom.

**Challenges to enhancement of crop productivity of Cardamom:**

- Unseasonal erratic rainfall pattern.
- Increased temperature which affects crop physiology.
- Increased soil erosion due to heavy rains within a short period of time.
- Lack of proper land management practices.
- Reduced soil fertility due to overuse of mineral fertilisers and plant protection chemicals.
- Increased pest resistance for pesticides.
- Increased use of weedicides which reduces beneficial soil microbes and thus, reduces soil biodiversity.

The practice of sustainable and organic agriculture is important to address the challenges for cardamom production as well as to ensure crop productivity and quality of the spices.

# 3 Sustainable Cardamom Cultivation Practices

# Sustainable Cardamom Cultivation Practices

The name cardamom is used for herbs of the Zingiberaceae family.

*Image represents Green and Black cardamom*

***Whereas,***

**Elettaria:** Elettaria commonly called green cardamom. Elettaria pods are light green in colour.

**Amomum:** Momum commonly known as black cardamom or brown/java cardamom. Amomum pods are larger and dark brown in colour.

- Small Cardamom take the form of a small seedpod, triangular in cross-section and spindle-shaped, with a thin papery outer shell and small black seeds.
- Leaves of cardamom plant are deep green, oblong to lanceolate or ovate, panicles are semi-erect (pendent) and capsules are bold, globose or ovoid in shape.
- It is extensively cultivated in Kerala and Tamil Nadu at elevations ranging from 900 - 1,200 meters above sea level.

## TYPES OF CULTIVARS:

Based on adaptability, nature of panicle, shape and size of capsules, the cultivars are categorised into Malabar, Mysore and Vazhukka.

**Malabar (Nadan/Native)**

- Native variety of Kerala.
- Panicles grow horizontally along the ground.
- Plants have medium height (2m-3m) on maturity.

**Mysore**

- Native variety of Karnataka.
- Panicles grow vertically upwards.
- Plants are robust and attain 3m-4m height on maturity.

**Vazhuka**

- Naturally occurring hybrid between Malabar and Mysore varieties.
- Semi-erect panicles.
- Most popular cultivar in Kerala.
- High yielding plants multiplies in a large scale.

All these types are grown in different tracts and mostly identified on the nature of panicles, size of plants and other morphological characters.

**VARIETIES OF CARDAMOM:**

- Cardamom varieties are highly location specific.
- The most popular high yielding variety is Njallani.
- It is a unique high-yielding cardamom variety.
- This variety yields 1500 kg/hectare as compared to the conventional 200 kg/ha.
- The increased yield revolutionised cardamom cultivation in the state of Kerala.
- High yielding varieties of cardamom released include ICRI 1,2,3: TDK 4 & 11; PV 1, PV2, CCS 1 Mudugiri 1, NCC 200; MCC 12, 16 & 40.

# Requirements for Cardamom Cultivation

**CLIMATE :**

- Climate and weather variations can substantially influence the development and distribution of pest insects and disease-causing organisms across cardamom agro-ecosystem.
- The most favourable condition requires the following:
  - Cardamom growth requires a moist and shady environment.
  - Annual Rainfall: 1,500 mm - 2,500 mm.
  - Altitude: 600 m - 1,200 m above Mean Sea Level.
  - Temperature: ranging from 15ºC - 35ºC.
  - Relative humidity: 75 - 90%.
  - Rainfall distribution should be good and summer showers during February - April are essential for panicle initiation.
  - Decrease in precipitation level especially for monsoon months can affect the productivity as it is sensitive both to drought and excess rainfall.
  - Cardamom grows well within 50 - 60% shade conditions.

## SOIL CONDITION:

- Cardamom usually thrives well in soils rich in organic matter. Ideal soil conditions for cardamom are as follows:
  - o Soil type preferred: Forest loamy soils.
  - o Soil pH: 4.2 - 6.8, generally acidic in nature.
- Soil nutrient status: High in organic matter and nitrogen; low to medium in available phosphorus; and medium to high in available potassium.

## CROP MANAGEMENT:

- A mature cardamom plant may measure 2 - 4 m in height.
- Tiller production takes place throughout the year. However, peak period is from January to March.
- Flowers are borne on panicles, which emerge directly from the swollen base of the aerial shoot.
- About 90 - 120 days are required for the fruits to attain maturity.

# Cultural Practices

## PLANTING MATERIAL

- Propagation of small cardamom is done through seeds and suckers.
- Propagation by vegetative means through suckers is considered to be the most preferred method.
- Planting through suckers ensure high productivity, if they are collected from high yielding, disease-free plants.
- The propagation through seeds enables production of a large number of seedlings.
- Virus diseases are not transmitted through seeds and therefore, the seedlings are free from virus diseases, if adequate care is taken to isolate and protect the nursery from fresh infection.
- Plants raised from seeds need not necessarily be high yielders even if they are collected from very productive plants due to cross pollination.

## CLONAL NURSERY

Establishment of clonal nursery is essential for large-scale multiplication of high yielding varieties/selections.

- **Site Selection:**
  - Open, well-drained areas adjacent to a perennial water source.
- **Planting Material:**
  - Grown-up tiller with a portion of the rhizome and a developing shoot.
- **Time:**
  - First week of March to September.
- **Trenches:**
  - Width and depth of 45 cm and convenient length.
  - Trenches should be filled with humus rich top soil, sand and well decomposed compost.

- **Plant Spacing:**
  - 1.8 m x 0.6 m in the trenches.
- **Shading Management:**
  - To protect the planting units from direct sunlight and desiccation, overhead shade/pandal need to be provided.
- **Irrigation:**
  - Once in a fortnight.
- **Nutrient Management:**
  - Apply fertilisers 48:48:96 g NPK per sucker in 2 - 3 splits starting from two months after planting.
  - Neem cake 100 - 150 g/plant may also be applied along with the fertilisers.

## NURSERY RAISING

- Ripe capsules of the desired cultivar are collected from high yielding plants during September - October.
- Sowing in September is the best for high germination. Sowing during southwest monsoon and winter should be avoided.


When it becomes necessary to store the seeds, it is advisable to store them in capsule form. It can be preserved in this form for one month, without deterioration of viability. Polythene lined gunny bags or hermetic bags can be used for this.

In Kerala and Tamil Nadu, 18-month-old seedlings are used for planting. The seeds are sown in a primary nursery from where the young seedlings are transplanted to a secondary nursery and maintained for one year before planting in the main field.

## PRIMARY NURSERY

- **Land Preparation:**
  - The nursery site is selected in open, well-drained areas, near a water source.
  - Prepare the area by removing existing vegetation, stumps, stubbles and stones and dig to a depth of 30 cm.
  - In the prepared area, beds of size 6 m x 1 m x 0.2 m are made and a thin layer of humus-rich forest soil is uniformly spread over the beds.

- **Planting Material:**
  - Fully ripened bold capsules from high yielding, disease-free mother clumps are collected from second and third harvests during the month of September.
  - One kg fresh capsules comprising about 500 - 800 fruits is sufficient to produce 3000 - 5000 seedlings.
- **Seed Treatment:**
  - The seeds are extracted by gently pressing the capsules and then washed 3 - 4 times in cold water to remove the mucilage adhering to the seeds.
  - The washed seeds are then drained, mixed with wood ash and dried under shade.
  - To ensure early and uniform germination, seeds should be sown immediately after extraction, preferably within 15 days since viability of the seed is lost during storage.
  - Acid scarification with 25% nitric acid increases the germination percentage. For this, wrap the extracted seeds in nylon net, tie it loosely and then immerse in 25% nitric acid for 10 minutes. After treatment, the seeds are removed and washed repeatedly in cold water to remove traces of acid.
- **Sowing Time:**
  - September in Karnataka, November-January in Kerala and Tamil Nadu. Sowing in September is best for high germination. Sowing during southwest monsoon and winter should be avoided.
- **Spacing:**
  - Row spacing of 10 cm and plant spacing of 1-2 cm.
- **Seed Rate:**
  - 30-50 g for 6 m x 1 m sized bed.
- **Mulching:**
  - After sowing, the beds are covered with a thin layer of sand and mulched with grass or paddy straw to a thickness of 2 cm over which tree twigs are laid.

The seeds are extracted by gently pressing the capsules and then washed 3 - 4 times in cold water to remove the mucilage adhering to the seeds.

- **Irrigation:**
  - Water the beds regularly to maintain sufficient moisture and to promote germination.
  - Germination commences in about 20 - 25 days and may continue for a month or two.
  - Once sprouting is observed, remove existing mulch and maintain thin mulch material between the rows.
- **Shade Management:**
  - Protect the seedlings by providing overhead shade.
- **Transplanting:**
  - Transplant the seedlings at 3 - 4 leaf stage.

## SECONDARY NURSERY

After preparing the site properly, mixing of well decomposed cattle manure and wood ash with the top layer of the soil will help the seedlings to establish themselves well and grow vigorously.

These can be of the following two types:

- **Bed Nursery:**
  - The beds are prepared as described in primary nursery.
  - Spread a layer of compost on the bed and mix thoroughly with soil.
  - Seedlings with 3 - 4 leaves are transplanted at a distance of 20 - 25 cm.
  - Mulching and watering should be done immediately after transplanting.
  - In Kerala and Tamil Nadu, transplanting is carried out during June - July, whereas in Karnataka it is undertaken during the months of November - January.
  - Apply 90:60:120 g N,P,K per bed of 6 m × 1 m size, in three equal splits at an interval of 45 days. The first dose of fertiliser may be applied at 30 days after transplanting.
  - Earthing up needs to be undertaken after each fertiliser application and hand weeding is to be done once in 20- 25 days.
  - One month before uprooting, the shade should be removed to encourage better tillering.
  - The seedlings will be ready for transplanting after 8 - 10 months of planting.

- **Polybag Nursery:**
  - Polythene bags of size 20 cm × 20 cm and 100-gauge thickness are filled with potting mixture consisting of forest topsoil, cow dung and sand (ratio 3:1:1).
  - Provide sufficient holes at the base of polybags to ensure good drainage.
  - Seedlings at 3 - 4 leaf stages are transplanted into each bag (one seedling/bag).
  - Seedlings raised in polybags have a uniform growth and nursery period could be reduced by 5 - 6 months.

## PLANTING

- In Karnataka, 10 - months - old seedlings are preferred for planting in the main field, while in Kerala and Tamil Nadu 18 - months - old seedlings are commonly used.

## LAND PREPARATION

- The land selected for planting is cleared of all under growth, weeds etc. Old cardamom plants, if any, may also be removed.
- Field operations are to be undertaken with the objective of preventing soil erosion and to conserve soil moisture.
- In sloppy areas, soil should be protected from soil erosion.
- It should be prepared before commencement of monsoon.

## PIT DETAILS

- For planting, pits of required size are prepared before ommencement of the monsoon season (April - May).
- Pits are left open for weathering for a fortnight and then about 1/3 of the pit should be filled with top soil and 1/3 should be filled with 1:3 mixture of organic manure and top soil.

- Pit dimensions:
  - Malabar types: 45 cm x 45 cm x 45 cm
  - Mysore 90 cm × 90 cm × 45 cm
  - Vazhukka types, 90 cm × 90 × 90 cm.
- The pits are filled to one third with top soil.
- Stakes should be provided to avoid the damage caused by wind and the plant base need to be covered with suitable mulching material.
- Planting diagonally on the slopes helps to prevent run off.
- Trench system of planting (60 cm × 30 cm) with a spacing of 2 m × 1 m is generally preferred over pit system, as it results in better establishment of the plants, higher yield and greater moisture retention.

Deep planting should be avoided, as it results in suppression of the growth of new shoots and might result in death of the plants.

- In sloppy lands, contour terraces need to be prepared and pits are taken along the contours at 2 m × 1 m spacing.
- Based on slope, terraces are made at 2 - 3 m between the contours.

## PLANT SPACING

- For Mysore and Vazhukka cultivars, plants to plants distances can be 3x3 meters i.e. 1111 plants per hectare. A spacing of 2.4 x 2.4 meters i.e. estimated 1736 plants per hectare is recommended for Tamil Nadu.
- 1.8x1.8 meters spacing i.e. estimated 3086 plants per hectare is suitable for Malabar in Karnataka. Immediately after planting, the plant base should be mulched well with available dried leaves to prevent soil erosion and conserve moisture. Planting should be done diagonally to the slope to reduce runoff.

## MANURING

- Cardamom responds to both manuring and fertiliser application.
- A soil test based judicious manuring schedule should be followed to achieve optimum production on sustainable basis.
- Apply well decomposed Farmyard Manure/Compost at 5 - 10 Kg in May/June along with rock phosphate (180 grams per plant) and muriate of potash (90 grams/plant).
- Organic manures such as neem cake (one kg per plant), bone meal (one kg per plant) or vermicompost (one kg per plant) have beneficial effects on root proliferation and plant growth and also help to reduce nematode and root grub infestation.
- Apply lime/dolomite if pH of the soil is <5.5 in two splits. Fertiliser shall be applied only after 15 - 20 days of lime application.
- Apply Zinc Sulphate at 250 grams/100 litres of water during April/May and Sept./Oct to increase growth and development of crop and enhance quality of produce.
- Under high production technology, where crop is harvested from 18 months onwards, fertiliser recommendations for full-grown plantations could be adopted from the second year onwards.
- Fertilisers would be applied in smaller doses in four or more splits after every harvest or combining both soil and foliar application of fertilisers.
- Whenever the plant growth is affected due to root damage (root grub/fusarium diseases/soil compactness), foliar application of DAP (two per cent) + MOP (two percent) could be adopted.

## FERTILISER APPLICATION

- A soil test based judicious application of fertilisers schedule should be followed to achieve optimum production on sustainable basis.

## SHADE MANAGEMENT

- Cardamom is a shade loving plant.
- Shade requirements of cardamom plants vary from place to place depending on the slope of land, soil type, rainfall patterns, crop combination etc.
- Climatic factors adversely affect the growth, development and production. It is noticed heavy or less shade hinders crop growth and production.
- Lopping of branches of shade trees is very important and should be done before onset of monsoon. But at the same time, exposure to direct sunlight causes yellowing of leaves.
- Exposure to direct sunlight causes yellowing of leaves. Therefore, judicious shade management is very important for good growth, timely flowering and for better crops about 50% shade is ideal.
- Shade regulation, terracing and preparation of planting pits should be done during summer months in the areas identified for fresh planting.
- Shade regulation is undertaken by pruning branches of shade trees to provide 40-60% filtered light. To ensure a balanced canopy, lopping of branches is carried out on all sides of the shade trees.

Exposure to direct sunlight causes yellowing of leaves. Therefore, judicious shade management is very important for good growth, timely flowering and for better crop about 50% shade is found ideal.

***Table 1:*** *Schedule for the use of NPK fertilisers*

| Soil-cum-Foliar | Time of Application | |
|---|---|---|
| | Soil | Foliar |
| NPK 37.5:37.5:75kg/ha and Urea (2.5%). Single super phosphate (0.75%), Muriate of potash (1.0%) | May/June/ September/ October/ December/ January | September/ November/ January |

Some of the most ideal shade trees to be grown in the plantations

| | |
|---|---|
| *Acrocarpus fraxinifolius* | *Actinodaphne malabarica* |
| *Canarium strictum* | *Bischofia javanica* |
| *Mesua ferrea* | *Mesopsis eminii* |
| *Myristica attenuata* | *Vateria indica* |
| *Vernonia arborea* | *Zedrella toona* |

*and many more*

## POLLINATION

- The principal pollinating agent in cardamom is honey bee (Apis cerana indica).
- The foraging behaviour of honeybees commence in the morning and continue till evening. However, peak forage is encountered from 9 am to 11 pm and this coincides with maximum capsules formation.
- Tree flowers act as pollen as well as nectar source for bees.
- The quality as well as the capsule set is related to the number of bee visits.
- Maintaining four bee colonies per hectare during the flowering season is recommended to increase pollination, promoting fruit set and production of more number of capsules.
- To maintain higher productivity, undertake replanting once in 8 - 10 years. Replanting may also be taken up, once the yield starts declining below the economic level.

A total of 19 tree species were listed in the cardamom plantations which supports the domestication of honey bees.

## SOIL AND WATER CONSERVATION MEASURES

- On gentle sloppy areas, opening of rectangular silt pits (1.0 m × 0.5 m × 0.6 m) between four plants will help in soil and water conservation.
- If the slope is steep, construct stone pitching walls at 10 - 20 m intervals across the slope and erect water collecting trenches along drainage channels to strengthen soil and water conservation measures.
- In valleys and high rainfall areas with medium slopes, suitable drains (45 cm depth and 30 cm width) are provided in between two rows of cardamom.

## WEEDING CONTROL

- Weed control is important for maximum utilisation of available soil moisture and nutrients by the plants.
- Use of spade for weeding is to be avoided as it will loosen the soil and cause soil erosion.
- As far as possible, the entire plantation particularly the plant base are to be kept under mulch to reduce evaporation loss, suppress weed growth and to maintain optimum soil temperature.
- Later, depending on the intensity of weed growth, 2 c3 rounds of hand weeding at the plant base during May, September and December/January and slash weeding in the interspaces are recommended.

To facilitate honey bee movement, remove mulch during May-June after the receipt of pre-monsoon showers.

## MULCHING

- It is very essential to keep the plant base mulched (5 - 10 cm thick), except during periods of heavy (June - September).

## FORKING

- Through adopting the best soil management practices, the soils will remain loose and friable. However, in situations where soil has become compact and hard, forking the plant base to a distance up to 90 cm and to a depth of 9 - 12 cm may be beneficial to enhance root proliferation, better infiltration of summer showers and for improving soil aeration.

- Forking could be done with the cessation of north east monsoon during November/December taking care to cause least damages to the root system.

## TRASHING

- Trashing consists of removing old tillers, dead Rhizome, dry leaves and leaf sheaths.
- Trashing may be carried out once a year with the onset of monsoon under rainfed conditions and 2-3 times in high-density plantation provided with irrigation facilities.

## PRUNING

- Pruning is the operation undertaken with sharp sickles for removing the dead and hanging leaves from the pseudo-stem.
- Care should be taken not to peel off the leaf sheath from the Pseudo-stem.
- This operation may be done during January and September, which coincides with the peak population.
- The resultant plant materials obtained through pruning can be used for mulching.

## EARTHING UP

Whenever, the top soil covering the plant base is washed away and the rhizomes and roots are exposed, earthing up of the plant base with top soil is recommended during November/December, before the withdrawal of north-east monsoon.

## IRRIGATION

- Irrigation is necessary from January to May.
- Irrigation interval should be of 10-15 days till the onset of monsoon, by adopting a convenient method of irrigation by hose/ sprinkler/micro sprinkler/ drip.

- Irrigation can be done at weekly intervals at the rate of 20 - 30 litres per plant depending upon the clump size.
- Fogger/ mist are used widely in the cardamom plantations to create a suitable microclimate (maintain the relative humidity) within the plant eco-system to create favourable environment for growth, flowering and seed setting.
- In case of drip irrigation, it needs to be supplemented with sprinkler irrigation once a month.
- The frequency of operation of the irrigation systems depends on the macroclimate in the plantation and hence must be standardised for specific local weather situations.
- Irrigation is to be undertaken with utmost care to avoid excess wetness at the plant base for prolonged period to prevent occurrence of rot diseases.

# Pest and Disease Management

## Diseases-Nursery Stage

### NURSERY LEAF SPOT

- **Primary Nursery:**
  - **Causing agent**: Fungus *Phyllosticta elettariae*.
  - **Period:** Appears mostly during February-April with the receipt of summer showers.
  - **Symptoms:**
    - Early stage - Small, round or oval spots, which are dull white in colour.
    - Later stage - Central portion of the spot withers off leading to the formation of shot hole.
- **Secondary Nursery:**
  - **Causing agent:** *Cercospora zingiberi.*
  - **Symptoms:**

    Yellowish to reddish brown rectangular patches on the lamina which are almost parallel to the side vein. The practice of raising nurseries continuously on the same site may be avoided.

**Management:**

- Sowing of seeds should be done in August - September, to ensure sufficient growth of seedlings, so that they develop tolerance to the disease.
- The practice of raising nurseries continuously on the same site may be avoided.
- Avoid exposure to direct sunlight from top or sides.

## NURSERY LEAF ROT

- **Causing Agent:** Fungi *(Fusarium and Alternaria)*
- **Period:** Appears on 3 - 4 months old, young seedlings.
- **Symptoms:**
  - Water-soaked lesions on the foliage.
  - Usually the leaf tip and distal portions are damaged.
  - In severe cases, rotting extends to the petiole and leaf sheaths also
- **Management:**
  - Give proper drainage.
  - Avoid excessive watering of the seedlings..

## DAMPING OFF OR SEEDLING ROT

- **Causing agent:** soil-borne pathogens such as *Pythium vexans* and *Rhizoctonia solani.*
- *Fusarium oxysporum* also causes similar seedling rot resulting in wilting of the entire seedlings.

**Management:**

- Avoid water stagnation in the field by providing proper drainage.
- Maintain optimum plant population.
- Maintain proper phyto-sanitary measures in the nurseries by removing infected and dead seedlings.

- Pre-treatment of seeds with Trichoderma or Pseudomonas before sowing, or Application of Trichoderma to the nursery bed at 100 g/m2 (talc formulation with 106 cfu/g).

## DISEASES IN PLANTATION

### Capsule Rot/Azhukal

During heavy and continuous rainfall, crop loss is high as 40%.

**Symptoms:**

- Appear during the rainy season on leaves, tender shoots, panicles and capsules.
- Leaves: Water soaked lesions appear first and rotting and shredding of leaves along the veins occur thereafter.

- Capsules become dull greenish brown and rot.
- Mature capsules when infected, become shriveled upon drying.
- This emits a foul smell and subsequently sheds off.
- High incidence of the disease is usually noticed during July-August with heavy rainfall and high relative humidity.

**Management:**

**Cultural Control:**

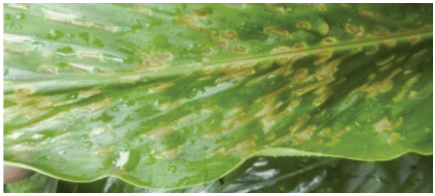
- Phytosanitation
- Shade regulation
- Proper drainage
- Apply neem cake before monsoon as a soil amendment to reduce the population of the pathogen.

**Biocontrol:**

- Eco-friendly disease management system to fight against plant pathogens in a totally safe manner avoiding the use of expensive synthetic chemical fungicides.
- The isolates of *Trichoderma viride, T. harzianum* and *Laetisaria sp* are very effective to control the disease.
- *T. harzianum* at 100g along with 5 kg farm yard manure and 500 g neem cake per plant and as sole application at 3 L per plant respectively is most effective strategy, Or
- *Trichoderma harzianum* 0.50% WS at 100 g/plant (soil treatment): Apply 100 g product/plant along with neem cake (0.5 Kg/plant) and 5 Kg FYM/plant.

## Clump Rot/Rhizome Rot

- Occurs during monsoon period.
- This disease is caused by combined infection of *Pythium vexans, Rhizoctonia solani* and *Fusarium sp.*



**Symptoms:**

- Decaying of tillers at the collar region.
- Yellowing of foliage.

- Toppling of tillers as the disease advance.
- Discoloration on the basal portion of the infected clump.

**Management:**

**Cultural Control:**

- Maintain optimum soil moisture by providing proper drainage.
- Remove mulch from the base of the plant, weeding and trashing before the commencement of monsoon.
- Shade regulation.
- Removal and destruction of infected plants.
- Cultivate rhizome rot-resistant variety IISR Avinash in disease prone areas.

**Bioformulations:**

- Apply neem seed extract (neem gold) and garlic extract against the disease as per guidance

**Bioagents:**

- *Rhizome bacterization* and soil application of bacterial *(P. fluorescens* and *Bacillus subtilis)* OR
- Basal application of *T. harzianum, P. fluorescens* and *B. subtilis* gives better yield
- *Trichoderma harzianum* mass multiplied on suitable carrier media may be applied to plant basins at 1 kg during May and September-October. If the soil is drenched with copper oxychloride or other fungicides, Trichoderma should be applied only after 15 days.

## Fusarium Rot /Stem Rot / Stem Lodging

- This disease caused by a fungus *"Fusarium oxysporum".*
- Normally appears during post - monsoon period.

**Symptoms:**

- The pathogen usually attacks middle portion of the tillers and produces a pale discoloured lesion leading to dry rotting.
- The partially broken tillers bend down and hang from the point of infection.

The infected tillers are weakened at the point of infection and leads to partial breakage of the tillers.

- The infected tillers fall off and give lodged appearance if the infection occurs at lower part of the tillers.

**Management:**

**Cultural Control:**

- Phytosanitation.
- Provide adequate shade in the plantation.

**Biocontrol:**

- *T. viride, T. harzianum, B. subtilis* and *P. fluorescens* effectively inhibits the growth of disease and reduced the its severity.
- Basal application of *T. harzianum,* along with spraying and drenching of P.fluorescens or
- Basal application of *T. harzianum* at 50g with one kg neem cake and aerial spray with either *P. fluorescens* or consortium containing *P. fluorescens* strains IISR 6 and IISR 859 at 2% is an effective management strategy.

## Leaf Blight

- Caused by foliar infection of *Colletotrichum gloeosporioides*
- Brownish spots and patches on the leaf lamina
- **Early stage:** water-soaked lesions on leaves which later coalesce to form yellowish-brown to reddish-brown patches and subsequently withers off.
- **Advanced stage:** several such lesions develop on young and older leaves, which eventually dries up and gives a burnt appearance to the plants

**Management:**

**Cultural Control:**

- Collect and destroy affected plant.
- Provide adequate shade in the plantation.
- Maintain optimum shade levels of 40-60% filtered light.

**Biocontrol:**

- Spraying of the plants with 1 - 2% P. fluorescens 3 - 4 times a year.

## VIRAL DISEASES

### Mosaic or Katte Disease

- The disease is caused by Cardamom mosaic virus (CdMV).
- Results in gradual decline in productivity.
- Total decline of plants occurs after 3 - 5 years of infection with a yield reduction upto 70%.
- The virus is disseminated by the aphid vector *(Pentalonia caladii)* and also through infected rhizomes.

Undertake shade management before the onset of South-West monsoon season.

**Symptoms:**

- In early stages, youngest leaf appears as slender chlorotic flecks. These flecks later develop into pale green discontinuous stripes.
- Later, the characteristic mosaic symptoms appear on the leaf lamina.
- Mosaic type of mottling is also observed on the leaf sheaths and young pseudostems.
- Plants of all stages are susceptible to the infection and in the advanced stages, the affected plants produce shorter and slender tillers with few shorter panicles and degenerate gradually.

### Chlorotic Streak Disease

- This disease is a new threat to cardamom cultivation particularly in Kerala and Karnataka.
- Causing agent: a strain of Banana bract mosaic virus (BBrMV) October 2022 | 51.
- It is transmitted through planting of infected suckers.

**Symptoms:**

- In early stages, continuous or discontinuous spindle shaped yellow or light green streaks on leaves intravenously and along the midrib, and in advanced stages the veins turn yellow or light green in colour.
- Discontinuous spindle shaped mottling appears on the pseudostem and also on the petioles.

**Management of Viral Diseases:**

**Integrated management of viral diseases of cardamom:**

- Prompt inspection of plantation, detection and rouging of virus sources reduces re-infection from the diseased source.
- Use of virus-free planting materials prevents introduction of disease into disease-free locations.
- Seedling and clonal nurseries have to be raised in isolated sites.
- Clones from apparently healthy high yielding plants may be used for gap filling and for establishing new plantations.
- Removal of infected plants and destroy them
- Periodical removal of older parts is effective in reducing the aphid population and the spread of viral diseases.
- Plant resistant variety, IISR Vijetha in Katte prone areas.
- Removal of natural hosts like Colocasia and Caladium destroys the breeding sites and check population build-up of the vector.
- Neem based products at 0.1% concentration significantly reduces settlement of aphids on the cardamom leaves and are also lethal to the aphids at higher concentrations.
- Natural enemies such as *Peragum indica, Cocinella transversalis,* and *Ischiodon scutellaris* are also observed to predate the cardamom aphids.

## INSPECT PESTS OF CARDAMOM

### Shoot/ Panicle/ Capsule Borer [Conogethes punctiferalis (Guen.)]

*Image represent Shoot Borer on steam*

**Early stages:**

Larvae bore the panicles and immature capsules and following symptoms are observed on the pansicles and capsules.

**Panicles:** drying up of the entire panicle.

**Capsules:** emptying of capsules.

**Late stages:**

Larva feeds on the central core of the stem and affect the phloem vessels interrupting the passage of food materials to the growing parts finally leading to drying of central leaf tip known as “dead heart” symptom.

**Management:**

**Cultural Control:**

- Removal and destruction of infested suckers during September -October (when the infestation is less than 10%)
- Castor seeds 0.4 - 0.8 Kg/acre may be sown as trap crop in open areas/ boundary.

**Mechanical control:**

- Infected Castor inflorescence should be collected and destroyed.
- Use of pheromones in the monitoring and controlling of the pest and therefore correct timing of application of biorationals shall be recommended.

**Botanical:**

- Spray 0.2% poneem (1:1 mixture of pungam oil and neem oil).

**Bioagents:**

- Application of Bacillus thuringiensis when early-instar larvae are found in capsule or panicle or unopened lead buds i.e., within 20 days of adult moth emergence.

## Cardamom Thrips [Sciothrips cardamomi (Ramk.)]

- The most destructive and persistent pest of cardamom.
- Found in almost all the cardamom growing areas.
- Occurs during the post monsoon and summer months and declines with the onset of monsoon rains.
- Thrips breed inside the unopened leaf spindles, leaf sheaths, flower bracts and flower tubes.
- The Mysore and Vazhukka types are highly susceptible to thrips infestation.

**Symptoms:**

The adults and larvae lacerate the tissues of leaves, shoots, panicles, flowers and immature capsules and feed on the exuding sap resulting in shedding of flowers and immature capsules as well as scab formation on mature capsules.

**Management:**

**Cultural Control:**

- Removal of dry drooping leaves as well as dry leaf sheath (trashing) during January-Febrauary.
- Destruction of collateral host plants.

- Detrashing and weeding reduce thrips infestation.
- Regulation of shade level in the plantation by pruning lower branches of shade trees and removal of collateral hosts like *(Panicum longipes, Amomum spp., Aframomum sp. Colocasia sp.* and *Alocasia sp.*) in the vicinity of plantations helps reducing the buildup of thrips population in the field.

**Biological Control:**

- Fish oil insecticidal soap (Na) 2.5% + tobacco extract 2.5% effectively reduce the Thrips infestation.
- Release Chrysoperla zastrowi sillemi at 2 larvae/plant in early stage of the plant and 4 larvae/plant in later stage.

**Mechanical Control:**

- Install blue sticky traps at 10-12 traps per acre.

## NATURAL ENEMIES OF THRIPS

To conserve and encourage naturally occurring populations of these beneficials, avoid creating dust and consider periodically rinsing dust off of small plants, avoid persistent pesticides, and grow a diversity of plant species.

### Banded Thrips, Aeolothrips fasciatus

- **Identification Tip:**
  - This predatory thrips is black with three broad white bands on each forewing. It feeds on other thrips and pests, such as mites and whiteflies.

### Black Hunter Thrips, Leptothrips mali

- **Identification Tip:**
  - This species is dark brown or black and adults have white wings. It preys on mites and certain other pests, such as scales, and is more active than similar-looking adult greenhouse thrips.

## Sixspotted Thrips

- **Identification Tip:**
  - o There are three dark blotches on each forewing of this mite predator.

## *Franklinothrips sp.*

- **Identification Tip:**
  - o *Franklinothrips orizabensis* and *F. vespiformis* are predators of avocado thrips, persea mite, and other pests such as avocado lace bug.
  - o *F. orizabensis* is more common in avocado groves, but these Franklinothrips cannot be reliably distinguished in the field.

## *Franklinothrips sp.* Larva

- **Identification Tip:**
  - o In comparison with avocado thrips larvae, this second-instar predatory thrips has a more oval shape and is darker yellow with an orange or red swollen abdomen that appears as a colored dot to the naked eye.

## Root Grub/White Grub [Basilepta fulvicorne (Jacoby)]

**Symptoms:**

- The larvae feed on young roots and the above ground
- It damages the roots and rhizomes sometimes entire root system of the plant
- Yellowing of leaves, which later results in the drying up and death of the plant.
- The peak periods of adult emergence are during April and September.
- Grubs have two periods of occurrence, first during April-July and January.

**Management:**

**Cultural Control:**

- Collect and destroy adult beetles during peak periods of emergence i.e. April-May and September- October.
- Avoid planting jack, mango, fig etc. as shade trees as these trees are alternate hosts of the pest.
- Mulching of plant base with leaves of wild *Helianthus sp.* to prevent egg laying of adult beetles.
- Earthing up and detrashing.
- Irrigation at15-20 l per plant reduces root grub population.

**Mechanical Control:**

- Set up light trap at 1/acre.

## MINOR PESTS

### Hairy Caterpillars

- Appear sporadically in large numbers and cause severe damage by defoliating the plants.
- The caterpillars are gregarious in habit and congregate on trunks of shade trees during the daytime.
- During early stages of the life cycle, they feed on shade trees and become a pest of cardamom during the later stages.

**Management:**

- Swarms of hairy caterpillars congregating on the trunk of shade trees during daytime should be collected and killed mechanically.
- Use light traps or solar light traps at 1 per acre for controlling the pests at night.
- Spray Dashparni ark at 200 litres per acre.
- Spray Neem ark to control the pest infestation.

## Root-knot Nematode

**Symptoms:**

- Infested plants exhibit stunting, reduced tillering, reduced leaf size, yellowing of foliage, immature capsule drop and increased incidence of rhizome rot.

**Cultural Control:**

- Nursery should be raised in nematode free sites or fumigated or solarised beds.
- Ensure planting of nematode free seedlings.
- The roots should be pruned prior to distribution or transplanting.
- Regular application of organic manures such as neem cake twice a year at 250-1000 g depending on the clump size reduces nematode infestation.
- Mulching the plant base with leaves of weeds like wild sunflower, Eupatorium, Clerodendron etc.

**Biological Control:**

- Soil application of neem cake at 500 g/plant.
- Spray Jeevamrutha at 10 litres along with *Azospirillum* and *T. viride* (10g each) / plant increased plant for better growth and increasing yield of nematode infested cardamom plantation OR
- Dip the cardamom rhizomes in 1% mixture of *P. fluorescens* and *Azadirachtin* solution for 10 minutes and sowing with the application of cow dung + Neem cake + Marotti cake + AMF + P. lilacinus (90 kg: 5 kg : 2 kg :2 kg :1 kg) mixture at 1 kg/pit before planting. Two AMF fungi vis., *G. fasciculatum* and *Gigaspora margarita* were also found effective in minimising the root knot nematode problems in cardamom seedlings (Thomas et al. 1989).

Avoiding planting of alternate hosts such as banana, colocasia and jackfruit.

## Whitefly

Occurs during the dry and summer seasons.

**Symptoms:**

- Chlorotic patches appear initially on leaves, which turn yellow and become necrotic in the advanced stages.
- Nymphs secrete sticky honey dew which drop on the lower leaves. This invites sooty mould fungi to invade thereby interrupts photosynthetic efficiency.

**Management:**

**Cultural Control:**

- Use of yellow sticky traps for collection and monitoring.
- Apply neem oil at 0.5% on the leaves.

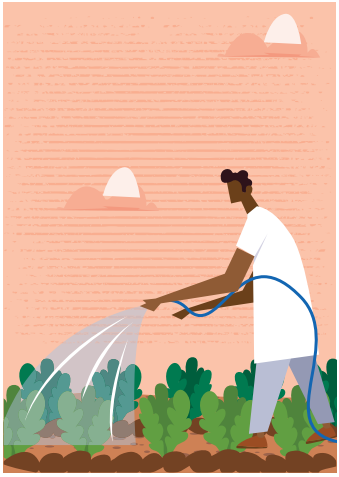
**Biological Control:**

- Release Chrysoperla zastrowi sillemi at 2 larvae/plant in early stage of the plant and 4 larvae/plant in later stage.
- Spraying of neem oil at 50ml with soap solution in 500 ml in 100 liter of water (lower surface of leaf).

## INTEGRATED MANAGEMENT TECHNIQUES

Integrated Pest Management (IPM) is an important method for cardamom pest management. There are a few things which farmers should take care:

- Prompt inspection of plantation, detection and rouging of virus sources reduces reinfection from the diseased source.
- Production and use of virus-free planting materials prevent the introduction of disease into disease-free locations.
- Seedling and clonal nurseries have to be raised in isolated sites.
- Clones from apparently healthy high yielding plants may be used for gap filling and for establishing new plantations.
- Collection and use of clones from severely infected gardens may be avoided.
- Removal of infected volunteers in the replanted area and totally avoid the presence of volunteers from nursery area.
- Periodical removal of older parts is effective in reducing the aphid population and the spread of viral diseases.
- Plant resistant variety, IISR Vijetha in Katte prone areas.
- Neem based products at 0.1% concentration significantly reduces settlement of aphids on the cardamom leaves and are also lethal to the aphids at higher concentrations.



## IRRIGATION MANAGEMENT

- Irrigation is required generally during summer months and also, during periods of prolonged dry spells, if it coincides with the critical periods of plant growth where development of young tillers and panicles take place.
- Micro-sprinkler irrigation system is used in the cardamom plantations to create a suitable microclimate within the plant eco-system to create favourable environment for growth, flowering and seed setting.

- The frequency of operation of the irrigation systems depends on the macroclimate in the plantation and hence has to be standardised for specific local weather situations.
- Irrigation is to be undertaken with utmost care to avoid excess wetness at the plant base for prolonged period to prevent occurrence of rot diseases. Irrigation can be done at weekly intervals at the rate of 20-30 litres per plant depending upon the clump size.

## HARVEST

Harvesting of capsules at correct maturity stage is a pre-requisite for improving the quality of the produce. Harvesting period starts

- After two-three years after planting suckers or seedlings, respectively.
- Capsules ripen within a period of 120-135 days after its formation.
- From June-July and continues till January-February in Kerala and Tamil Nadu.
- Usually harvesting is done at an interval of 15-30 days.
- Harvesting of ripened capsules is avoided as it leads to the loss of green colour and also causes splitting of capsules during the curing process.
- Immature capsules on processing yields uneven sized, shrivelled and undesirably coloured produce.
- Freshly harvested capsules are washed in water to remove the soil particles and other dirt adhering to it and to get good quality commodity.
- Maturity of capsules and curing temperature influences the colour and quality of processed cardamom.
- Storage of capsules after harvest for longer duration adversely affects quality of the end product.

Good quality of the produce can be achieved through timely harvest and adoption of scientific post-harvest operations.

**Drying:**

- Moisture of freshly harvested capsules is reduced from 80 to 10-12% through indirect heating.
- During curing, a temperature range of 40-45°C is maintained during all the stages of drying which helps in good retention of green colour.
- Gradual increase of drying temperature to 50-60°C in the last two hours of curing enables easy removal of floral remnants during polishing.
- During curing, if temperature exceeds the threshold levels, capsules develop brownish streaks due to heat injury.
- An increase in drying temperature also results in loss of oil from the seeds.

**Flue curing Natural:**

- It is one of the best methods of drying by which high quality green cardamom can be obtained.
- A traditional firewood based curing house consists of a furnace for burning the wood, flue pipes for conveying the hot air and drying racks for stacking the trays.
- A drying chamber with dimensions of 4.5 m in length and breadth is sufficient for a plantation which has a production capacity of 2 tonnes of fresh cardamom.
- In general, 3-4 kg of firewood is consumed for drying 1 kg of fresh cardamom.
- The capsules are evenly spread as a single layer on the trays. After staking the trays on the racks in the drying chamber, the curing room is closed.
- Hot air generated by burning firewood in the furnace is circulated through the flue pipes, which are placed few centimeters above the floor. This process enhances the room temperature to 45-55°C, which is maintained for a period of 3-4 hours.
- During this period, the capsules sweat and give off the moisture. The drying process is facilitated by opening the ventilators to sweep out the water vapour generated from the drying capsules.

- Exhaust fans are also used for the speedy removal of moisture. After complete removal of water vapour, the ventilators are closed and the temperature inside the chamber is again maintained at 45-55 $^{0}$C for a period of 18-24 hours.
- In the final stage of curing process, the temperature is further raised to 60-65°C for another 1-2 hours. The temperature is raised to hasten the cleaning process by which debris like stalks attached to the capsules can be removed easily.
- Temperature inside the curing chamber is maintained around 65°C to avoid splitting of the capsules and also to prevent the loss of volatile oil.
- Under these conditions, it is possible to obtain high quality green cardamom in about 24-30 hours.

**Polishing, Grading and Sorting:**

- Dried capsules are polished either manually or with the help of machines.
- Polishing is carried out by rubbing the dried capsules in hot state against a hard surface.
- The polished produce is subsequently graded based on the quality parameters such as colour, weight per volume, size and percentage of empties, malformed, shrivelled and immature capsules.

**Storage:**

- After grading, cardamom capsules are stored.
- The capsules are stored at a moisture content of less than 10% to retain the original parrot green colour and to prevent mould growth.
- Use of 300 gauge black polythene lined gunny bags improves efficiency of storage. It is advisable to store the dried cardamom in wooden boxes at room temperature, preferably in the curing houses.

Cardamom curing may be defined as the process in which moisture of freshly harvested capsules are reduced from 80% to 10 - 12% through indirect heating.

Drying is the most important unit operation that determines the colour of the end products.

- Apart from quality in terms of colour, flavour components such as 1 - 8 cineole, terpenyl acetate, linalool etc are also important.
- After keeping cardamom trays in the racks, curing room is closed and heating is done by burning firewood in the furnace.
- The hot air passed through the pipes placed a few centimetres above the floor enhances the room temperature to 45˚C - 55˚C and this temperature status should be maintained for 3 - 4 hours initially.

- Apart from quality in terms of colour, flavour components such as 1-8 cineole, terpenyl acetate, linalool etc are also important.
- After keeping cardamom trays in the racks, curing room is closed and heating is done by burning firewood in the furnace.
- The hot air passed through the pipes placed a few centimetres above the floor enhances the room temperature to 45˚C-55˚C and this temperature status should be maintained for three to four hours initially.
- At this stage the capsules sweat and with the enhanced temperature, give off moisture.
- The ventilators are opened to sweep out water vapour from the drying fruits.
- After the complete removal of water vapour, ventilators are closed and the temperature inside the chamber should be maintained again at 45˚C-55˚C for about 18-24 hours.
- The temperature is again raised to 60˚C-65˚C for another one or two hours to complete the curing process.

Post-harvest operation consists of washing, pre-treatment with recommended chemicals, curing, cleaning, grading and packing.

**Post-Harvesting:**

- Wash the capsules in water, immediately after harvest to remove the adhering soil and treat them with 2% washing soda for 10 minutes to retain green colour.
- Dry them either in sun or in drying houses by heat radiation, under controlled temperature to retain the delicate flavour and green colour.
- After drying, rub the capsules with coir mat/ gunny cloth/ steel mesh, sieve and grade.
- Cured cardamom has to be protected against light, air and temperature by packing in polyethene lined gunny or cloth bags.

**Following are the poinst which need to be taken care of:**

- Remove extraneous matter and wash thoroughly the harvested produce before drying.
- Dry the capsules immediately after harvest.
- Dried cardamom should not contain more than 10% moisture for better shelf life.
- Use clean, polythene lined gunny bags for storing.
- Store in dry places and in wooden boxes. Take necessary precautions against rat and insect damages.
- Adopt flue pipe system of curing to retain the original colour, aroma and flavour.
- Remove tails after drying.
- Grade according to size and colour and store in moist proof containers.
- The dried cardamom may be preferably sold soon after drying provided the growers get remunerative price, as long storage may lead to deterioration of quality.

# 4 Certification for Farm Sustainability Assessment (FSA)

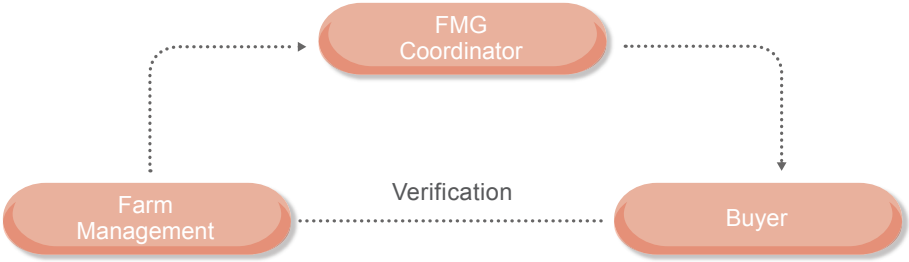
# Certification for Farm Sustainability Assessment (FSA)

Farm Sustainability Assessment (FSA) is a food and beverage industry-aligned multi-purpose tool to assess, communicate and improve on-farm sustainability. FSA is designed to improve social, environmental, economic and general farm management practices. It is the tool that gives insight about understanding how to grow crops using sustainable practices. It helps the farmers to include evidence-based farm sustainability to broaden their understanding of cost, efficiency, and yield improvements. Further, it made growers more aware of the value of sustainable farming in their customer relationships.

**There are three key benefits of FSA for farmers:**

1. FSA is a great way to assess sustainable agriculture practices and communicate with customers.
2. Using the tool helps save time and money, by removing the need to complete multiple assessments for multiple customers.
3. Being a user of FSA increases market access, by selling to more companies who use FSA as their sustainable sourcing standard.

## FUNCTIONS AND ROLES WITHIN FSA IMPLEMENTATION




A farm may be composed of several physical separate farm fields producing crop(s) in scope of the assessment. A farmer is the person carrying final responsibility for the farm's performance and the SAQ. This may be the farmer-owner or an appointed farm manager.

The FMG is a group of farms that implement the FSA together, optionally including the direct buyer for their crop(s). The FMG needs to fulfil FSA requirements to ensure that it is a coherent, engaged, and transparent group of farms. The FMG is managed by an FMG Coordinator.

The Farm Management Group Coordinator is the organisation that legally represents the Farm 60 | Sustainable Production Practices for Cumin Management Group. It is usually a first level aggregator or processor or a cooperative. The FMG Coordinator typically buys raw agricultural products from farms and is responsible for implementing the FSA in accordance with normative documents. The FMG Coordinator sets up and manages the FSA Management System. The individual responsible for FSA implementation within the FMG Coordinator is referred to as FMG Manager.

Verification Bodies are SAI Platform approved independent organisations, accredited to perform FSA verification audits and issue FSA Letters of Attestation.

## FSA MODULES

The FSA is a set of adaptable modules supported by tools and guidance materials. The use of these modules and tools are governed by normative documents to ensure users can demonstrate to auditors that they have used the tools correctly and confidently communicate the results.

**The modules contain:**

1. Self-Assessment Questionnaire (SAQ).
2. Priority Screening Module (PSM).
3. Continuous Improvement Module (CIM).
4. Outcome Measurement Module.
5. Verification Module.
6. Benchmarking Module.
7. Supply Chain Module.

A buyer is an organisation in the supply chain buying FSA verified material from a standalone farm, an FMG Coordinator or another buyer.

**Self-Assessment Questionnaire (SAQ)**

FSA based on the Self-Assessment Questionnaire (SAQ), ensures that the FSA is implemented effectively, consistently, and accurately, so that any resulting performance claims are reliable. The FSA is made up of 112 questions; there are three levels of questions with an increasing complexity: 'Essential', 'Basic' and 'Advanced'.

- **'Essential'** questions are about decent citizenship (e.g. prohibiting forced or bonded labour) and should be straightforward to comply with for any farmer working towards sustainability.
- **'Basic'** questions identify the fundamental elements of sustainable farming.
- The next step in sustainable farming is captured in the **'Advanced'** questions.

The FSA questions are organised by topics (e.g. crop protection), in phases (e.g. assess, plan, store) and by focus areas (i.e. people, plant, profit). Sorting filters on each column allows the user to sort the questions in the way that best suits them.

After the FSA is completed, a performance score is automatically generated. To allow a proper analysis of the scores and to identify the points for improvement, the scores are presented per topic, phase and PPP classification.

**There are three levels of performance: bronze, silver and gold, each with a specific threshold:**

**Bronze:**

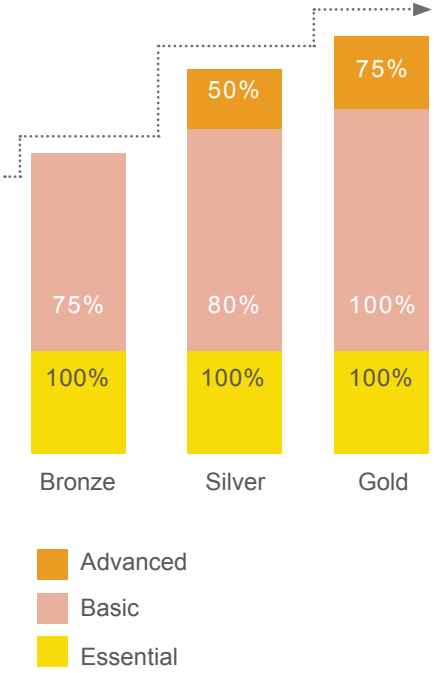
- Bronze Compliance with 100% 'Essential' questions and;
- A minimum of 75% 'Basic' questions.

**Silver:**

- Compliance with 100% 'Essential' questions;
- 80% 'Basic' questions and;
- A minimum of 50 % 'Advanced' questions.

**Gold:**

- Compliance with 100% 'Essential' questions;
- 100% 'Basic' questions and;
- A minimum of 75% 'Advanced' questions.



**Priority Screening Module**

The Priority Screening Module is meant for the Farm Management Group (FMG) Coordinator to perform a high-level screening of social, environmental, and business priorities for the farms in the FMG. This provides the FMG Coordinator with an opportunity to better understand the sustainability context in which the farms operate, in connection to farm characteristics and customer priorities.

**Continuous Improvement Module**

The Continuous Improvement Module is a set of guidance materials and templates to help the FMG Coordinators develop, implement, and monitor a continuous improvement plan for the FMG. The Continuous Improvement Plan will be subject to the FSA Management System audit in case of independent verification of Farm Management Group Performance and is optional for verification at stand-alone farms.

**Outcome Measurement Module**

The Outcome Measurement Module provides an overview of tools to help measure environmental and social outcomes of farming. The module provides guidance on linking outcome measurement tools to Continuous Improvement Plans, how to select the right tool for the Farm Management Group and how to use the results in communicating outcomes.

**Verification Module**

The Verification Module allows farms or FMGs that have implemented the FSA to demonstrate their performance through independent third-party verification. Verification by SAI Platform approved Verification Bodies results in an FSA performance claim at bronze/silver/gold level.

**Benchmarking Module**

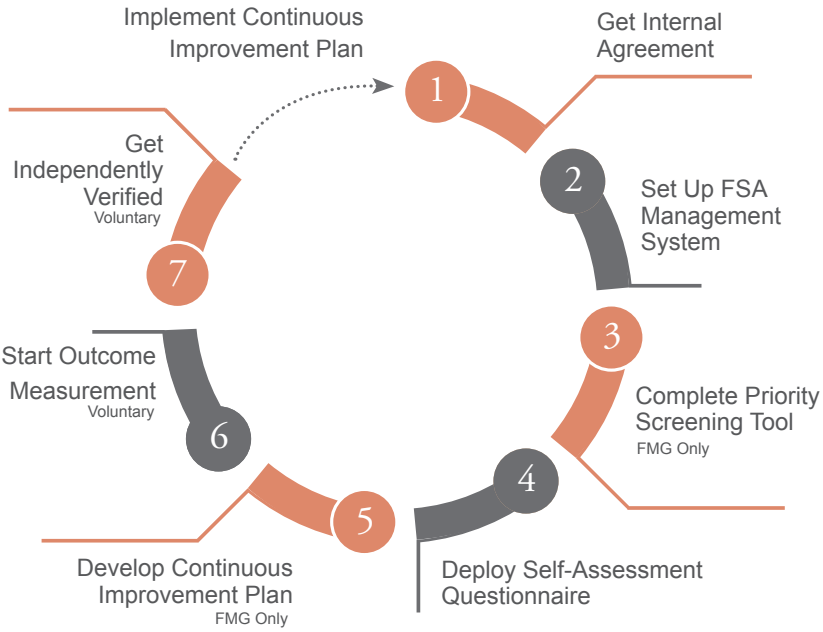
The Benchmarking Module allows agricultural sustainability schemes to be benchmarked against the FSA Self-Assessment Questionnaire and FSA normative documents.

**Supply Chain Module**

The Supply Chain Module guides businesses that buy agricultural ingredients, or products with such ingredients, in implementing the FSA in their business and with their suppliers.

**Step-by-Step FSA Implementation**

The process for implementing the FSA is outlined in a step-by-step way to make it easier to understand. In most cases, this will also be the most effective and efficient way to implement the FSA.




**Step 1: Get Internal Agreement**

FSA Implementation works best if internal management of the FMG Coordinator and Farm Managers buy into the 'why' and the 'how' of it. It is important to keep an open mind to adjust your aspirations based on the external conversations you have about them, and the learnings that come through implementing the FSA.

**Step 2: Set up the FSA Management System**

Having an adequate FSA Management System in place is a key requirement for FSA Implementation, as well as a key verification requirement. This is to ensure the FSA is implemented in accordance with the Implementation Framework as well as to enable the FMG Coordinator or Stand-Alone Farm to take accountability for the results.

**The FSA Management System should consist of the following components:**

- Farm Management Group
- Accountability and Administration
- Volume Accounting System
- Continuous Improvement Plan and Report/ Accounting period
- Setting up the Farm Management Group

  The Farm Management Group (FMG) is a group of farms implementing the FSA in a joint fashion. This is the most efficient way to organise farmer engagement, achieve farm improvements, and perform FSA performance level assessments. By being part of a group, farmers can share expertise and experience, and support each other in making improvements. It is recommended that farms in a group are already naturally grouped because this facilitates a smoother implementation of the FSA.
- Accountability and Administration of FMG Coordinator.

  The FMG Coordinator is the legal entity responsible for implementing the FSA in accordance with the Implementation Framework. This means it is responsible for identifying and engaging the individual farms within the FMG. During an FSA Management System Audit, the FMG Coordinator must be able to show the auditor that it fulfilled its responsibility.

**Therefore, the FMG Coordinator needs to demonstrate conformance with the requirements given below:**

FMG Coordinator Requirements on Accountability:

- o The FMG Coordinator’s top management must document its commitment to implement and maintain the FSA Management System in accordance with the FSA Implementation Framework.
- o The day-to-day implementation of the FSA is managed by an FMG Manager, who is a competent person with a contractual relationship with the FMG Coordinator.
- o The FMG Coordinator must regularly evaluate the implementation of procedures and conformance with the FSA Management System requirements, at least once per year. The findings must be reviewed by the FMG Coordinators' top management.

FMG Coordinator must maintain sufficient records, including the following information:

- List of farms included in the FMG including contact details per farm.
- Completed Self-Assessment Questionnaires by sampled farms in the FMG.
- FSA Audit Reports and FSA Letters of Attestation per FMG.
- The FMG Coordinator must demonstrate that its Volume Accounting System meets the requirements and record volume accounts at least annually.

The FMG Coordinator must have written procedures and definitions for managing the FSA Management System.

- The FMG Coordinator must demonstrate that its Continuous Improvement Plan meets the requirements and record progress against the plan at least annually.

- **Volume Accounting System**

  The purpose of the Volume Accounting System is to support the generation of accurate and reliable verified FSA claims and to ensure there is no double counting of FSA-verified volume. Following are the terms required to be understood:

  - Mass balance Accounting:

    This is a system in which FSA-verified and nonverified material is mixed physically but kept separate via an administrative trial to ensure there is no overselling of FSA-verified volumes.

  - Quantity Credit Method:

    The FSA requires the use of the quantity credit method for mass balance accounting. A ‘credit’ is a unit of material at a specific verified FSA performance level (i.e. bronze, silver, or gold). The FMG Coordinator must set up and maintain a credit account for each crop at each FSA performance level used as an output declaration. The credit output (volume of material sold at that performance level) must be deducted from the credit account for that material/performance level, up to the limit in, but not exceeding, the credit account (considering conversion factors). The credit account balance cannot be negative.

**Step 3: Priority Screening Module**

This module is built around the Priority Screening Tool (PST) and the summary report this tool generates. The PST is available as an online application. Once there is clarity on the composition of the Farm Management Group, the FMG Coordinator must fill out the PST. The PST can also be used by a Stand-Alone Farm voluntarily, although not all sections are equally relevant. The PST summary report serves three basic purposes:

- Understanding the sustainability context of the FMG.
- Identifying potential mistakes in the set-up of the FMG.
- Informing the Verification Body about the farm base and farming context.

**Step 4: Deploy FSA Self-Assessment Questionnaire**

Implementing the FSA at a stand-alone farm simply requires the farmer to complete the SAQ. Since the questions are formulated generically, farmers might find it useful to consult the question level requirements and guidance included in the SAQ. When implementing the FSA with a Farm Management Group (FMG), the FMG Coordinator needs to take an Internal Self-Assessment Sample of farms from the group according to the sampling regime. This must be a random sample to ensure there is no bias in the sample. The FMG Coordinator may also ask a Verification Body or another service provider to take the sample on its behalf. This makes sampling easier for the FMG Coordinator and ensures it is being done correctly.

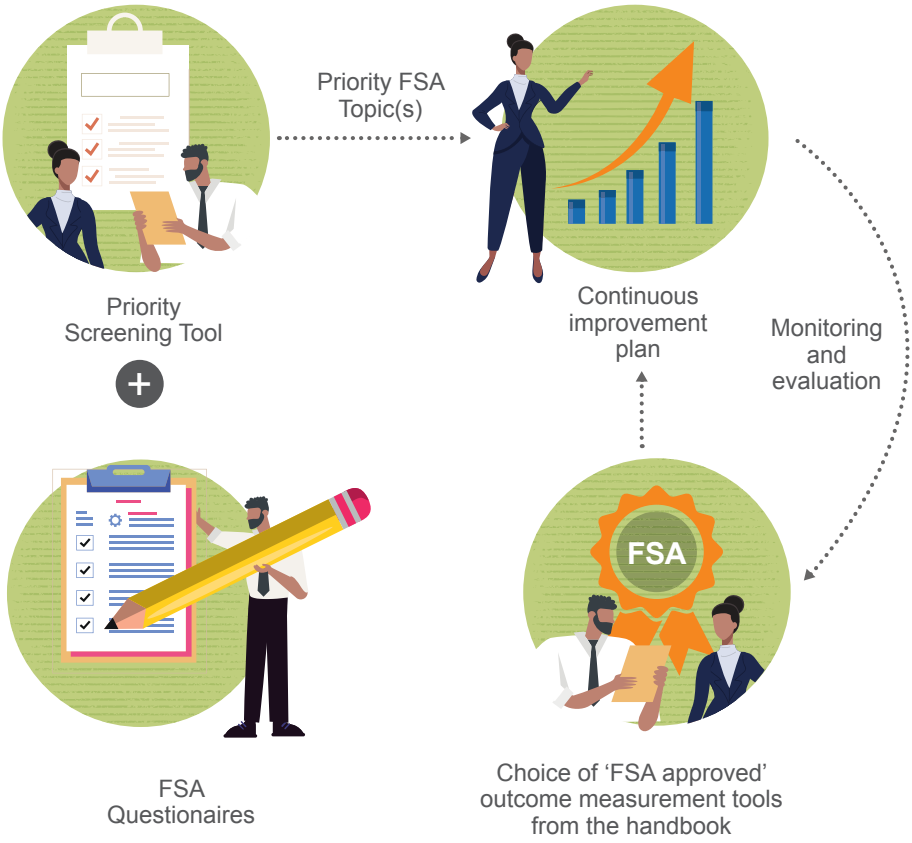
**Step 5: Develop Continuous Improvement Plan**

This module provides guidance for Farm Sustainability Assessment (FSA) users on how to develop a Continuous Improvement Plan (CIP). The guidance has been created with a focus on the process for Farm Management Groups (FMGs) which need to have a CIP as part of their FSA Management System. The approach can be adapted for Stand-Alone Farms, although the CIP is a voluntary requirement for them. It is generally not required by the FSA to have CIPs at farm level. The process for developing a CIP is designed to be flexible rather than rigid and overly prescriptive. This flexible design allows for multiple pathways for addressing continuous improvement priorities and targets identified as part of the process. Optimising farmer engagement and outreach are key to developing and implementing a Continuous Improvement Plan successfully.

**Step 6: Start Outcome Measurement**

SAI Platform encourages FMGs to use outcome measurement tools to monitor and support progress on those topics where there are CIPs in place.

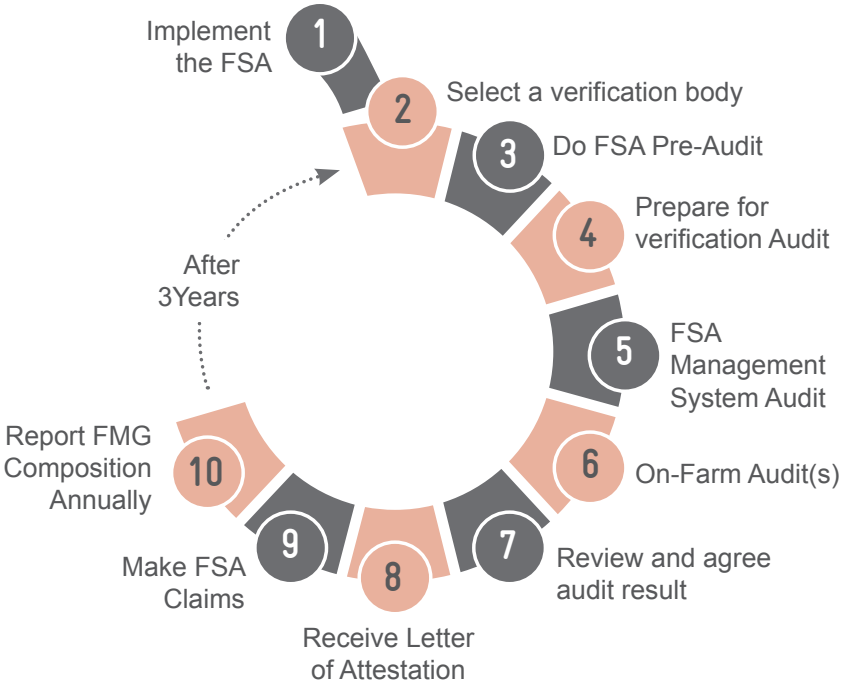
**Outcome Measurement Pathway**



**Step 7: FSA Verification Audit**

The purpose of the FSA Verification Audit is to validate that the FSA has been implemented correctly and that the result of the FSA Self-Assessment is accurate and applicable to the Stand-Alone Farm or the entire Farm Management Group (FMG).

A successful FSA Verification Audit results in a Letter of Attestation confirming the performance of the Stand- Alone Farm or FMG. A valid Letter of Attestation is required for making FSA Volume Claims.


1
Implement the FSA
2
Select a verification body
3
Do FSA Pre-Audit
4
Prepare for verification Audit
5
FSA Management System Audit
6
On-Farm Audit(s)
7
Review and agree audit result
8
Receive Letter of Attestation
9
Make FSA Claims
10
Report FMG Composition Annually
After 3Years

# How to complete the Farm Sustainability Assessment

**Step 1 - General Data**

To begin, provide answers to the general questions about the farm. These answers do not affect the performance score, but they help to put the results into context and prevent misinterpretation.

- This section is made up of 15 questions, most of which have open answers.
- Use the guidance notes in Section 4 to learn more about the background of a question.
- If you wish to share additional comments or information, please use the comments column.

**Step 2 - Farm Sustainability Assessment**

After the general section, you can start filling in the FSA. FSA is made up of 112 questions which have been separated into tables according to topic as follows:

| Topic | Number of Questions | Codes |
|---|---|---|
| Legal Compliance | 3 | FSA1 - FSA3 |
| Financial Stability | 4 | FSA4 -FSA7 |
| Farm Management | 5 | FSA8 -FSA12 |
| Planting | 6 | FSA13 -FSA18 |
| Soil Management | 4 | FSA19 -FSA22 |
| Nutrient Management | 7 | FSA23 -FSA29 |
| Crop Protection | 12 | FSA30 -FSA41 |
| Agro-chemicals | 9 | FSA42 - FSA50 |
| Waste Management | 2 | FSA51 - FSA52 |
| Water Management | 10 | FSA53 -FSA62 |
| Biodiversity | 6 | FSA63 - FSA68 |
| Air | 2 | FSA69 - FSA70 |
| Greenhouse Gas Emissions | 2 | FSA71 - FSA72 |
| Market Access | 4 | FSA73 - FSA76 |

| Topic | Number of Questions | Codes |
|---|---|---|
| Labor Conditions | 22 | FSA77 - FSA98 |
| Health and Safety | 11 | FSA99 - FSA109 |
| Local community | 3 | FSA110 - FSA112 |

- Essential' questions are coloured orange.
- 'Basic' questions are coloured red.
- 'Advanced' questions are coloured blue.

**Acceptable Responses:**

- You can only answer 'yes', 'no' or 'N/A'. If you only partially comply with the question, the answer should be 'no'.
- Not all questions can be considered 'N/A'. The requirements column explains when N/A can be used.

**Guidance Notes:**

- Use the guidance notes in Section 4 to learn more about the background of a question.

**Optional Questions:**

- If you do not use irrigation, you do not need to answer the following questions:
  - FSA53 – FSA58
  - FSA62

- If you do not have any employees, you do not need to answer the following questions:
  - FSA77 – FSA 94
  - FSA98
- All applicable questions should be answered once the FSA is answered completely.
- As a final check, go to the top of the document to see if you have answered all questions.

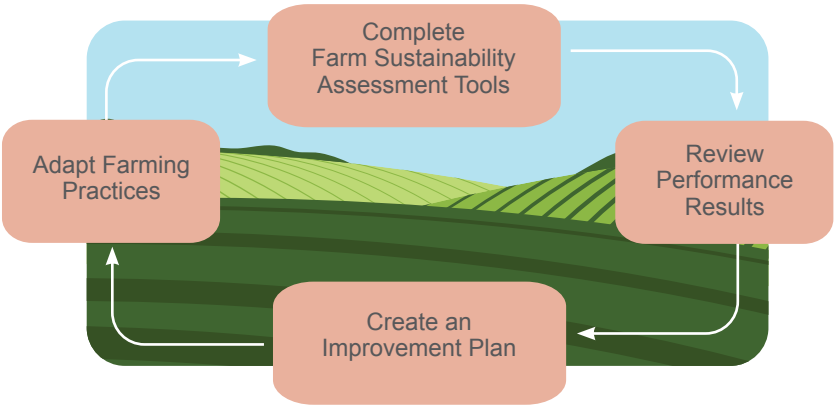
**Step 3 - How to Calculate Your Performance Score?**

Once both the general and the Farm Sustainability Assessment questions have been filled in, this information can then be entered into either the offline/ excel tool or the online calculation by you or another relevant party.

It is the choice of the farmer whether to share the results of Farm Sustainability Assessment with interested parties.

**Step 4 - Improvement Potential**

An improvement plan can be created using the scores per topic i.e. which topics are well covered and which are not by your current farming practices. After you have assessed which farming practices can be changed or new ones can be used, and after these changes are put into place on your farm, you can redo the FSA to see how these changes have improved your overall score.



# Summary

Sustainable agriculture in the context of spice production involves practices that ensure the long-term viability of spice cultivation while minimising negative environmental and social impacts. Here are some key principles of sustainable agriculture specifically tailored to spice production:

**Biodiversity Conservation:** Preserve and promote diverse ecosystems on spice farms to support natural pest control, enhance soil health, soil fertility, and protect local flora and fauna. It will help to prevent soil and water erosion and improve the overall resilience of the farm by implementing a Biodiversity Action Plan for the Cardamom farms.

**Soil Health Management:** Implement practices such as cover cropping, composting, and reduced tillage to maintain soil fertility, structure, and microbial diversity, ensuring the health of the soil by enhancing soil organic carbon for spice cultivation.

**Integrated Pest Management (IPM):** Adopt IPM strategies to manage pests and diseases in a holistic manner. This includes using biological control agents, crop rotation, trap crop cultivation, use of mechanical traps such as Yellow Sticky traps, Blue Sticky traps, Pheromone traps and targeted pesticide application only when necessary if pest infestation goes beyond ETL (Economic Threshold Level).

**Water Efficiency:** Employ efficient irrigation techniques such as drip or precision irrigation as per crop water requirements to minimise water usage and reduce water-related environmental impacts.

**Agroforestry:** Integrate spice cultivation with tree planting to create shade, prevent soil erosion, enhance biodiversity, and improve overall farm resilience.

**Seed Saving and Diversity:** Encourage the saving and sharing of traditional spice seeds to maintain genetic diversity and resilience within spice crops. Conserving own seed will also reduce the cost of cultivation.

**Local and Indigenous Knowledge**: Incorporate traditional knowledge and practices of local communities in spice cultivation, respecting their expertise and understanding of the land.

**Organic Farming Practices:** Opt for organic farming methods to avoid synthetic pesticides and fertilisers, reduce chemical runoff and promote healthier ecosystems.

**Capacity Building:** Provide training and resources to spice farmers to enhance their knowledge of sustainable agricultural practices and their ability to implement them effectively.

**Traceability and Quality Control:** Establish traceability systems to ensure the quality and safety of spices from farm to market, enhancing consumer trust and reducing the risk of contamination.

**Energy Efficiency:** Explore renewable energy sources such as solar power for spice processing and drying, reducing the carbon footprint of spice production.

**Waste Reduction and Recycling:** Develop methods for reusing and recycling waste materials from spice processing and packaging, minimising environmental impact.

**Certification:** FSA SAI certification for farmers' group for helping them to get better prices.

**Production of safe-to-consume spices:** Promote the cultivation of sustainable and organic spices, reducing the risk associated with contamination of crops with pesticide residues and ensuring suitable for safe consumption..

**Market Linkages:** Build industry-wide capabilities around sustainable spice farming by providing buy-back arrangements and market access to the farming communities engaged in the sustainable production of spices.

**Reducing the cost of cultivation:** All the above-mentioned practices will reduce the cost of cultivation without compromising the yield which ultimately contributes to the enhancement of farmers' income.

# References


- Spices Board. (n.d.). Www.indianspices.com. Retrieved November 15, 2023, from http://www.indianspices.com
- Pretty, J. (2007). Agricultural sustainability: concepts, principles and evidence. Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1491), 447–465. https://doi.org/10.1098/rstb.2007.2163



**OTHER AVAILABLE RESOURCES ON THE WEBSITE:**

- Handbooks on Concept and Methods of Integrated Pest Management in Sustainable Agriculture, Soil Sampling and Soil Testing, Integrated Nutrient Management and Low-Cost Organic Formulations (English, Hindi, Kannada and Malayalam).

- Farmers' Manuals on Sustainable Production Practices for Cardamom (English and Malayalam), Cumin (English and Hindi) and Turmeric (English, Kannada and Tamil).

- Farmers' Diaries on Cumin (Hindi), Turmeric (Tamil), Dill seed and Celery (Hindi).

- Animated Video Series on Practicing Sustainable Agriculture, Sustainable Food production, organic farming and more (English, Hindi, Kannada and Malayalam).

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