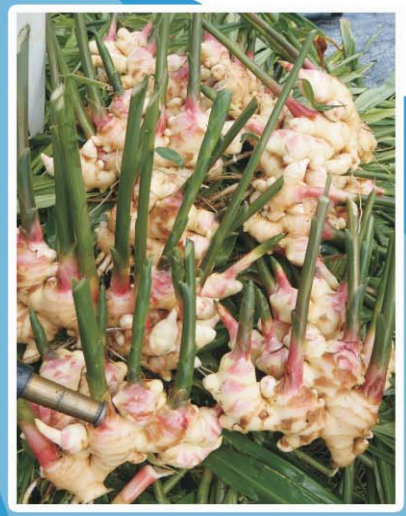
Organic Package of spices for North East Region
(Black Pepper, Ginger, Turmeric and Large Cardamom)



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Contents

Organic production technologies of major spices for North Eastern States

India is the land of spices, major producer, consumer and exporter in the world, growing about 60 different varieties of spices comprising of approximately 8.12 million tonnes from an area of 3.88 million ha (2017-18). Out of these, about 11 % is exported to more than 150 countries. Since organic foods are free from chemical and contaminants, the demand for these products is steadily increasing in the developed countries and the estimated demand is approximately 1 to 1.5 %. Since spices are mainly used in medicine and for flavouring foods, the demand for organic spices and spice products are also steadily increasing. Out of the major spices though Kerala contributes major share of Black pepper and small cardamom, the North Eastern states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) is contributing major share of Zingiberaceous spices (ginger, turmeric and large cardamom). In the above context the organic package developed for cultivation of black pepper, ginger, turmeric and large cardamom for North-Eastern states are detailed below.

General guidelines for organic production

For a viable and sustainable agro-ecosystem organic management, whole farm should be converted according to the standards over a period of time. The standard requirements for nutrient and disease management should be followed during the conversion period. It is essential that all the crops in the field be maintained following organic method of production. Mixed farming system by integrating crop husbandry and livestock is most ideal, where the livestock is also maintained following organic standards. This would enable the use of farm yard manure available in the farm itself without depending on external sources. All the crop residues and farm wastes should be recycled through composting including vermi-composting so that soil fertility is restored and maintained at a very high level. Soil and nutrient loss through soil wash, run off and percolating water should be minimized through proper practices. Weeding is to be limited to slashing. Such materials should be used for mulching the plant base in the case of perennials. The plantation should have a green cover with leguminous crops. They should be cut and mulched to prevent moisture loss. Shade and support trees especially leguminous ones and green manuring shrubs to provide bio-mass and other plant protection agents to help control of diseases and pests should find a place within or on the border of such organic farm. For new planting, varieties that are resistant or tolerant to disease, pest and nematode infection should be used. Prophylactic measures should be taken to prevent diseases. No chemical fertilizers, insecticides or fungicides may be applied. However lime, magnesium sulphate, micronutrient mixtures, natural sulphate of potash, rock phosphate, bone meal etc for correcting nutrient deficiencies and pH after soil testing can be used in limited quantities. A nutrient mixture consisting of natural sources of potassium and

other allowed secondary and micronutrients suitable for organic crop formulated by IISR, Kozhikode can be used for the purpose. Similarly Bordeaux mixture for fungal disease control and neem oil as insecticides are generally allowed. In all these cases proper records must be maintained for submission to the certifying agency.

ORGANIC BLACK PEPPER

India is one of the leading producer, consumer and exporter of black pepper in the World. Black pepper is cultivated to a large extent in Kerala and Karnataka and to a limited extent in Tamil Nadu and North Eastern states, especially Assam. In India, the crop is grown in about 1.34 lakh hectares with a production of 66,000 tonnes (DASD 2018). It is a popular ingredient in different dishes, in the west as well as in original cooking. It is being used in traditional medicines in many parts of the world. It is widely used in Ayurvedic treatment in India and preparation of Jams in Indonesia. Hence demand for organic black pepper is steadily increasing. Products that are certified and sold as 'organic black pepper' fetch a premium price compared to conventionally produced ones.

Climate and soil

Black pepper is a plant of humid tropics requiring adequate rainfall and humidity. The crop tolerates temperatures between 10^{o} and 40° C. However, the favourable temperature range is 23-32^{0}C. A well distributed annual rainfall of 125-200 cm is considered ideal for black pepper. It can be grown in a wide range of soils with a pH of 5.5 to 6.5, though in its natural habitat it thrives well in red laterite soils.

Conversion of existing garden to organic

For an existing plantation, a minimum of three years is required as conversion period where as for a newly planted or replanted area, the first yield itself can be considered as organic produce provided chemicals have not been used in the previous cropping. For new planting, varieties that are resistant or tolerant to diseases, pests and nematode infection should be used. All crop residues and farm waste available on the farm is to be recycled so that soil fertility is maintained at high level.

Varieties

A majority of the cultivated types are monoecious (male and female flowers found in the same spike). Over 75 cultivars of black pepper are being cultivated in India. Local cultivars about eighteen improved varieties of black pepper are released from research institutions. Among the varieties Panniyur -1 is suited to open areas, Panniyur -2 & 5are shade tolerant, Panchami & Panniyur -3 are late maturing, Panniyur 4 is a stable yielder, Subhakara, Sreekara, Panniyur -6

& 7 are suited to all black pepper tracts, IISR Thevam, IISR Shakthi & Panniyur-8 are tolerant to *Phytophthora* foot rot, IISR Girimunda and Malabar Excel are suited to high altitudes and Arka Coorg Excel is a high yielding, variety with long spikes and bold berries.

Planting material production

In black pepper vines, three types of aerial shoots, namely (a) primary stem with long internodes, with adventitious roots clinging to the standards (b) runner shoots originating from the base of the vine with long internodes and (c) fruit bearing lateral branches are normally seen. Rooted cuttings are raised mainly from runner shoots, and terminal shoots. Lateral branches can be rooted for raising bush pepper. In traditional method, runner shoots from high yielding and healthy vines are separated from the vine during February-March, and after trimming the leaves, cuttings of 2-3 nodes each are planted either in nursery beds or in polythene bags filled with fertile soil. Adequate shade has to be provided and the polythene bags are to be irrigated frequently. The cuttings become ready for planting during May-June. Rooted cuttings of high yielding/ disease resistant varieties can be easily multiplied rapidly by serpentine or column methods developed by ICAR-IISR for further planting.

Standards for trailing

Providing of ideal support/standards plays an important role in successful establishment of blackpepper vines. In homesteads gardens, it is usually trained on arecanut, coconut, mango, jack trees etc. When interplanted in cardamom and coffee plantations, it is trailed on various trees like *Erythrina indica, Garuga pinnata, Gliricidia sepium, Leucaena leucocephala, Ailanthus malabarica and Grevillia robusta* etc. The non-living standards like reinforced concrete posts, granite pillars and teak poles etc can also be used. The standards are to be planted in pits of 60 x 60 x 60 cm size filled with farm yard manure and top soil at convenient spacing of 3 x 3 m.

Planting of rooted cuttings

Pits of 60 cm x 60 cm x 60 cm at a distance of 30 cm away from the base, on the north eastern or north eastern side of supporting tree are taken with the onset of monsoon. The pits are filled with a mixture of top soil, farmyard manure @ 5 kg/pit and 150 g rock phosphate. Vermi compost or well decomposed FYM @500 g and *Trichoderma harzianum* @ 50 g may be mixed in the pit at the time of planting. Two rooted cuttings are planted with the onset of monsoon in the pits. At least one node of the cutting should be planted below the soil for proper anchorage. Under mono cropping system the optimum spacing is 3 m x 3 m, whereas in sloppy land 3 m x 2 m spacing is recommended. When the vines reaches one meter on the supporting trees, lowering of vines are to be done which induce more leader shoots and laterals from the base of the standards.

Cultural practices

As the plants grow, the shoots are to be tied to the standards regularly using suitable materials for anchorage. Pruning of terminal shoots to be practiced to increase number of spikes and of bearing laterals. The young vines are to be covered with dry arecanut or coconut leaves or twigs of trees during summer. Regulation of shade by pruning branches of standards in black pepper gardens during March and July-August will allow sufficient light for crop growth. Mulching around the basins of vines with organic materials especially green leaves @10 kg/vine to a radius of 1 m is required at the end of North-East monsoon. Live mulch (cover crops) such as *Calapagonium mucanoides* and *Mimosa invisa* can also be grown to provide soil cover and to prevent soil erosion. Hand weeding in the basins and slashing in interspaces promotes growth and enhances yield in black pepper

Manuring

For nutritional management under organic farming, a judicious application of a combination of organic manures such as farmyard manure @ 5 kg/vine and vermi compost @ 1 kg/vine per year can be made during May-June from 3rd year onwards. FYM can be increased to 10 kg/vine from third year onwards. Biofertilizers such as and *Azotobactor* can also be applied @ 50 g/vine mixed with farmyard manure. The requirement of potassium can be given as ash (0.5-1 kg) or can be substituted with natural sulphate of potash (SOP) @100-250 gm per vine. In acidic soil, it is desirable to apply lime or dolomite at the rate of 500 g/vine in April-May with receipt of pre monsoon showers in alternate years. To eliminate the deficiency of Mg, Zn, B etc in high yielding plantations foliar micronutrient mixture developed by ICAR-IISR compatible under organic farming to be sprayed @ 5gm per litre water in May- June and September-October for getting 15 to 25% extra yield.

Disease management

The major disease of black pepper is foot rot caused by *Phytophthora* capsici. The minor diseases are Pollu disease caused by *Colletotrichum gloeosporioides*, and stunted disease by viral infection and slow decline disease by nematodes in association with *Phytophthora*. For the control of foot rot disease, regular adoption of phytosanitary measures is most important. Tillage operations are to be kept to the minimum to avoid soil disturbance and root damage. Proper drainage is essential. Application of *Trichoderma* multiplied in a suitable carrier medium @ 500 g/vine/year is also recommended. Whenever pollu disease and aerial symptoms of foot rot is noticed, restricted spraying of Bordeaux mixture 1 % may be done. Application of biocontrol agents like *Pochonia chlamydosporia* @ 50 g/vine in suitable carrier media like FYM or vermi compost twice a year (during April-May and September-October) is suitable to control slow decline/

nematode problems. Pollu beetle (*Longitarsus nigripennis*) may be managed by spraying organic based insecticides such as neem oil, fish oil rosin etc at 2-3 week intervals.

Harvest and postharvest operations

Normally pepper flowers with the onset of monsoon in May-June. The crop takes about 6-8 months from flowering to harvest. The harvest season extends from November to January in plains and January to March in hills. During harvesting the whole spike is hand picked when one or two berries in the spike turn bright orange red. The berries are separated from the harvested spikes and dried in the sun for 7-8 days, on a clean concrete floor or bamboo mat till they are crisp. The product is dried to the final moisture content of 10%, packed in polythene lined bags and stored at dried place.

ORGANIC GINGER

India ranks first and contributes about 29.0 percent of total world's ginger production followed by China (26.0%), Indonesia (14.0%) and Nigeria (10.0%). In India, it is cultivated in an area of approximately 1.60 lakh ha with a production of 11.18 lakh tons. Though it is cultivated in most of the states, Karnataka, Orissa, Assam, Meghalaya, Arunachal Pradesh and Gujarat together contribute 65.0 percent to the country's total production. Indian ginger has high esteem in the global market because of its characteristic lemon like flavour. Since spices like ginger form part of many of ethnic medicines, the demand for organically produced ginger is also increasing considerably.

Climate

Ginger is a shade loving plant. It requires warm humid climate with well distributed rainfall of 1500-3000 mm over a span of 8-10 months to produce good crop. It comes up well up to an altitude of 1500 m above MSL. The optimum soil temperature of 25-30°C is preferable for germination of rhizomes. Good sunshine, heavy rainfall and high relative humidity are necessary for getting good yield. The crop is sensitive to water logging, frost and salinity.

Soil

Well-drained loose and friable soil rich in organic matter content and nutrient and good drainage is preferable for ginger cultivation. The optimum soil pH is 5.0-7.0. The soil should be relatively free of root knot nematodes and soil-borne pathogens causing rhizome rot and bacterial wilt. If pH of the soil is less than 5.0, hydrated lime/ dolomite @ 1 ton/ha may be applied at the time of last plough to the soil. Raised beds of 75-100 cm width, 20-30 cm height and of convenient length (preferably 3m) with a gentle slope outward are prepared for planting. In areas prone to rhizome rot disease and nematode infestations, solarisation of beds for 40 days using transparent polythene sheets is recommended.

Varieties

Several cultivars of ginger are grown in different ginger growing areas in India. For organic production, traditional varieties adapted to the local soil and climatic conditions that are resistant or tolerant to diseases, pests and nematode infection should be used. Some of the prominent indigenous cultivars suited to NE region are Bhaise, Gorubathane, Majhauley, Himachal and Nadia. The improved varieties like IISR Varada, IISR Rejatha, and IISR Mahima are also popular.

Conversion plan

For certified organic production of ginger, at least 18 months the crop should be under organic management i.e. only the second crop of ginger can be sold as organic. The conversion period may be relaxed if the organic farm is being established on a land where chemicals were not previously used, provided sufficient proof of history of the area is available. It is desirable that organic method of production is followed in the entire farm; but in the case of large extent of area, the transition can be done in a phased manner for which a conversion plan has to be prepared. A suitable buffer zone with definite border 20 meter is to be maintained around organic plot to avoid contamination.

Cultural practices

Planting

Ginger is propagated by portions of rhizomes known as seed rhizomes. Carefully preserved seed rhizomes from organically cultivated farms free from pests and diseases are cut into small pieces of 2.5-5.0 cm length weighing approximately 40-50 g each with one or two good buds are suitable for planting. The seed rate varies from 2000 to 2500 kg/ha. In NE India, ginger is planted during April-May when pre-monsoon showers are there. While planting, the seed can be dipped in 47^0c hot water or bio control agent *Trichoderma viride* @ 2% or PGPR strain of GRB-35 solution developed by IISR (1 capsule/ 100 Lit of water) for 30 minutes and drained for enhancing growth and suppressing diseases. The healthy seed rhizomes so selected and processed are planted in small pits prepared with a hand hoe on raised bed at a spacing of 30-45 cm between rows and 15-20 cm between plants. The distances between rows can be increased to 60/90 cm if maize is intercropped which can be planted between rows. Prior to planting of seed rhizome in the soil, six-inch cushion of leaves increases the production of ginger by the loosening of soil texture around seed rhizome at later stages.

Manuring

All crops residues and farm waste available in the farm should be recycled through composting. At the time of planting well- decomposed farm yard manure or compost @ 20-25 t/ha, neem cake @ 2 t/ha, biofertilizer (*Azospirillum* + Phosphorus solubilizing bacteria) @5-6 kg/ha to be applied in raised beds. If the soil is low in phosphorous, rock phosphate @ 250 kg/ha may

Improved varieties of Black pepper


IISR Girimunda

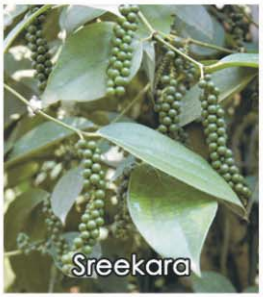

IISR Thevam


IISR Malabar excel


IISR Shakthi


Panchami

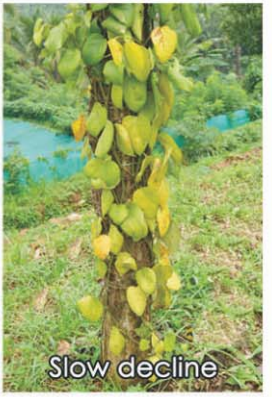

Pournami


Sreekara

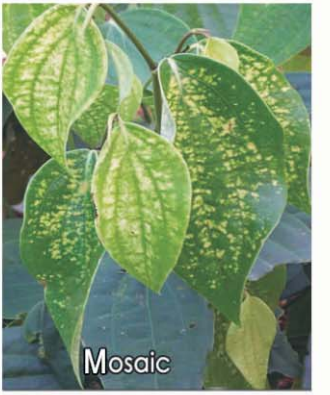

Subhakara


Black Pepper at Arunachal Pradesh

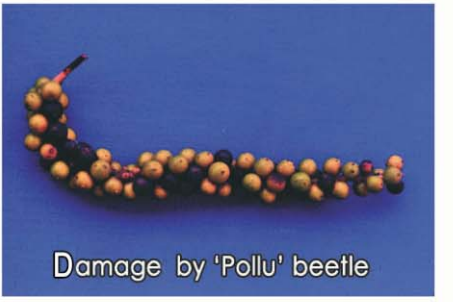
Symptoms of Pest, diseases in Black Pepper


Slow decline


Phytophthora foot rot


Mosaic


Stunted Disease


Damage by 'Pollu' beetle


Marginal gall forming thrips infestation


severely affected by Scale Insects


Topshoot borer

also be combined with farm yard manure while planting. Two months after planting vermi compost @5 t/ha should also be applied for better growth and production. If the soil is low in potassium status, wood ash @ 0.5 t/ha or sulphate of potash (SOP) @ 125 kg/ha may also be applied during this stage. Ginger micro nutrient mixture developed by ICAR-IISR can be sprayed @ 5 gm/l of water during 60 and 90 days after planting to get 15-25 % increase in yield.

Manuring schedule for ginger (per ha)

Schedule	Neem or Karanji/Mahua cake	Rock phosphate	Ash	Organic manure
Basal	2 tons	250 kg	-	20 tons FYM
After 45 days	-	-	0.5 -1 ton	2 ton Vermicompost
After 90 days	-	-	50 kg Sulphate of Potash	2 ton Vermicompost

Mulching

Mulching the beds with green leaves/organic wastes is essential to prevent soil splashing and erosion of soil due to heavy rain. It will enhance germination, conserves moisture, prevents run off, increases infiltration, regulates temperature, suppresses weed growth and improves soil fertility. The first mulching is done at the time of planting with green or dry leaves @ 10-12 tonnes/ha. It is to be repeated @ 7.5 tonnes/ha at 45 and 90 days after planting along with weeding, manuring and earthling up. Since, most of the deciduous plant shed their leaves in winter season, the shed leaves can be used as mulch. Mulching using leaves of *Schima wallichi* (Chilaune) or *Artimisia vulgaris* (Titepati) will reduce disease problem.

Weed Management

Weeds are serious problem in ginger cultivation and reduce the yield considerably. The traditional method of hand weeding is the common practice and is done just before manure application and mulching. The first weeding is done on 45 DAP and the second weeding during 90-120 DAP. Soil solarisation before planting and application of mulches at the time of planting, and also during 45 & 90 DAP is effective in suppressing the weed population. Earthing up may be combined with hand hoeing (weeding) and mulching.

Shade management

Shading is helpful in reducing water loss and provides a micro climate suitable for the plant. Dry matter production, nutrient uptake, yield and quality are also

higher under low to medium shade (25 per cent). A heavier shade (beyond 50 percent) decreases number of tillers and yield. The incidence of *Phyllosticta* leaf spot disease is also much less under shade.

Cropping system/ Crop rotation

Ginger can be grown as a sole crop (under open or shade) or as a component in inter or mixed cropping systems. It can be intercropped with chillies, tapioca and rice in rain fed areas and leguminous crops, maize and vegetables in irrigated conditions. All the component crops in the cropping system also should be grown organically. To avoid insect pest and diseases ginger should not be taken continuously in the same field and should be rotated with other crops at least for two crop season.

Disease management

Soft rot is the most destructive disease of ginger which results in total loss of affected clumps. Cultural practices such as selection of well drained soils for planting is important for managing the disease, since stagnation of water predisposes the plant to infection. Soil solarisation before planting may be practiced to kill the pathogen in the soil. Selection of healthy rhizomes, seed treatment and soil application of biocontrol agents like Trichoderma, PGPR or *Pseudomonas* multiplied in suitable carrier media such as coir pith compost, well rotten cow dung may be done at the time of sowing and at regular intervals to keep the rhizome rot disease in check. To control leaf spot spraying of Bordeaux mixture 1% may be done restricting the quantity to 8 kg copper per hectare per annum. Root knot (*Meloidogyne spp.*), burrowing (*Radopholus similis*) and lesion (*Pratylenchus spp.*) nematodes are major nematode pests of ginger. The nematodes can be controlled by solarising ginger beds before planting /using nematode free seed rhizomes and treating infested rhizomes with hot water (50°C) for 10 minutes. In areas were root knot nematode population is high, the resistant variety IISR-Mahima may be cultivated. Application of bioagents *Pochonia chlamydosporia* 20 g/bed at 10^{6}cfu/g) in suitable carrier medium at the time of sowing will be useful to check the nematode population. Soil solarisation of beds for 40-50 days (preferably from 1st March to April 15) and soil drenching with *Bacillus licheniformis* (GAB 107, Bacillich 1 %) as 5 applications @ 5 lit /bed (*cfu of* 10^{6} */ml*) at the time of planting and at 30, 45, 60 and 90 days helps to overcome the bacterial wilt of ginger caused by *Ralstonia sp.*

Insect pests

The shoot borer (*Conogethes punctiferalis*) is the most serious pest of ginger and can be managed by spraying neem based insecticide (0.6%) at 21 day intervals during July to October. An integrated strategy involving pruning and destroying freshly infested pseudostems during July-August (at fortnightly intervals) and spraying neem based insecticide during September-October (at monthly intervals) is also effective against the pest. The rhizome scale

(*Aspidiella hartii*) infests rhizomes in the field (at later stages) and in storage. This pest can also be managed with neem based insecticides.

Harvesting

Ginger attains full maturity in 210-240 days after planting. The crop is ready for harvest in about 7-8 months after planting when the leaves turn yellow, and start drying up gradually. For preparing vegetable ginger, harvesting is done from sixth month onwards. The rhizomes are thoroughly washed in water and sun-dried for a day. In large scale cultivations, tractor or power tiller drawn harvesters are used for harvesting the rhizomes.

Processing of ginger

Production of dry ginger involves peeling of the ginger rhizomes to remove the outer skin and sun drying to a safe moisture level. Peeling is done by scrapping the outer skin with bamboo splits having pointed ends and are washed before drying. Then it is sun dried in open yard which takes about 8 to 10 days for complete drying. The yield of dry ginger is about 19-25 *per cent* of fresh ginger depending on the variety. Polishing is done by rubbing the dried ginger against hard surface. Cleaning of dry ginger is done manually to remove the extraneous matter and the light pieces. Fully dried rhizomes can be stored in airtight containers such as high density polyethylene or similar packaging materials.

Storage of Seed rhizomes

In order to obtain good germination, the seed rhizomes are to be stored properly in pits under shade. For seed material, bold and healthy rhizomes from disease free plants are selected immediately after harvest. For this purpose, healthy and disease-free clumps are marked in the field when the crop is 6-8 months old and still green. Disease free bold rhizomes are selected after harvest, cleaned and are treated with Bordeaux mixture 1% for 20 minutes and shade dried and stored in pits of convenient size in sheds. The seed rhizomes are placed in pits in layers along with well dried sand/saw dust (put seed rhizomes one feet height, then put 5 cm thick layer of sand/saw dust.) The pits can be covered with wooden planks with one or two small openings for aeration.

ORGANIC TURMERIC

Turmeric (*Curcuma longa*) (Family: Zingiberaceae) is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. India is a leading producer and exporter of turmeric in the world. We produce approximately 11.33 lakhs tones from an area of 2.38 lakh hectares. Tamil Nadu, Telengana, Andhra Pradesh, Karnataka, Gujarat, West Bengal, Orissa,

Mizoram, Meghalaya and Assam are some of the important states cultivating turmeric. India exports 6.48% of its production to more than 50 countries mainly as dry produce (63%) and powder (37%). The share of organic turmeric is only 11 percent compared to conventional turmeric. Growing demand for natural colours in industry, fast food chains, pharmaceuticals offer a potential scope for organic production especially in North East.

Climate and soil

Turmeric can be grown in diverse tropical conditions from sea level to 1500 m above sea level, at a temperature range of 20-35^{0}C with an annual rainfall of 1500 mm or more, under rain fed or irrigated conditions. Though it can be grown on different types of soils, it thrives best in well-drained sandy or clay loam soils with a pH range of 4.5-7.5 with good organic status.

Varieties

Many local cultivars of turmeric are known mostly by the names of locality. Important local cultivars are Lakadong, Megha Turmeric-, Duggirala, Thekurpeat, sugandham, Amalapuram, Erode Local, Muvattupuzha, etc. Improved turmeric varieties like IISR Praba, Prathiba, Alleppey Supreme, Pragathi etc with high yield and curcumin content also available for cultivation out of which Lakadang and MeghaTurmeric-1 are most popular in North East. Varieties tolerant to pest and diseases and high curcumin content may be selected in organic farming.

Conversion plan

For certified organic production, just like ginger at least 18 months the crop should be under organic management i.e. only the second crop of turmeric can be sold as organic. It is desirable that organic method of production is followed in the entire farm; but in the case of large extent of area, the transition can be done in a phased manner for which a conversion plan has to be prepared.

Seed material

For organic production, traditional varieties adapted to the local soil and climatic conditions that are resistant or tolerant to diseases, pests and nematode infection should be used. Healthy and disease free rhizome selected for seed may be treated with 1% Bordeaux mixture for 20 minutes dried in shade and may be stored with layers of sand or sawdust under shade or ground pits of 1 x1x1m size. The pits are to be covered with wooden planks with one or two openings for aeration. However there is a practice of storing rhizomes under the shade of the trees or well ventilated rooms covered with turmeric leaves. The seed rate varies from 1500- 2500 kg per hectare.

Improved varieties of Ginger

IISR Varada

IISR Rejatha

IISR Mahima

Pest & disease in Ginger

Shoot borer

Rhizome scale

Leaf spot

Rhizome rot

Improved varieties of Turmeric


Aleppey Supreme


IISR Kedaram


Megha Turmeric-1


Turmeric field in Meghalaya


Megha Turmeric-1


NDH98 Rhizome


Turmeric Local CV


Pragathi

Pest, diseases and cropping system in Turmeric


Shoot borer


Rhizome scale


Rhizome rot


Colletotrichum leaf spot


Helminthosporium leaf spot


Leaf blotch


Intercropping of turmeric in cocnut garden

Cultural practices

The land is to be prepared during March. The soil is brought to a fine tilth by giving about four deep ploughings. If the pH is less than 5, hydrated lime or dolomite @ 1000 kg/ha has to be applied and ploughed. Immediately with the receipt of pre-monsoon showers, beds of 1.0 m width, 30 cm height and of convenient length are prepared with spacing of 50 cm between beds. Ridges and furrows are preferred where seeds are planted on top of the furrows. Small pits are made with a hand hoe on the beds with a spacing of 45-60 cm between ridges and 15-20 cm between plants. Pits are filled with well decomposed cattle manure or compost enriched with *Trichoderma*, seed rhizomes are placed over it then covered with soil. The seed can be dipped for 15 minutes in PGPR strain GRB 35 or GEB 17 developed by IISR (cfu 10^{9}) or in slurry of *Trichoderma viride* @5g/kg before planting for enhancing growth and suppressing diseases.

Manuring

Based on soil test, application of lime/dolomite, rock phosphate and wood ash has to be done to get required quantity of phosphorus and potassium supplementation. The soil having potassium deficiency sulphate of potash may be applied in two splits (45&90 DAP) @ 200 kg/ha. At the time of planting, well decomposed cattle manure or compost @ 25-30 tonnes/ha has to be applied in pits at the time of planting. Biofertilizer such as *Azospirillum* and *Bacillus* can also be used along with organic manures for better growth. When the deficient conditions of trace elements become yield limiting, restricted use of mineral/chemical sources of micronutrients by soil application or foliar spray are allowed as per the limits of standard setting or certifying organizations. Turmeric micronutrient mixture developed by IISR can be sprayed @ 5g/litre of water during 60 and 90 days after planting to get 15-25% increased yield.

Manuring schedule for Turmeric

Schedule	Neem or Karanji/Mahua cake	Rock phosphate	Ash	Organic manure
Basal	2 tons	250 kg	-	20 tons FYM
After 45 days	-	-	0.5 -1 ton	2 ton Vermicompost
After 90 days	-	-	50 kg Sulphate of Potash	2 ton Vermicompost

Mulching

The crop is to be mulched immediately after planting with green leaves @ 12-15 t/ha. Mulching may be repeated @ 7.5 t/ha at 40 and 90 days after planting. After weeding, application of manures at 45 and 90 days after planting and earthing up may be done for proper aeration and for the development of rhizomes. Mulching can be done with paddy straw, green or available weed biomass and dry leaves. Cow dung slurry may be poured above the mulch to enhance microbial activity and nutrient availability.

Weeding and irrigation

Turmeric is grown as rain fed crop in NE India. Weeding has to be done thrice at 60, 90 and 120 days after planting depending upon weed intensity.

Mixed farming/crop rotation

As a mixed crop it can grown or rotated with chillies, colocasia, onion, brinjal, maize, ragi etc. enabling effective nutrient built up and pest or disease control. It can be also grown as a mixed crop in coconut and arecanut plantations. When grown in a mixed cultivation system, it is essential that all the crops in the field are also subjected to organic methods of production.

Disease management

Use of biopesticides, biocontrol agents, cultural and phyto sanitary measures for the management of insect pests and diseases forms the main strategy under organic system. Spraying Neem gold 0.5% or neem oil 0.5% during July-October (at 21 day intervals) is effective against the shoot borer. Selection of healthy rhizomes, soil solarization and incorporation of *Trichoderma*, seed treatment and soil application of biocontrol agents like *Trichoderma* or *Pseudomonas* multiplied in suitable carrier media such as coir pith compost, well rotten cow dung or neem cake may be done at the time of sowing and at regular intervals to control the rhizome rot disease. To control other foliar diseases spraying of Bordeaux mixture 1% may be done. Application of

quality neem cake mentioned earlier along with the bioagents *Pochonia chlamydosporia* will be useful to check the nematode population.

Harvesting

Depending upon the variety, the crop becomes ready for harvest in 7-9 months after planting. Early varieties mature in 7-8 months, medium varieties in 8-9 months and late varieties after 9 months. The land is ploughed and the rhizomes are gathered by hand picking or the clumps are carefully lifted with a spade. The harvested rhizomes are cleared of mud and other extraneous matter adhering to them.

Curing and drying

Cleaned rhizomes are boiled in fresh water by putting in a trough placed in boiling water in a pan or in large pot to soften them. Boiling influences the colour and aroma of the final produce. It can be judged by piercing boiled rhizomes with a blunt piece of stick. Over-cooking spoils the colour of the final product and under-cooking renders the dried product brittle. The cooked turmeric is taken out of the pan by lifting the troughs and draining the water into the pan itself. They are then dried on bamboo mats or cement floor under the sun for 10-15 days or solar or in electric drier until they are dry and hard. They are then packed in air tight bags with proper labelling and stored. The dry recovery varies from 15 to 25%.

ORGANIC LARGE CARDAMOM

Large cardamom (*Amomum subulatum* Roxb.) is one of the ancient spices belonging to the Zingiberaceae family. It is a perennial bush with sheathed stem, reaching about 2–5 m with a large tuberous rhizome and long leaves. The leafy stalk that grows from the plant base at ground level bears the seed pod. The flowers are yellow in color with a white-purple vein tip. It is harvested before ripening to avoid capsules splitting during drying. It is widely used in curries, pulao (a rice dish), pickle and mulled wines. It acts as a flavour for Arab and Turkish coffee, in medicine it is used as a stimulant, carminative, in preparations for indigestion and flatulence. Due to its large uses for flavour and medicines the demand for organic produce is very high. The crop grows well in shaded areas and is one of the main cash crops cultivated in Sikkim and other North Eastern states where it is cultivated mainly as organic crop. India produced approximately 5570 tones from an area of 26617 hectares (Spices board, 2019).

Climate

Large cardamom is a shade-loving plant with natural habitat in the humid, subtropical, semi-evergreen forests on the steep hills of the eastern sub-Himalayan. It requires well-distributed rainfall, of about 3,000–3,500 mm/year in around 200 days. It grows well at an altitude of 600–2,350 m above

MSL. Normally it is cultivated at lower altitudes in cooler areas and higher altitudes in warmer areas. During severe winter, the plants remain dormant and can withstand up to 20^{0}C. Continuous rain during flowering hampers the foraging activity of pollinating bees resulting in poor capsule setting and barren spikes.

Soil

The crop is generally grown in forest loamy soil of brownish yellow to dark brown colour with texture from sandy, sandy loam, silty loam. Soil with adequate drainage, rich organic carbon and nitrogen, medium phosphorus and potassium status having pH ranging from 5.0 to 5.5 is ideal for the crop.

Varieties

There are mainly six popular cultivars viz., Ramsey, Ramla, Sawney, Varlangey, Seremna and Dzongu Golsey. Ramsey is suited to high altitudes and even in steep slopes. Cultivar Ramla found to grow at few high altitude areas in North Sikkim. Sawney and Varlangey are suited to medium and high altitude areas. Seremna cultivar is suited to low altitude areas especially Hee-Gaon areas. Dzongu Golsey is found to grow in low altitude and suited to Dzongu area. ICRI Sikkim 1 and ICRI Sikkim 2 are high yielding selection from the cultivar Sawney and suited to Sikkim and Darjeeling. Some other unpopular local cultivars are Chivey, Gardo Seto Ramnag, Madhusey, Seto Golsey, Slant Golsey, Red Sawney, Green Sawney and Mingney.

Propagation

Propagation of large cardamom is done either by seeds (seedlings) or by planting healthy suckers. Seeds are collected from high yielding and well-maintained plantations that are free from viral diseases. Well-matured capsules from the bottom and middle portion of the spikes are selected for extraction of seeds. After de-husking, the seeds are mixed with sand and rubbed with the hand and washed in water to remove the mucilage. The washed seeds are mixed with wood ash for 30 minutes, dried in the shade and sown immediately in the primary nursery.

Nursery management

Primary nursery

Seed beds of 15–25 cm height, 1 m width and convenient length are prepared in a well drained soil. The soil is tilled to a depth of about 30 cm and left for three to four weeks for weathering. Well decomposed cattle manure is mixed with the soil and the surface of the bed is prepared to a fine tilth. About 80–100 g of seed per bed is sown in lines across the bed at a distance of 10 cm and is mulched with local plant material. Seeds are sown in September-October.

Irrigation is to be given at regular intervals. The germination commences around 25–30 days after sowing. Shades are given using bamboo mats or thatch grass or by agro shade nets. When the seedlings attain 3–4 leaf stage, they are transplanted to either in secondary beds or in polythene bags.

Secondary nursery

Nursery beds of 15 cm height, 100 cm width and any convenient length are prepared on contour terraces. Well decomposed cattle manure or Vermi compost or leaf compost is mixed with the soil. Seedlings with 3–4 leaves are transplanted into the beds in May–June with a spacing of about 15 cm between them. The interspace is mulched with chopped paddy straw or dried leaf. Overhead shade are given using bamboo, thatch grass etc. The soil is kept moist with regular sprinkling of water. Once the seedlings attain 45–60 cm height and have 2–3 tillers, they are planted in the main field during June–July of the subsequent year.

Poly bag nursery

Polythene bags of size 15x15 cm are filled with soil, sand and FYM in 4:1:1 proportion are arranged in rows of one meter width and in convenient length under shade. Seedlings of 3-4 leaves are planted in the polybags in May-June and irrigation may be given in regular intervals. They can be field planted after 10-12 months.

Sucker multiplication nursery

Multiplication through suckers should take adequate precautions to ensure that viral diseases are not transmitted through them. The suckers should be from disease free, high yielding plantations. Nurseries are established either under the shade of forest trees or pandals. The site of nursery should be located at least 500 m away from the existing plantations. It should be near to irrigation source and easily accessible by roads. Trenches of 45 cm width x 30 cm depth are prepared at convenient length with an interspace of 30 cm. Well decomposed cattle manure or compost is mixed with soil and are filled to the brim. One grown up shoot with vegetative buds are planted 30 cm apart from another, in the trenches, during May–June. After planting, the plant base is mulched with dry leaves. The multiplication rate in this method is about 1: 8 in a year. The grown up tillers each have an emerging bud and they are planted in the main field in June–July. Grasses may be applied as mulch and irrigation may be given from November to March depending on soil moisture.

Cultural practices

Main field preparation

Pits having a size of 30 x 30 x 30 cm are prepared on contour terraces, at a

spacing of 1.5 m x 1.5 m (1.8 m x 1.8 m for robust cultivars) after the onset of monsoon showers. The pits are left for weathering for a fortnight and thereafter filled with topsoil mixed with cow dung/ compost/FYM @1-2 kg per pit. Pit making and filling operation should be completed in the third week of May before the onset of pre-monsoon showers. Planting is done in June-July when there is enough moisture in the soil. A mature tiller with 2-3 immature tillers/vegetative buds is used as planting unit. Suckers/seedlings are planted by scooping a little soil from the centre of the pits and planted up to collar zone. Deep planting should be avoided. Staking is needed to avoid lodging from heavy rain and wind and mulching is done at the plant base.

Manuring

Replenishment of nutrients is very essential for sustained good yield and to compensate the nutrient loss from the soil. Application of well-decomposed cattle manure/compost or organic products @ 5kg /plant at least twice a year in April-May and August-September is beneficial. Vermi compost, having favourable impact on soil physical properties and good source of nutrients, may be applied @1kg/clump in two equal doses in combination with FYM. Since farmers in the hilly regions of the NER generally select sites that are rich in organic matter or cultivate under Alnus trees, manuring is not normally done. The leaves that fall down retain moisture and decompose fast, ultimately becoming good manure to the plant.

Mulching

Mulching at the plant base with easily degradable organic materials is good for conserving both moisture and soil. Mulch is well-known to improve the soil physical condition and fertility. Dried organic matter, leaves, weeds etc. can be used as mulch.

Water management

Though it is a rain fed crop the, first year of planting irrigation is required at least once in 10 days during the dry months of November to January for better growth there after. It is observed that plant growth and productivity is higher in plantations where irrigation is provided. Depending on the availability of water sources hose/sprinkler/flood irrigation through small channels is advised. Water harvesting pits made in between four plants of nearby rows during rainy season can to some extent support the water requirement of the crop in the dry season and is a cost-effective option.

Shade regulation

About 50% shade is found ideal for large cardamom. *Alnus nepalensis* (utis) is the most common shade tree and *Alnus nepalensis* (Himalayan alder)-large cardamom is very good agro-forestry system for sustainable production in the

region. The other species of shade trees are *Termalia myriocarpa* (Panisâj), *Bucklandia* spp. (Pipli), *Macaranga denticulata* (Malato), *Edgeworthia gardneri* (argeli), *Viburnum erubescens* (Asare), *Maesa chisia* (Bilaune), *Symplocos spp*. (Kharane), *Albizzia lebbeck* (Siris), *Erythrina indica* (Phaledo), *Eurjata panica* (Jhingani), *Schima wallichi* (Chilaune) etc. The lopping of branches of the shade trees is very important and should be done before the onset of the monsoon during June-July.

Weed management

Weeding can be done either by hand or with a sickle, depending on the intensity of weed growth. Around the plant base, the weeds can be pulled out by hand and the weeds in the inter space needs only be slashed with sickle. While weeding, dried shoots and other thrashed materials can be used as mulch around the base of the plant which will help conserve moisture in the ensuing dry months, cover the exposed roots and prevent weed growth around the plant base. During flowering period, the thrashed materials should not cover the inflorescences. The old stems can be removed and used for mulching.

Pollinators of Large Cardamom

The bumle bee, *Bombus breviceps* and *B.haemarrhoidalis* have been identified as main pollinators of large cardamom in all the latitudes. Maximum foraging activities of bumble bees is seen during morning hours on clear days and fewer activity in rainy days. Care should be taken during farm operations to keep the nests in the soil undisturbed to conserve the pollinators in their natural habitat. Flowering plants need to be grown in the plantation throughout the year to maintain their uninterrupted supply of their food.

Pest Management

Problems due to sporadic incidences of leaf eating caterpillars are found in isolated areas. Initially the caterpillar of the moth (*Artona chorista*) feeds on the leaf lamina from the under surface and finally defoliates the leaves completely leaving only the midribs. This can be controlled by hand picking the infested leaf and by destroying in a distant place. The incidence of leaf eating caterpillars is reported more in mixed forestry based cultivation. This is because some trees harbour the pest which falls onto the leaf of the cardamom. Peak infestation of stemborer is seen in December- January, March-April, May-June and September- October. Shootfly incidence is noticed in new plantations of 1-3 years old. Other animals like rodents, porcupine, and wild boar destroy the crops. Inorder to prevent rodents, wild varieties of cardamom can be planted near the plantation. Infected leaves/young shoots with larvae should be removed and may be destroyed. White grubs incidence can be reduced by collecting the beetles using hand nets during April-May and may be killed.

Disease management

Chirke disease

Symptoms of this disease are appearance of a mosaic patches on the tender leaves with pale streaks that slowly turn brown and slowly the plants wither away. It will affect the growth and yield of the crop. The disease is transmitted by aphids. It is also spread by planting infected suckers. Often the knife used for harvesting and cutting the suckers itself transmits the disease.

Foorkey disease

In the affected plants numerous small tillers appear at the base of the plant with stunted growth and fail to produce productive inflorescence, spikes and yield. Smoking the area at certain periodic intervals is practised as a preventive measure. Being a viral disease, the affected plants cannot be cured. However disease spread can be minimized by removing and burning affected plants.

Blight

The disease is caused by *Colletotrichum gloeosporioids* generally seen in April-May and progress during rainy season. Water soaked lesions appear on the leaves, rapidly enlarge, coalesce and cover entire leaf lamina giving a blighted appearance. The mature and bearing tillers cut during harvest and other operations may be used for composting so that most pathogens get killed in raised temperature during composting. Collateral hosts such as marigold, *Amomum dealbatum*, Canna, wild colocasia, ornamental basil may be destroyed. Fortified *Trichoderma* with FYM (1:100) may be applied @ 2kg/clump at basin of the plants. Pre treatment of suckers with bioagent *Pseudomoas fluorescence* @ 5 liter in 100 liter water at the time of planting is suggested to reduce the disease incidence.

Leaf spot

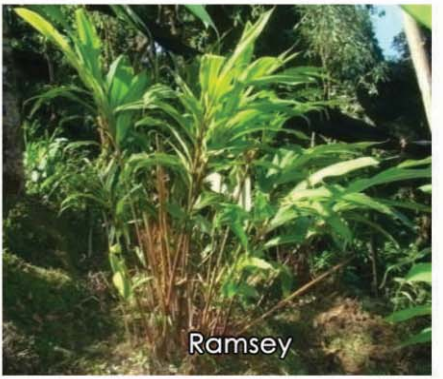
The disease is caused by *Phoma sp.* is seen in seedling nurseries of Arunachal Pradesh and field plants in Sikkim. Water soaked lesions appear on leaf lamina, which coalesce and become yellowish and dry out. Spraying of 1% Bordeaux mixture at 20-25 days will reduce the diseases.

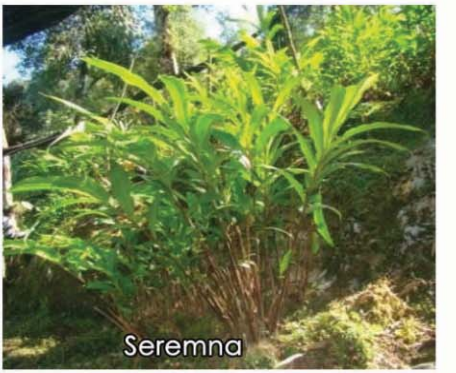
Harvesting and curing

Harvesting is done by cutting the spike with a special sickle that is sharpened at both sides of the end tip. The harvested spikes are heaped and the capsules separated and dried immediately after harvest. The dried capsules are rubbed on a wire mesh for cleaning and for removal of the tail. Traditionally, cardamom is dried on bamboo mats. The capsules are dried by direct heating with smoke or sunlight for 15 days. Most farmers prefer the traditional method of sun drying. In smoke-driers, the capsule turns dark brown with a smoky

Improved varieties of Large cardamom

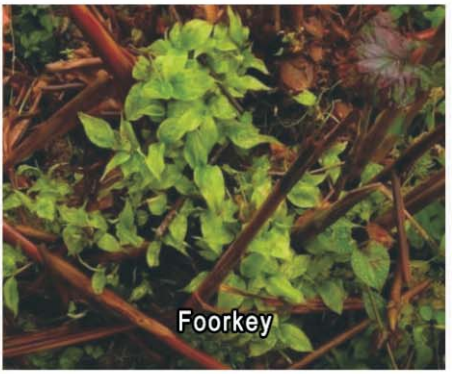
Cultivars of Large cardamom





Pest & Diseases in Large Cardamom


Chirke


Foorkey


leaf blight


blight affected field


phoma leaf spot


shoot borer


white grub


Adult & Larvey

smell. Modern drying methods have been introduced both in Sikkim and Nagaland where smoked or hot air is blown through fairly large pipes made of fabricated in over evenly spread produce on a wire mesh. An improved curing technique called the 'Bhatti (oven) system' is available at ICRI Spices Board, where it is dried by indirect heating at 45–50^0 0 C for 30 hours. These improved methods help the cardamom to retain its original colour, flavour and aroma, which in turn get the grower a better price. Grading is done manually according to size, fullness and shape of capsules/pods. Properly dried capsules are allowed to cool and packed in moist-proof containers preferably polythene lined jute bags. The bags are stored on wooden platforms to avoid absorption of moisture.

Organic Certification

Under organic farming, processing methods also should be based on mechanized, physical and biological processes to maintain the vital quality of organic ingredient throughout each step of its processing. All the ingredients and additives used in processing should be of agriculture origin and certified organic. Labelling should clearly indicate the organic status of the product as "produce of organic agriculture". Certification and labelling is usually done by an independent body to provide a guarantee that the production standards are met. Govt. of India has taken steps to have indigenous certification system to help small and marginal growers and to issue valid organic certificates through certifying agencies accredited by APEDA and Spices Board. The inspectors appointed by the certification agencies will carry out inspection of the farm operations through records maintained and by periodic site inspections. Documentation of farm activities is must for acquiring certification. Certification and labelling is usually done by an independent body to provide a guarantee that the production standards have met. Group certification programmes are also available for organized group of producers and processors with similar production systems located in geographical proximity. To make certification system affordable a farmer group centric certification system under Participatory Guarantee System (PGS) India programme was also launched under National Project on Organic Farming by the Ministry of Agriculture, Co-Operation, and Farmers Welfare with National Centre of Organic Farming ((NCOF) as its secretariat. Only group of farmers and farming /food processing operations taken up by the grower groups are covered under this system. In India about twenty eight accredited certification agencies authorised under National Programme for Organic Production (NPOP) for certifying organic produces some of which are listed below.

LIST OF ACCREDITED CERTIFICATION BODIES

1. ECOCERT India Pvt. Ltd., Aurangabad, Sector-3, Hindustan Awas Ltd., Walmi-Waluj Road, Nakshatrawadi, Aurangabad – 431 002 (Maharashtra) Tel.No:0240-6607101 to 105 Fax No.:0240-6607135, Email: office.india@ecocert.in, certification@ecocert.in

2. Indian Organic Certification Agency (INDOCERT), Thottumugham P.O. Aluva-683 105,Cochin (Kerala) Telefax: 0484-2630908-09/2620943, Email: info@indocert.org43

3. Lacon Quality Certification Pvt.Ltd., Thiruvalla (Kerala) Chenathra, Theepany, Thiruvalla - 689 101 (Kerala) Tel. No: 0469 2606447 Fax: 0469 2631902 Email: info@laconindia.com
   Web: www.laconindia.com

4. Natural Organic Certification Agro Pvt. Ltd.Flat No: 2, First Floor, Karan Plaza II near Rosary School Mumbai – Bangalore Highway Warje, Pune – 411058Tel. No: +91-20-65218063 Fax no: +91-20-25457869 E-mail: nocaindia@gmail.com
   Website: www.nocaindia.com

5. Uttarakhand State Organic Certification Agency (USOCA)12/II Vasant Vihar Dehradun-248 006, (Uttarakhand)
   Tel. No.: 01352760861 Fax: 0135-27607 34
   Mail: uss_opca@rediffmail.com ua_usoca@yahoo.co.in

6. APOF Organic Certification Agency (AOCA) 126, 1st Floor, Govindappa Road,Off D.V.G. Road, Gandhi Bazar, Bangalore-560 004 (Karnataka) India.Tel: +91-80-26677275, +91-80-41203848 Mobile: 09342349255/09886019021 Mail: aocabangalore@yahoo.co.in Website: www.aoca.in

7. Rajasthan Organic Certification Agency (ROCA) 3rd Floor, Pant Krishi Bhawan, Janpath, Jaipur 302 005, (Rajasthan) Tel.No.: 0141-2227104,Tele Fax: 0141-2227456
   Email rocajpr.cb@gmail.com

8. Vedic Organic Certification Agency Plot No. 55, Ushodaya Enclave, Mythrinagar, Miyanagar, Hyderabad–500050
   Mobile No.:09290450666, Tel. No.:040-65276784, Fax:040-23045338
   Email:voca_org@yahoo.com;usha_preetham@yahoo.co.in

9. ISCOP (Indian Society for Certification of Organic Products) Rasi building, 162/163, Ponnaiyarajapuram Coimbatore – 641001Tamil Nadu Mob. No.: 094432 43119 Tel. No.:0422-2544199/0422-6586060 E-mail:iscop_cbe@yahoo.inprofdrkkk@yahoo.com
   Website: www.iscoporganiccertification.org

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