ORGANIC SPICES PRODUCTION

Black Pepper, Ginger, Turmeric

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Organic Spices Production

India is the major producer, consumer and exporter of spices in the world, growing about 60 different varieties of spices and produces about 60 lakh MT of spices, of which, about 6.9 lakh MT (11%) is exported to more than 150 countries. Since organic foods are free from chemical contaminants, the demand for these products is steadily increasing. Organic farming is a form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control. In this system only natural fertilizers and pesticides are allowed, but it excludes or strictly limits the use of fertilizers and pesticides, plant growth regulators such as hormones, genetically modified organisms; human sewage sludge and nano materials.The organic farming does not aim only at higher crop yield or returns but also developing long term self sustainable practices. With the demand for organic foods, the demand for spices and spice products are also steadily increasing. Among spices black pepper, ginger and turmeric are more important crops and the package developed under Network project on organic farming (NPOF) is described below.

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. The crop is grown in India about 1.28 lakh hectares with a production of 64,640 tonnes (2014-15).

Climate and soil

Black pepper is a plant of humid tropics requiring adequate rainfall and humidity. The hot and humid climate of sub mountainous tracts of Western Ghats is ideal for its cultivation.

It grows successfully between 20° North and South latitude, and from sea level up to 1500 m above sea level. The crop tolerates temperatures between 10^{o} and 40° C. The favourable temperature range is 23-32^{0}c. A well distributed annual rainfall of 125-200 cm is considered ideal for black pepper. Black pepper 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 and isolation

When pepper is grown in a mixed cultivation system, it is essential that all the crops in the field are also subjected to organic methods of production. An isolation belt of is to be left from all around. For an existing plantation, a minimum of three years is required as conversion period for organic cultivation. For a newly planted or replanted area raised through organic cultivation practices, the first yield itself can be considered as organic produce provided chemicals have not been used in the previous cropping. It is desirable that organic method of production is followed in the entire farm, but in large estates the transition can be phased out for which a conversion plan is to be prepared. 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 recycled so that soil fertility is maintained at high level. Weeding is to be limited to slashing as far as possible and burning should not be resorted to. Mulching should be practiced with slashed materials and ground should be covered with green manure crops. Prophylatic measures should be taken to prevent diseases. No chemical pesticides or fungicides may be applied. However, Bordeaux mixture for fungus disease control is generally allowed. An isolation belt must be maintained around an organic holding. In small holder groups, where the pepper holdings are contiguous, the isolation

belt need only be at the outer periphery of the entire group of holdings. Any produce grown on this isolation belt cannot be treated as organic. Precautions should be taken to avoid the entry of runoff water and chemical drift from neighbouring farms, if they are not organically cultivated.

Selection of site

The land that is proposed for planting black pepper should be cleared of weeds and undergrowth. In level and low lands proper drainage channels should be provided to prevent water stagnation during periods of high rainfall. Areas having 1%-3% slope are ideal for planting black pepper. Planting in slopes facing south should be avoided so that the vines are not subjected to the scorching effect of the southern sun during summer. In sloppy lands adequate soil and moisture conservation measures are to be adopted.

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 and Karimunda is the most popular cultivar in Kerala. The other important cultivars are Kottanadan (South Kerala), Narayakodi (Central Kerala), Aimpiriyan (Wynad), Neelamundi (Idukki), Kuthiravally (Kozhikode and Idukki), Balancotta, Kalluvally (North Kerala), Malligesara and Uddagare (Karnataka). Kuthiravally and Balancotta exhibit alternate bearing habit. In terms of quality, Kottanadan has the highest oleoresin (17.8%) content followed by Aimpiriyan (15.7%). Further, eighteen improved varieties of black pepper are released from research institutions for cultivation. Panniyur-1 and Panniyur-3 are hybrids evolved at the Pepper Research Station, Panniyur (Kerala) and IISR Girimunda and IISR Malabar Excel are hybrids developed at ICAR-IISR, Kozhikode.

Table 1. Improved varieties of Black pepper

Variety	Main yeild (Dry) (kg/ha)	Dry recovery	Quality arttributes			Features
			Piperine (%)	Oleoresin (%)	Essential oil(%)	
Kerala Agricultural University (KAU). PRS, Panniyur, Kerala						
Panniyur -1	1242	35.3	5.3	11.8	3.5	High yielding, not suited to heavily shaded area
Panniyur -2	2570	35.7	6.6	10.9	-	Shade tolerant
Panniyur -3	1953	27.8	5.2	12.7	-	Late maturing
Panniyur -4	1277	34.7	-	9.2	-	Stable yielder
Panniyur -5	1098	35.7	5.5	12.3	3.8	Tolerant to shade
Panniyur -6	2127	32.9	4.9	8.3	1.3	Suited to all black pepper tracts
Panniyur -7	1410	33.6	5.6	10.6	1.5	Suited to all black pepper tracts
Panniyur -8	1365	39.0	5.7	12.2	1.2	High yielding, field tolerant to Phytophthora foot rot and drought
ICAR- Indian Institute of Spice Research, Kozhikode, Kerala						
Subhakara	2352	3505	4.0	10.0	6.0	Suited to all black pepper tracts
Sreekara	2677	35.0	4.2	13.0	4.0	Suited to all black pepper tracts
Panchami	2828	34.0	4.7	12.5	3.4	Late maturing
Pournami	2333	31.0	4.1	13.8	3.4	Tolerant to root knot nematode
PLD-2	2475	-	3.3	15.5	3.5	Suited to/Thiru-vananthapuram & Kollam districts in Kerala
IISR Shakthi	2253	43.0	3.3	10.2	3.7	Tolerant to Phytophthora foot rot.

IISR Thevam	2481	32.0	1.7	8.2	3.1	Tolerant to Phytophthora foot rot; suited to high altitudes and plains
IISR Girimunda	2880	32.0	2.2	9.7	3.4	Suited to high altitudes
IISR Malabar Excel	1440	32.0	4.9	14.6	4.1	Suited to high altitudes; rich in oleoresin
ICAR-Indian Institure of Horticulture Research, CHES, Chettali and Indian Institute of Spices Research, Appangala, Karnataka						
Arka Coorge Excel	3267	37.8	2.1	6.9	1.6	High yield-ing, with long spikes and bold berries

Propagation

Black pepper vines develop three types of aerial shoots, namely (a) primary stem with long internodes, with adventitious roots which cling to the standards (b) runner shoots which originate from the base of the vine and have long internodes which strike roots at each node and (c) fruit bearing lateral branches. Cuttings are raised mainly from runner shoots, though terminal shoots can also be used. Cuttings from lateral branches are seldom used since they develop a bushy habit. However, rooted lateral branches are useful for raising bush pepper.

Traditional method of Production of rooted cuttings

Runner shoots from high yielding and healthy vines which are grown organically are kept coiled on wooden pegs fixed at the base of the vine to prevent the shoots from coming in contact with soil and striking roots. The runner shoots 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. For large scale production of planting materials serpentine method of propagation can be used.

Serpentine method

In a nursery shed with roofing sheet or shade net, rooted black pepper cuttings are planted in polythene bags holding about 500 g potting mixture, which will serve as mother plants. As the plant grows and produces few nodes, small polythene bags (20 x10 cm) filled with potting mixture has to kept under each node. The node may be kept gently pressed in to the mixture assuring contact with the potting mixture with the help of a flexible twig such as mid rib of a coconut leaflet to enable rooting at that junction. Roots start growing from the nodes and the cuttings keep on growing further. The process of keeping potting mixture filled polythene bags at every node to induce rooting at each node is repeated. In 3 months the first 10 to 12 nodes (from the mother plants) would have rooted profusely and will be ready for harvest. Each node with the ploythene bag is cut just before the rooted node and the cut end is also buried into the mixture to induce more roots. Polythene bags filled with solarized potting mixture or soil, sand/granite powder and farmyard manure in 2:1:1 proportion is recommended for producing disease free rooted cuttings. The rooted nodes will produce new sprouts in a week time and will be ready for field planting in 2-3 months time. Daily irrigation can be given with a rose can drenching with IISR black pepper PGPR consortia at 10 ml per bag will ensure healthy root system production. On

an average, the multipicaton rate is 1: 60 plants in a year.

Soil-less nursery mixture

The plug-tray nursery technique involves initial multiplication of black pepper runners in a modified serpentine method, ie. by allowing runners to strike roots in the partially decomposed coir pith and vermicompost (75:25) bed of convenient dimension (1.5 m width, 10 cm height and convenient length). The vines trail on rooting medium and strike roots at every node. After 45-60 days, leaving the terminal 5 nodes, about 15-20 node rooted runner is cut into single node rooted cuttings and transferred to plug-trays (cell dimension of 7.5 × 7.5 × 10.0 cm) filled with soil-less nursery mixture [composted coir pith and vermicompost (75:25) enriched with Trichoderma]. Better rooting and establishment is recorded under humidity controlled green house (27±2^{o}C) with intermittent mist. The cuttings are retained in the trays for about 45-60 days (4-5 leaf stage) for initial establishment. The established cuttings are then transferred to shade net/ naturally ventilated green house for hardening (45-60 days). Healthy black pepper rooted cuttings are ready for field planting after 120-150 days.

Standards for trailing

Providing of ideal supports /standards plays an important role in successful establishment of black pepper vines. The standards used for trailing black pepper vines are of two types namely, living and non-living. The non-living standards include reinforced concrete posts, granite pillars and teak poles. In homestead gardens in Kerala, black pepper is usually trained on arecanut and coconut and also on mango, jack, etc. When inter planted in cardamom and coffee plantations, especially in Kodagu and Chickmagalur districts in Karnataka and Idukki and Wyanad

districts in Kerala, black pepper is trailed on various forest trees. Erythrina indica is the common live standard planted for trailing black pepper in Kerala. Other common standards that can be used are *Garuga pinnata, Gliricidia sepium, Leucaena leucocephala, Ailanthus malabarica* and *Grevillia robusta*. In case stems/stem cuttings of *Gliricidia sepium* or *Garuga pinnata* are used, they are to be cut to suitable lengths during March-April and stacked in shade. The stacked stems start sprouting in May. With the receipt of first rains in May-June, they are planted in pits of 60 x 60 x 60 cm size filled with cowdung and top soil at a spacing of 3m x 3m which would accommodate 1110 standards per hectare. Living standards *Grevillea robusta* (Silver oak) and *Ailanthus triphysa* /*Ailanthus malabarica* should be planted 3-4 years in advance so as to attain sufficient height and girth at the time of planting of black pepper. The soil should be well pressed around the standards to avoid air pockets and keep the standards firm in the soil.

Planting

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 topsoil, farmyard manure @ 5 kg/pit and 150 g rock phosphate. Neem cake @ 500 g and *Trichoderma harzianum* @ 50 g may be mixed in the pit at the time of planting. Two rooted cuttings are planted during May at the centre of 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 which will help the standards to grow straight, enhance productivity and also to reduce the incidence of diseases.

Mulching around the basins of black pepper 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. These cover crops are to be cut back regularly from the base to prevent them from twining along with black pepper vines. During the second year, the same practices are repeated. Weeds are a major problem in black pepper plantations that are not maintained properly. Hand weeding in the basins and slashing in interspaces promotes growth and enhances yield in black pepper. During the second year the same cultural practices are repeated.

Irrigation

In Kerala, irrigating black pepper vines @ 20-35 litres per vine 7 -10 days interval during summer is recommended. The water is to be applied in basins taken around the plants at

a radius of 75 cm. In case drip irrigation is adopted, 7 litres of water per day through drip during October to May is recommended. In Karnataka, summer irrigation (March 15th to May 15th) at fortnightly intervals enhanced productivity 90 to 100 % by compared to unirrigated crop. Vines are irrigated at the basin through hose and 50 litres per vine is recommended for vines those more than 15 years of age. The quantity can be reduced to 40 litres for vines between 11-15 years age and 30 litres to vines aged between 5 - 10 years. The spiking will be uniform in the irrigated crop as most of the spikes (> 90%) emerge by July while in rain fed crop only around 60% of spikes emerge in July and may extend till September.

Manuring

For nutritional management under organic farming, a judicious application of a combination of organic manures such as farmyard manure @ 5 kg/vine, neemcake @ 1 kg/vine and vermicompost @ 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 yielding year onwards. Biofertilizers such as Phosphobacteria and Azospirillum can also be applied @ 50 g/vine mixed with farmyard manure. Application of PGPR consortia at 1 - 2 litre per vine (disloving 1 capsule in 200 L water) or enriching the compost / FYM with PGPR and applying at 1-2 kg per vine also helps in increasing the vigour and root growth of the plants. All these mainly provide the nitrogen sources depending upon soil test results. The requirement of potassium can be substituted as ash (0.5-1 kg) or SOP (250-500g. Sulphate of Potash). Similarly the deficiency of Magnesium, Zinc, Boron and other micronutrients can be corrected either by soil or foliar application to the permissible levels in initial years. IISR has developed foliar micronutrient mixture for black pepper to be

sprayed @ 5gm per litre water in May- June and September-October for 15 to 25% extra yield. 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.

Cropping System

Multiple cropping is the practice of growing two or more crops in the same field simultaneously. Effective root zone of black pepper extend up to about 90 cm deep from the base and 30 cm radius. So ample space is available for multiple cropping without affecting black pepper. With these in view, tuber, rhizomatous crops, fodder, medicinal plants, vegetable and pulses were tried in juvenile black pepper garden at ICAR-IISR. Maximum yield and net return was recorded by greater yam, elephant foot yam (tuber), hybrid Napier grass, guinea grass (fodder), *Ayyapana tripli, Vetiveria Zizanioides , Alpine carcarata* (medicinal plants), Amaranthus species red, Amaranthus species green (vegetables), green gram and black gram (pulses) etc. whereas elephant foot yam, ginger, Hybrid Napier grass, *Plumbago rosea* and *Pogostemon cablin* are the profitable crops suited to established black pepper gardens of more than 15 years old.

Multiple cropping in black pepper gardens is a routine practice in Kerala and parts of Karnataka. Colacassia, vanilla and banana are the other crops suited to grow with Black pepper. At higher altitudes, black pepper is grown along with coffee, cardamom and tea. Black pepper is also trailed on coconut and arecanut palms in most of the areas. In these cases the rooted black pepper plants are planted away from the base of palms and as and when the vines grow, they are trailed along the ground and on to the trunk of coconut or arecanut palms. The varieties Sreekara, Subhakara and Panniyur-5 perform well as intercrops in coconut and arecanut gardens. Multiple cropping with black

pepper as one of the component crops also offers immense scope in Kerala and in North-eastern states.

Plant Protection in nursery

Phytophthora infection

Phytophthora infection is noticed on leaves, stems and roots of cuttings in the nursery. Dark spots with fimbriate margins appear on the leaves, which spread rapidly resulting in defoliation. The infection on the stem is seen as black lesions which result in blight. The symptoms on the roots appear as rotting of the entire root system.

The potting mixture may be sterilized through solarization. To the sterilized mixture, bio agents such as VAM @ 100 cc/kg of mixture and Trichoderma harzianum @ 1 g/kg of soil (Trichoderma population @ 10^{10} cfu/g) may be added at the time of filling of nursery mixture in polythene bags. Spraying Bordeaux mixture (1%) on leaves at monthly intervals prevents the disease.

Anthracnose

The disease is caused by the fungus *Colletotrichum gloeosporioides.* The fungus infects the leaves causing yellowish brown to dark brown irregular leaf spots with a chlorotic halo. Spraying Bordeaux mixture (1%) is effective against the disease.

Leaf rot and blight

The disease is caused by the fungus *Rhizoctonia solani* and is often serious in nurseries during April-May during warm humid conditions. The fungus infects both leaves and stems. Grey sunken spots and mycelia threads appear on the leaves and the infected leaves are attached to one another with the mycelia threads. On stems, the infection occurs as dark brown lesions which spread upwards and downwards. The new flushes

subtending the points of infection gradually droop and dry up. A prophylactic spray with Bordeaux mixture (1%) prevents both the diseases.

Basal wilt

The disease is mainly noticed in nurseries during June-September and is caused by the fungus *Sclerotium rolfsii*. Grey lesions appear on stems and leaves. On the leaves white mycelium are seen at the advancing edges of the lesions. The mycelia threads later girdle the stem resulting in drooping of leaves beyond the point of infection and in advanced stages the rooted cuttings dry up. Small whitish to cream coloured grain like sclerotia bodies appear on the mature lesions. The disease can be controlled from the beginning stages, by adopting phytosanitary measures. The affected cuttings along with defoliated leaves should be removed and destroyed. After periodic sanitation, the cuttings are to be sprayed with Bordeaux mixture (1%).

Infections

Vein clearing, mosaic, yellow specks, mottling and small sized leaves are the most apparent symptoms for identifying viral infections in the nursery. As viruses are systemic in nature, primary spread occurs through planting material since black pepper is vegetatively propagated. When infected plants are used as source of planting material, the cuttings will also be infected. Hence selection of virus free healthy mother plants is very important for producing disease free cuttings. Secondary spread of the disease occurs through insects such as aphids and mealy bugs. When the poly bag cuttings are placed close and crowded in the nursery, chances of spread through these insects are more. Besides, inspection and removal of infected plants should also be done at regular intervals.

Nematode infestation

Root-knot nematodes (*Meloidogyne spp*.) and burrowing nematode, *Radopholus similis* are the two important nematode species infesting rooted cuttings in the nursery. The damage caused to roots by nematode infestations result in poor growth, foliar yellowing and sometimes interveinal chlorosis of leaves. The establishment of nematode infected cuttings will be poor when planted in the field and such cuttings develop slow decline symptoms at a later date.

Soil solarization or Steam sterilization can be done for sterilizing the nursery mixture. The sterilized nursery mixture may be fortified with biocontrol agents such as *Pochonia chlamydosporia* or *Trichoderma harzianum* @ 1-2 g/kg of soil, the product containing 10^6 cfu /g of substrate.

Plant protection in the field

The major disease of pepper is foot rot caused by the fungus *Phytophthora capsici*. The minor diseases are Pollu disease caused by *Colletotrichum gloeosporioides*, stunted disease and slow decline. 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 or aerial symptoms of phytophthora is noticed, restricted spraying of Bordeaux mixture 1 % may be done. Planting materials from mother vines showing symptoms of stunted disease and phyllody should not be collected for raising rooted cuttings. Application of crushed neem seed @ 1kg per vine or biocontrol agents like *Pochonia chlamydosporia* @ 50 g/vine in suitable carrier media like FYM or vermicompost

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 0.6% Neemgold (neem product) spray given at 2-3 week intervals. Clipping of severely infected branches and spraying Neemgold 0.6% and fish oil rosin 3% were also promising against scale insect.

Harvest and post harvest operations

In India, pepper flowers 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 handpicked when one or two berries in the spike turn bright orange red. At the time of harvesting no chemical should be applied to ward off red ants. 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. During sun drying it is important to turn over the material periodically to facilitate uniform drying. Without turning, mould contamination may result in a poorly dried product with greyish unattractive appearance. For the preparation of good quality black pepper, a simple blanching process which can be easily adopted by even small and marginal pepper growers, has been developed in India. For this the mature greenish yellow, pepper spikes are de spiked after harvest. The pepper berries after cleaning are transferred to perforated aluminium vessel or bamboo basket and dipped in boiling water for a minute, drained and spread out on a clean cement floor or bamboo mat for sun-drying. The product is dried to the final moisture content of 10%, packed in polythene lined bags and stored at dried place.

Improved varieties of Black Pepper

Symptoms of pest & diseases in Black Pepper


Slow decline


phytophthora root rot

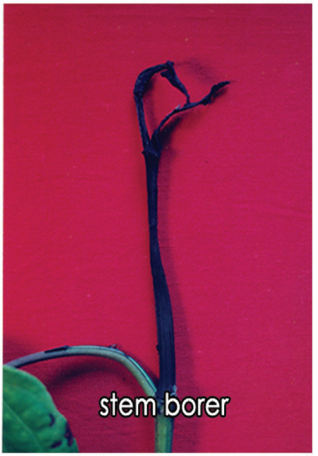

Mosaic on leaves


Stunted Disease


damaged by 'Pollu' beetle


Marginal gall forming thrips infestation


severely affected by Scale Insects


stem borer

Improved varieties of Ginger

Pest & diseases in Ginger

Improved varieties of Turmeric

Pest & diseases in Turmeric

Ginger

India ranks first and contributes about 29.0 % total world's ginger production followed by China (26.0%), Indonesia (14.0%) and Nigeria (10.0%). During 2014-15 the country produced 7.60 lakh tonnes of the spice from an area of 11.41 lakh ha. Ginger is cultivated in most of the states in India. However, Karnataka, Orissa, Assam, Meghalaya, Arunachal Pradesh and Gujarat together contributes 65.0 % to the country's total production. Export of ginger showed a highly fluctuating trend during the last decade. India is exporting ginger mainly to Pakistan, Bangladesh, Saudi Arabia, UAE, Netherlands, Spain, Japan, Morocco, UK and USA. 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 in the importing countries.

Climate

Ginger requires a tropical or subtropical climate, being a shade loving plant. It prefers a warm, humid climate and cannot withstand very low temperature. It comes up well up to an altitude of 1500 m above MSL, the optimum being 300 - 900 m. The optimum soil temperature of 25-26°C is preferable for germination of rhizomes and 27.5°C for growth and development and below 15°C, ginger stops growing. Good sunshine, rainfall and high relative humidity are necessary for getting good yield. A well-distributed rainfall of 1500-3000 mm over a span of 8-10 months produces good crop. The crop is sensitive to water logging, frost and salinity.

Soil

Ginger can be grown on a wide variety of soils such as sandy loams, clay loams, alluvial and lateritic soils. However, it is mainly grown in red and laterite soils of Kerala, Karnataka, Orissa, West Bengal and North eastern states. Well-drained loose and friable soil is preferable for cultivation since the rhizomes and roots proliferate in the top 25 cm. By adopting cultural practices such as bedding and surface mulching, shallow soil can be utilized. Alluvial soils and drained paddy fields or well-drained marshy areas can also be utilized for ginger cultivation. Deep soils with rich organic matter content and nutrient availability are more suitable for cultivation. Deep slopes in hilly areas are not advisable for ginger cultivation as it leads to soil erosion during heavy rainfall.

The optimum soil pH preferred for ginger is 5.0-7.0 and if the pH is more than 8.0, growth is retarded. The soil should be relatively free of root knot nematodes and soil-borne diseases 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. Beds of about 1 m width, 30 cm height and of convenient length are prepared with an interspace of 50 cm in between beds. In case of irrigated crop, ridges are formed 40 cm apart. In areas prone to rhizome rot disease and nematode infestations, solarization 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 and they are generally named after the localities where they are grown. Some of the prominent indigenous cultivars are Maran, Kuruppampadi, Ernad, Wayanad, Himachal and Nadia. The exotic cultivar 'Rio-de-Janeiro' is also become

very popular among cultivators. The improved varieties of ginger and their salient features are given in Table 1. The variety IISR Varada is suited for fresh ginger, dry ginger and making candy while, IISR Rejatha is rich in essential oil.

Table 1. Improved varieties

Variety	Fresh mean yield (t/ha)	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin	Essential Oil (%)
Indian Institute of Spices Research, Kozhikode - 673 012, Kerala						
IISR Varada	22.6	200	20.7	4.5	6.7	1.8
IISR Mahima	23.2	200	23.0	3.3	4.5	1.7
IISR Rejatha	22.4	200	19.0	4.0	6.3	2.4
High Altitude Research Station, Orissa University of Agriculture and Technology, Pottangi - 764 039, Orissa						
Suprabha	16.6	229	20.5	4.4	8.9	1.9
Suruchi	11.6	218	23.5	3.8	10.0	2.0
Suravi	17.5	225	23.5	4.0	10.2	2.1
Subhada	18.0	210	22.4	3.4	10.4	2.0
Y.S Parmar university of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh - 173 230						
Himgiri	13.5	230	20.6	6.4	4.3	1.6
Kerala Agricultural University, Thrissur - 680 656, Kerala						
Athira	21.0	220-240	22.6	3.4	6.8	3.1
Karthika	19.0	220-240	21.6	3.7	7.2	3.2
Aswathy	23.0	220-240	19.7	3.5	7.5	3.3

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.

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.

In order to avoid contamination of organically cultivated plots from neighbouring non-organic farms, a suitable buffer zone with definite border is to be maintained. In smallholder groups, where the holdings are contiguous, the isolation belt is needed at the outer periphery of the entire group of holdings. Ginger grown on this isolation belt cannot be treated as organic. In sloppy lands adequate precaution should be taken to avoid the entry of runoff water and chemical drift from the neighbouring farms. Proper soil and water conservation measures by making conservation pits in the interspaces of beds across the slope have to be followed to minimize the erosion and runoff. Water stagnation has to be avoided in the low lying fields by taking deep trenches for drainage.

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 imme-

diately after harvest. For this purpose, healthy and disease-free clumps are marked in the field when the crop is 6 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 alternate layers along with well dried sand/saw dust with one feet hight of rhizomes and 5 cm thick layer of sand/saw dust. The pits can be covered with wooden planks with one or two small openings for aeration. Intermittant checking at fortnightly / monthly intervals is needed for observing any damage due to dieses / scale insects.

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 20-25 g each having one or two good buds. The healthy seed rhizomes weighing 25 g are planted in small pits prepared with a hand hoe at a spacing of 25 x 25 cm on bed and covered with well rotten farm yard manure @ 25-30 t/ha. In Kerala, the seed rate varies from 1500 to 2500 kg/ha. While planting, the seed can be dipped in PGPR strain of GRB-35 solution developed by IISR for enhancing growth and suppressing diseases (1 capsule/ 100 L of water). Seed rhizomes can be planted at a spacing of 20-25 cm along the rows and 20-25 cm between the rows.

Transplanting

Though transplanting in ginger is not conventional, it is found profitable. A transplanting technique in ginger by using single bud sprouts (about 5 g) has been standardized to produce good quality planting material with reduced cost. The yield level

of ginger transplants is on-par with that of conventional planting system. The technique involves raising transplants from single sprout seed rhizomes in the pro-tray and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Procedure

- Select healthy ginger rhizomes for seed purpose
- Treat the selected rhizomes with Bordeaux mixture 1% for storing. One month before planting, the seed rhizomes are cut into single buds with small piece of rhizomes weighing 4-6 g.
- Treat the single bud sprouts with GRB 35 solution (1 capsule for 100 litre water) for 30 min before planting
- Fill the pro-trays (98 well) with nursery medium containing partially decomposed coir pith and vermicompost (75:25), enriched with PGPR/Trichoderma (10g/kg of mixture)
- Plant the ginger bud sprouts in pro-trays
- Maintain the pro-trays under shade net house
- Adopt need based irrigation with rose can or by using suitable sprinklers
- Seedlings will be ready within 30-40 days for transplanting

Mulching

Mulching enhances germination, conserves moisture, prevents run off, increases infiltration, regulates temperature, suppresses weed growth and improves soil fertility by adding organic matter. Mulching the beds with green leaves/organic wastes is essential to prevent soil splashing and erosion of soil due to heavy rain. It also adds organic matter to the soil, checks weed emergence and conserves moisture during the latter part

of the cropping season. The first mulching is done at the time of planting with green leaves @ 10-12 tonnes/ha. Green leaf mulching is to be repeated @ 7.5 tonnes/ha at 45 and 90 days after planting. Immediately after weeding, manures should be applied followed by earthling up.

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. Application of dried coconut leaves after removing the petiole at 5.4 t/ha at the time of planting or paddy straw (6 t/ha) at the time of planting and green leaves 7.5 t/ha 45 & 90 DAP in ginger is also recommended for effective weed control. Soil solarisation is also effective in suppressing the weed population. Earthing up may be combined with hand hoeing (weeding) and mulching.

Irrigation

Ginger is cultivated as rain fed crop in high rainfall areas (uniform distribution for 5 to 7 months) and irrigated crop in less rainfall areas where rainfall distribution is not uniform. Ginger requires 1300-1500 mm of water during its crop cycle. The critical stages for irrigation are during germination, rhizome initiation (90 DAP) and rhizome development stages (135 DAP). The first irrigation should be done immediately after planting and subsequent irrigations are given at intervals of 7 to 10 days in conventional irrigation (based on prevailing weather and soil type). Sprinklers and drip system can also be employed for better water use efficiency and enhanced yield.

Shade management

Even though shade is not absolutely necessary, ginger prefers light shade. 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%). A heavier shade (beyond 50%) decreases number of tillers and yield. The incidence of Phyllosticta leaf spot disease is also much less under shade.

Cropping system

Ginger can be grown as a sole crop (under open or shade) or as a component in inter or mixed cropping systems. Cropping system helps in building up of depleted nutrients removed by ginger and maintaining soil fertility. It also provides additional income to the farmers. Ginger can be intercropped with vegetables (cabbage, tomato, chillies, french bean and lady's finger), pulses (pigeon pea, black gram and horse gram), cereals (maize, finger millet), oilseeds (caster, soybean, sunflower and niger) and other crops (sesbania, tobacco and pineapple. All the component crops in the cropping system also should be grown organically.

Manuring

All crop residues and farm wastes like green loppings, crop residues, grasses, cow dung slurry, poultry droppings etc. available on the farm can be recycled through composting, including vermicomposting so that soil fertility is maintained at high level. No synthetic chemical fertilizers, pesticides or fungicides are allowed under organic system. If the soil having potassium deficiency ash or sulphate of potash may be applied in two splits (45 & 90 DAP) @ 125 kg/ha. Application of PGPR strain of *Bacillus amyloliquifaciens* (GRB 35) as talc formultion or biocapsules is also recommended for growth promotion and disease

control. Based on soil test, application of lime/dolomite, rock phosphate and wood ash may be done to get required quantity of phosphorus and potassium supplementation.

Schedule	Neem cake	Rock phosphate	Ash	Organic manure
Basal	2 tonnes	250 kg	-	30 tonnes cowdung
After 45 days	-	-	0.5-1 tonnes	2 tonnes vermicom-post
After 90 days	-	-	50 kg Sulphate of Potash	2 tonnes vermicom-post

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. IISR has developed ginger micronutrient mixture to be sprayed @ 5g/litre of water during 60 and 90 days after planting to get 15-25% increase in yield.

Plant protection

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 solarization 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 or quality neem cake 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 important nematode pests of ginger. The nematodes can be controlled by treating infested rhizomes with hot water (50°C) for 10 minutes, using nematode free seed rhizomes and solarizing ginger beds for 40 days. In areas were root knot nematode population is high, the resistant variety IISR-Mahima may be cultivated. Application of quality neem cake along with the bioagents *Pochonia chlamydosporia* 50 g/bed at 10^6 cfu/g) the time of sowing will be useful to check the nematode population.

Insect pests

The shoot borer (*Conogethes punctiferalis*) is the most serious pest of ginger and can be managed by spraying neem gold (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 gold 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. The pest can be managed by treating the seed material with neem based insecticides.

Harvesting and curing

The crop is ready for harvest in about 7-8 months after planting when the leaves turn yellow, and start drying up gradually. Ginger attains full maturity in 210-240 days after planting.

Irrigation is stopped one month before harvest and the clumps are lifted carefully with a spade or digging fork and the rhizomes are separated from the dried up leaves, roots and adhering soil. 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. In India, domestic market prefers fresh green ginger for culinary use while two types of dried ginger i.e. bleached and unbleached are produced for export purpose. The most important criteria in assessing the suitability of ginger rhizomes for particular processing purposes is the fibre content, volatile-oil content and the pungency level.

Processing

Production of dry ginger involves two stages, peeling of the ginger rhizomes to remove the outer skin and sun drying to a safe moisture level. Peeling of fully matured rhizomes is done by scrapping the outer skin with bamboo splits having pointed ends and this accelerates the drying process.The peeled rhizomes are washed before drying. Then ginger is sun dried in a single layer in open yard which takes about 8 to 10 days for complete drying. The sun dried ginger is brown in colour with irregular wrinkled surface and known as unbleached ginger. The yield of dry ginger is about 19-25 % of fresh ginger depending on the variety and climatic zone. 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. Once the ginger is cleaned and it is graded manually based on size of the rhizome, its colour, shape. Fully dried rhizomes can be stored in airtight containers such as high density polyethylene or similar packaging materials. Long term storage for more than two years would result in deterioration of its aroma, flavour and

pungency.

For the production of bleached ginger scrapped fresh ginger may be dipped in a slurry of slaked lime, $Ca(OH)_2$ (1 kg of slaked lime/120 L of water) followed by sun drying. When the water adhering to the rhizomes dry, the ginger is again dipped in the slurry. The process is to be repeated until the rhizomes become uniformly white in colour. Dry ginger can also be bleached by

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. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam are some of the important states cultivating turmeric, of which, Andhra Pradesh alone occupies 38.0% of area and 58.5% of production. During 2014-2015, the country produced 8.30 lakh tonnes of turmeric from an area of 1.84 lakh ha. India exports only 6.48% of its production of turmeric to more than 50 countries mainly as dry produce (63%) and powder (37%). The share of organic turmeric is only 11 per cent compared to conventional turmeric. There is a great demand for organic turmeric in USA, Germany, France and Japan and there is a growing demand for organic spices in the market. Growing demand for natural colours in industry, fast food chains, pharmaceuticals offer a potential scope for organic production of turmeric.

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 20-35oC with an annual rainfall of 1500 mm or more, under rainfed 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 Duggirala, Thekurpeat, Sungandam, Amalapuram, Eroad local, Muvattupuzha, Lackadong etc. Varities tolerant to pest and diseases may be selected in organic farming. Improved turmeric varieties are shown in

Table 1.
Improved varieties

Variety	Mean yield (Fresh) (t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential Oil (%)
ICAR- Indian Institute of Spices Research, Kozhikode						
Suvarna	17.4	200	20.0	4.3	13.5	7.0
Suguna	29.3	190	12.0	7.3	13.5	6.0
Sudarsana	28.8	190	12.0	5.3	15.0	7.0
IISR Prabha	37.5	195	19.5	6.5	15.0	7.0
IISR Prathibha	39.1	188	18.5	6.2	16.2	6.2
IISR Alleppey Supreme	35.4	210	19.3	6.0	16.0	4.0
IISR Kedaram	34.5	210	18.9	5.5	13.6	3.0
IISR Pragati	39.0	180	18.2	5.0	13.6	3.0
TamilNadu Agricultural University, Coimbatore						
Co-1	30.0	285	19.5	3.2	6.7	3.2
BSR-1	30.7	285	20.5	4.2	4.0	3.7
BSR-2	32.7	245	20.0	3.8		
High Altitude Research Station. OUAT, Pottangi, Odisha						
Roma	20.7	250	31.0	9.3	13.2	4.2
Suroma	20.0	255	26.0	9.3	13.1	4.4
Ranga	29.0	250	24.8	6.3	13.5	4.4
Rasmi	31.3	240	23.0	6.4	13.4	4.4
Surangi	23.4	180-200	28.0	4.5-6.5	12.7	4.6
Tirhut College of Agriculture, RAU, Dholi, Bihar						
Rajendra Sonia	42.0	225	18.0	8.4	10.0	5.0

ICAR Research Complex NEH Region, Shillong, Meghalaya						
Mega Turmeric1	23.0	310	16.4	6.8		
Kerala Agricultural University, Trissur						
Kanthi	37.7	240-270	20.2	7.2	8.3	5.2
Shobha	35.9	240-270	19.4	7.4	9.7	4.2
Sona	21.3	240-270	18.9	7.1	10.3	4.2
Varna	21.9	240-270	19.1	7.9	10.8	4.6
Sardarkrushinagar Dantiwada Agricultural University, Jagudan						
Sugandham	15.0	210	23.3	3.1	11.0	2.7

Conversion plan

For certified organic production, at least 18 months the crop should be under organic management ie only the second crop of turmeric 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.

Turmeric as a best component crop in agri-horti and silvi-horti systems, recycling of farm waste can be effectively done when grown with coconut, arecanut, mango, Leucaena, rubber etc. As a mixed crop it can also be grown or rotated with green manure/ legumes crops or trap crops enabling effective nutrient built up and pest or disease control. 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.

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 x 1 x 1m size. Temperature of the area for storing turmeric may be regulated below 25^0C. 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.

Preparation of land and planting

The land is prepared with the receipt of early monsoon showers. 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 for laterite soils and thoroughly 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.

Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 25 cm. Pits are filled with well decomposed cattle manure or compost, seed rhizomes are placed over it then covered with soil. A seed rate of 2,500 kg of rhizomes is required for planting one hectare of turmeric. While planting the seed can be dipped for 15 minutes in PGPR strain GRB 35 or GEB 17 developed by IISR (cfu 10^7) for enhancing growth and suppressing diseases. The optimum spacing in furrows and ridges is 45-60 cm between the rows and 25 cm between the plants.

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. Application of neem cake @ 2 tonnes/ha at the time of planting helps in reducing the incidence of rhizome rot disease/ nematode and increasing the yield 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 to be sprayed @ 5g/litre of water during 60 and 90 days after planting to get 15-25% increase yield.

Schedule	Neem cake	Rock phosphate	Ash	Organic manure
Basal	2 tonnes	250 kg	-	30 tonnes cowdung
After 45 days	-	-	0.5-1tonnes	2 tonnes ver-micompost
After 90 days	-	-	100 kg Sulphate of Potash	2 tonnes ver-micompost

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.

Weeding and irrigation

Weeding has to be done thrice at 60, 90 and 120 days after

planting depending upon weed intensity. In the case of irrigated crop, depending upon the weather and the soil conditions, about 15 to 23 irrigations are to be given in clayey soils and 40 irrigations in sandy loams.

Mixed cropping

Turmeric can be grown as an intercrop in coconut and arecanut plantations. It can also be raised as a mixed crop with chillies, colocasia, onion, brinjal and cereals like maize, ragi, etc.

Plant protection

Use of biopesticides, biocontrol agents, cultural and phytosanitary measures for the management of insect pests and diseases forms the main strategy under organic system. Spraying Neemgold 0.5% or neemoil 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 during January-March. Early varieties mature in 6-8 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.

Preservation of seed rhizome

In order to obtain good germination, the seed rhizomes are to be stored by heaping in well ventilated rooms and covered with turmeric leaves. 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.

Post harvest processing

The harvested turmeric rhizomes before entering into the market is converted into a stable commodity through a number of post harvest processing operations like boiling, drying and polishing. Boiling of turmeric is taken up within 3 or 4 days after harvest. The fingers and bulbs (or mother rhizomes) are separated and are cured separately, since the latter take a little longer to cook. The dry recovery of the different turmeric varieties vary widely ranging from 19 to 23%.

Boiling

Boiling is the first post harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product. In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling. Boiling of turmeric rhizomes is carried out till froth forms and white fumes come out of the pan with a characteristic odour. Boiling is considered complete by pressing a pointed stick in to

the rhizomes with slight pressure. An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential. Overcooking and under cooking are found to affect the quality of the rhizome.

Improved turmeric boiler using steam boiling technique is followed when large quantities of turmeric are to be cured. improved steam boiler for turmeric consists of a trough, inner perforated drums and lid. The outer drum is made of 18 SWG thick mild steel to a size of 122 x 122 x 55 cm. A lid is provided with hooks for easy lifting and also provided with an inspection door. For easy draining and cleaning, an outlet is placed at the bottom of the drum. Four numbers of inner drums of 48 x 48 x 45 cm size are provided in the outer drum. The capacity of four inner drum is 100 kg.

After placing the turmeric boiler on the furnace, about 75 litres of water is added (6-8 cm depth). About 55 - 70 kg of well washed rhizome is taken in each inner drum and placed in the boiler and the lid is placed in position. Using the available agricultural waste materials, the furnace is fired and it takes about 25 minutes to produce steam and boil the initial batch of rhizomes and 10 - 15 minutes for the subsequent batches.

Drying

The cooked fingers are dried in the sun by spreading in 5-7 cm thick layers on the drying floor. A thin layer is not desirable, as the colour of the dried product may be adversely affected. During night time, the material should be heaped or covered. It may take 10-12 days for the rhizome to become completely dry. The bulbs and fingers are dried separately, the former takes more time to dry. Turmeric should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter. Solar tunnel driers

covered by UV stabilized semi-transparent polyfilm sheet of 200 microns thickness can also be used for drying of turmeric.

Polishing and colouring

Dried turmeric has poor appearance and rough dull outer surface with scales and root bits. The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Manual polishing consists of rubbing the dried turmeric fingers on a hard surface. Manual polishing gives rough appearance and dull colour to the dried rhizome. In an improved method, polishing is done by using hand operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against each other as they roll inside the drum. The turmeric is also polished in power operated drums.

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.

Labeling should clearly indicate the organic status of the product as "produce of organic agriculture" or a similar description when the standards requirements are fulfilled. Moreover organic and non-organic products should not be stored and transported together.

Certification and labeling 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. 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 especially when both conventional and organic crops are raised. Group certification programmes are also available for organized group of producers and processors with similar production systems located in geographical proximity.

LIST OF ACREDITED CERTIFICATION BODIES UNDER NPOP

No	Name of the Certification Agency	Address
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 Agecy(INDOCERT)	Thottumugham P.O. Aluva-683 105, Cochin (Kerala) Telefax: 0484-2630908-09/2620943 Email: info@indocert.org

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 - 411058 Tel. 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.: 0135-2760861 Fax: 0135-2760734 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 – 500 050 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 – 641 001 Tamil Nadu Mob. No.: 094432 43119 Tel. No.: 0422-2544199; 0422-6586060 E-mail: iscop_cbe@yahoo.in profdrkkk@yahoo.com Website: www.iscoporganiccertification.org

हर कदम, हर डगर
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