

The Natural Resources of Kerala

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BLACK PEPPER, GINGER AND TURMERIC

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Introduction

The herb spices of importance to Kerala are black pepper, ginger, turmeric, cardamom and vanilla. Of these, the first three will be discussed.

India, emanating from the Malabar coast, has been noted from prehistoric times as the land of spices. Historic evidences are available from about 8th century BC about the travels of merchants from Phoenicia and Greece, and later from Arabia visiting the Malabar coast to do barter trade for buying spice from here. It was the search for a sea route to India for spices trade that led Christopher Columbus in the 15th century to discover the New World, and in 1498 for Vasco de Gama to land in Kozhikode.

Table 1
Area, production and yield of black pepper, ginger and turmeric (world, India, Kerala for 1990-91)

Particulars	World	India	Kerala
Black pepper			
Area ('000 ha)	362.77	173.43	168.51
Production ('000t)	194.74	47.95	46.80
Yield (kg/ha)	537	276	278
India's/Kerala's position in production and share	NA	2 (24.6%)	1 (97.5%)
Ginger			
Area ('000 ha)	NA	53.93	14.33
Production ('000t)	440.67	153.45	46.81
Yield (kg/ha)	NA	2845	3267
India's/Kerala's position in production and share		1 (34.8%)	1 (30.1%)
Turmeric			
Area ('000 ha)	160.8	117.5	2.9
Production ('000t)	414.1	349.0	5.8
Yield (kg/ha)	2575	2970	2000
India's/Kerala's position in production and share	NA	1 (84.3%)	8 (1.5%)

Note: See text for clarification if needed

Source: Directorate of Cocoa, Arecanut and Spices Development, Kozhikode

Area and Production

The area, production and yield of black pepper, ginger and turmeric in India and the World for 1990-91 along with India's

relative position and share of global production are given in Table 1. Also given in the same table, Kerala's position vis-a-vis India.

These crops earn substantial foreign exchange for India. India exports about 40% of its pepper production, 43% of ginger production and 6% of turmeric production. During 1992-93, India's foreign exchange earnings from all the spices was Rs. 393 crores (about 4% of India's export earnings from agricultural products).

In Kerala, pepper is grown throughout the State. Idukki, Wayanad, Kannur and Kozhikode are the important growing districts. Ginger too is grown throughout the State. But, Wayanad accounts for almost 40% of the total production and the other major growing districts are Idukki, Ernakulam and Kottayam. The situation is similar in turmeric also. Ernakulam, Palakkad and Kottayam together cover about 45% of the total area.

Black Pepper

General, botany and agronomy

Black pepper is the most important of all spices. It accounts for about 35% of the global trade in spices. It is a native of the humid tropical forests of Western Ghats. Black pepper belongs to the genus *Piper*, family Piperaceae. More than 2000 species are included in the genus *Piper*, out of which only around 120 occur in India. Sixteen *Piper* species occur in the Western Ghats. They are *Piper argyrophyllum* (2n=52), *P. attenuatum* (2n=52, 104), *P. barberi* (2n=52), *P. betle* (2n=36, 52, 64, 78), *P. galeatum* (2n=52), *P. harnium* (not known), *P. hookeri* (2n=104), *P. hymenophyllum* (2n=104), *P. longum* (2n=24, 26, 48, 52, 96), *P. mullesua* (2n=132), *P. nigrum* (2n=52), *P. schmidtii* (2n=96), *P. silentvalleyensis*, *P. sugandhi* (2n=52), *P. trichostachyon* (2n=52) and *P. wightii* (2n=52).

Black pepper requires a warm, humid, tropical climate having well distributed rainfall of 200-300cm and a temperature ranging from 10-40°C. The plant can be grown from sea level upto an altitude of about 1200 m. Black pepper grows well in humus rich, well drained soils having pH of 4.5-6.0.

Piper nigrum (2n=52) is a perennial, glabrous, woody climber growing upto a height of 15m or above depending on the support it climbs. Under cultivation as a monocrop the height is restricted to about 4-6m giving a column appearance. The branches are dimorphic consisting of the orthotropic, vegetative climbing branches and the plagiotropic fruiting

Table 2
Some popular varieties

Sl. No.	Cultivar	Remarks
1	Aimpiriyan	High yielding, good in quality, performs well at higher elevations, late maturing.
2	Arakkulam munda	Moderate but regular bearer, medium in quality, early maturing.
3	Balankotta	North Kerala variety with large droopy leaves, moderate and irregular bearer, medium quality.
4	Bilimalligesara	Moderate yielder, popular in the Malnad areas of Karnataka.
5	Chengannurkodi	Moderate yielder from South Kerala, medium in quality
6	Cheppakulamundi	Moderate yielder from central Kerala, medium in quality.
7	Cheriyakaniakadan	Popular in North Kerala, moderate and early bearing
8	Jeerakamundi	Small leaves and short spikes, alternate bearing
9	Kalluvally	From North Kerala, good yielder, having alternate bearing tendency, medium in quality with high dry recovery.
10	Karimunda	Most popular variety, suitable for most of the growing areas, high yielder and medium in quality.
11	Karimalligesara	A popular, good yielder in the Malnad areas of Karnataka.
12	Kottan	A North Kerala variety, moderate in yield and medium in quality.
13	Kottanadan	A high yielding variety from South Kerala, medium in quality.
14	Kurimalai	A Karnataka variety, moderate yielder with medium quality.
15	Kuthiravally	Possess long spikes, high yield and good quality.
16	Kuttianikodi	A moderate yielder from central Kerala with relatively long spikes and good spiking intensity.
17	Malamundi	A moderate yielder, medium in quality.
18	Manjamundi	A moderate yielder from North Kerala, medium in quality
19	Narayakodi	Popular in South Kerala, moderate yielder with medium quality.
20	Neelamundi	A good yielder from central Kerala medium in quality. Popular in Idukki district.
21	Nedumchola	Have small leaves and short spikes, moderate yielder.
22	Neyyattinkaramundi	From Central Kerala, medium in quality and yield.
23	Perambramunda	From North Kerala, moderate yielder with medium quality.

Sl. No.	Cultivar	Remarks
24	Perumkodi	From central Kerala, moderate in yield and quality.
25	Poonjaranmunda	From central Kerala, sporadically found in gardens of north Kerala, moderately good in yield and quality.
26	Tommarkodi	From central Kerala, medium in yield and quality.
27	Thulamundi	From central Kerala, medium in yield and quality.
28	Uddaler	A common variety in the Malnad area of Karnataka, good yielder.
29	Vadakkan	From North Kerala, medium in quality and yield with relatively large berries; a triploid. (3n=78)
30	Valiyakaniyakadan	Have large leaves, medium in yield and quality.
31	Vattamundi	A moderate yielder from central Kerala.
32	Vellanamban	Relatively moderate yielder and medium in quality characterised by the white colour of the young shoot tip.

branches. Two more types of shoots, namely, runner shoots (which is generally used for planting) and hanging shoots (usually removed and discarded) are also seen in black pepper. The internodes are 5-12 cm long. At each swollen node there is a leaf, an axillary bud which can grow out to give a plagiotropic fruiting branch or lateral and short adventitious roots which adhere firmly to the support. Leaves are alternate, simple and may be dimorphic. Lamina may be ovate, cordate, elliptical or lanceolate. The lateral flowering branch exhibits sympodial growth, the apical buds get converted into a spike and growth continues by developing axillary buds. Flowers are small, sessile and arranged on a fleshy, pendant spike. Each flower consists of an ovary and two stamens. The fruit is a drupe, but is commonly called berry.

Black pepper is mostly dioecious in its wild state while most of the cultivated types are bisexual. Cultivated black pepper is self pollinated, the mode being geitonogamy, aided by rain water or dew drops.

The vine is usually trailed on living standards like *Erythrina* sp., *Grevillea robusta*, *Ailanthus* sp., *Garuga pinnata* or dead standards such as concrete posts, earthen tubes, etc. under monocropping system. Black pepper is also trained on coconut, arecanut, jack, mango etc. as supports.

The supports are planted in pits (50cm³) with the onset of monsoon at a distance of 2.5 or 3.0m². Two-three pepper cuttings are planted in the pits filled with top soil and compost on

the north-eastern side of the support. In homesteads, the planting is usually done on existing supports during June-July months.

Shade regulation is very important for black pepper. The branches of the supports/shade trees are regulated twice in a year, once before the onset of monsoon and then after the rains.

Black pepper needs nutrients for better growth and yield. One kg neem cake, 250 g bone meal and 70 g Mussoorie rock phosphate are applied in the pits. A fertilizer dose, of 100:40:140g NPK/vine is also recommended from the 3rd year, annually in addition to 10kg compost/FYM per vine. During the first and second year of planting one-third and two-thirds of the above NPK dose are recommended. The fertilizers are given in two equal split doses. Once a year lime @ 1kg/vine may be applied 15 days before applying the fertilizers. Adequate mulching with green leaves/organic matter should be given towards the end of north-east monsoon. It is very important to avoid any sort of tillage operations around the vine.

Cultivar/variety diversity

Varietal diversity is one of the principal components of

diversity in black pepper. Over 100 black pepper varieties have been collected. They differ in leaf size, shape, spike length, fruit size and many other morphological and biochemical features. They are generally named after a specific feature of the vine such as colour or appearance of the plant (eg: Karimunda, Vellanamban) leaf shape (eg: 'Vattamundi') spike character (eg: 'Kuthiravally', 'Aimpiriyan') or place of origin ('Arakkulam munda', 'Perambra munda', Poonjaran munda') or after a person who has introduced a cultivar into a particular tract (eg: 'Yohannankodi', 'Thommankodi') etc. (Usually the words 'munda', 'mundi', or 'vally', all meaning vine, are suffixed with other words denoting the feature of the vine, shape of the leaf, name of a place or person).

The most popular varieties grown in Kerala are given in Table 2.

A few exotic varieties have been introduced. They are being maintained at the Indian Institute of Spices Research (IISR), Kozhikode.

Improved varieties So far 10 improved varieties have been released (Table 3).

Table 3
Improved varieties and their salient features

Name	Pedigree	Released from	Average yield kg/ha (dry)	Oleoresin (%)	Piperine (%)	E. oil (%)	Remark
Panniyur-1	F ₁ of Uthirankotta x Cheriakaniyakadan	Pepper Research Station Kerala Agri. University Panniyur	1242.0	11.8	5.3	3.5	Suited to all growing regions, does not tolerate heavy shade
Panniyur-2	Open pollinated progeny of Balankotta	"	2570.0	10.9	6.6	3.4	Suited to all pepper growing tracts of Kerala, appreciably tolerant to shade
Panniyur-3	F ₁ of Uthirankotta x Cheriakaniyakadan	"	1953.0	12.7	5.2	3.1	Suited to all pepper growing regions of Kerala, late maturing.
Panniyur-4	Clonal selection from Kuthiravally	"	1277.0	9.2	4.4	2.1	Suited to all pepper growing tracts of Kerala, performs well under adverse climatic conditions.
Panniyur-5	Open pollinated progeny of Perumkodi	"	1098.0	12.33	5.5	3.8	Suited to all pepper growing tracts, tolerant to nursery diseases.
Subhakara	Clonal selection from Karimunda	Indian Institute of Spices Research Kozhikode	2352.0	12.4	3.4	5.0	Suited to all pepper growing tracts of Kerala and South Karnataka.
Sreekara Panchami	"	"	2677.0	13.0	5.1	7.0	"
	Clonal selection from Aimpiriyan	"	2828.0	12.5	4.7	3.4	"
Pournami	Clonal selection from Ottaplackal	"	2333.0	13.8	4.1	3.4	Suited to all pepper growing tracts of Kerala and South Karnataka. Tolerant to root knot nematode infestation
PLD2	Clonal selection from Kottanadan	Central Plantation Crops Research Institute, Regional Station, Palode	2475.0	15.5	3.3	3.5	Recommended for release in Kollam and Thiruvananthapuram districts, Kerala

Post-harvest technology

Pepper is valued as a flavouring especially in the Western cuisine. This quality is contributed by the various essential oils present and also the piperine content. Varieties show good variations for these traits (Table 4).

Table 4

Composition of some important varieties (dry weight basis)

Sl. No.	Cultivar	Volatile oil% (w/w)	Oleoresin % (w/w)	Piperine % (w/w)	Starch % (w/w)
1	Arikottanadan	4.75	12.90	4.50	24.66
2	Arakkulamunda	4.75	9.84	4.40	36.18
3	Balankotta	5.12	9.35	4.26	25.20
4	Ceylon	3.75	13.50	7.60	15.66
5	Cheriyakaniakadan	3.75	9.05	3.95	24.84
6	Chumala	2.25	5.45	3.30	46.62
7	Doddigya	2.50	7.10	2.85	36.00
8	Kalluvally	3.25	8.80	4.24	31.50
9	Kalluvally (PTB)	0.40	10.90	4.65	29.00
10	Kalluvally Type-1	3.00	8.44	5.40	20.70
11	Kaniakadan	4.75	11.60	6.00	12.42
12	Kottanadan	2.50	17.80	6.60	23.40
13	Karimunda	4.00	11.00	4.40	39.60
14	Karuvilanchy	3.50	9.70	4.30	27.00
15	Kumbhakodi	4.50	14.90	7.60	18.20
16	Kuthiravally	4.50	14.90	5.97	14.04
17	Munda	4.75	7.00	5.60	22.70
18	Mundi	3.50	7.50	3.60	23.40
19	Narayakodi	4.00	10.85	5.40	24.50
20	Nilgiris	5.50	15.50	6.05	23.60
21	Palulauta	3.00	7.60	3.60	19.26
22	Panniyur-1	3.50	9.52	3.60	35.10
23	Perumkodi	3.00	8.60	4.00	28.80
24	Perumunda	4.00	8.00	7.40	26.64
25	Shimoga	2.50	7.20	4.56	17.64
26	Sullia	4.00	6.80	3.60	20.70
27	TMB II	2.50	10.80	5.80	32.60
28	Uthirankotta	4.75	8.65	3.92	28.80
29	Vally	2.50	6.53	4.90	16.02
30	Aimpiriyan	2.63	15.70	4.69	-
31	Udhakara	3.82	8.61	2.36	-
32	Thommankodi	5.98	13.77	2.77	-
33	Sreckara	7.00	13.00	5.10	-
34	Subhakara	6.00	12.40	3.40	-
35	Panchami	3.40	12.50	4.70	-
36	Pournami	3.35	13.80	4.10	-

Black pepper of commerce

Black pepper comes to harvest during December-February in the plains and January-April in the hills. Spikes with one or two ripe berries are harvested. Berries are separated from the spike either manually or mechanically and sun-dried for 7-10 days. The berries then give a characteristic shiny, wrinkled, black appearance of the black pepper of commerce. Blanching is another new technique for making premium quality black pepper. In this method despiked berries are cleaned by winnowing and they are collected in a bamboo basket and dipped in boiling water for 1 min. The berries are then spread out for sun-drying. Properly dried black pepper contains 10-11% moisture and dry recovery varies from 25-35% depending upon the varieties.

White Pepper

In the world market, about one fourth of the total produce is sold as white pepper. Indonesia, Malaysia and Brazil are the major producers of this commodity. White pepper is usually produced by removing the outer skin of fully ripe berries by retting in water, steaming or boiling.

Canned and dehydrated green pepper

Natural green pepper has good demand in some countries as a garnishing spice in salads. Madagascar is the leading producer of this item. Recently, India too has entered the trade.

Dehydrated pepper is made from fruits harvested before attaining full maturity (about 2 months earlier). They are dehydrated by freeze drying so that the product retains the green colour. Canned pepper is heat sterilized green pepper (harvested about 2 months prior to full maturity) packed in cans containing 2% solution of salt. In bottling technique the heat sterilization part is avoided and instead the berries are packed in 15-20% salt solutions in the bottle.

Flavouring and pungent principles

They include volatile oils and non-volatile pungent principles, mainly, piperine. The pepper oil is separated by hydrosteam distillation whereas the pungent principle can be extracted effectively by using organic solvents such as ethylene dichloride, ethyl acetate etc. Extraction of pepper with such organic solvents yields a product containing the volatile and non-volatile principle, oleoresin. Thus the quality of black pepper rests on its piperine, oleoresin and essential oil contents.

The pungency is mainly due to piperine. Piperine content of dried black pepper varies from 3-8%. Piperine is an amide of piperic acid and piperidine. Piperine also contains small quantities of chavicine, piperidine and piperettine which together give the sharp bite and pungency.

The aroma of black pepper is constituted by the essential oil present in the spice. The essential oil content of black pepper varies from 2-6%. In general, the major constituents of es-

sential oil are monoterpene hydrocarbons, sesquiterpene hydrocarbons and oxygenated compounds belonging to acids, esters, aldehydes, ketones, alcohols and oxides. Black pepper oil is almost a watery white or pale greenish grey mobile liquid which becomes viscous on ageing.

Oleoresin combines the aroma, pungency and the characteristic taste of black pepper and contains volatile oil and piperine. In dry fruits the oleoresin content varies from 7-17%. The pepper oleoresin when freshly prepared is a dark green, viscous, heavy liquid with a strong aroma, and on standing crystals of piperine appear.

Generally white pepper contains slightly lower quantities of these flavouring principles.

New product development and product diversification

R&D efforts are underway to develop more value added products. Some of them are micro encapsulated oil and oleoresin, super critical extracts of oil and oleoresin, spice drops, sauces, and so on.

Grades and grading

The price of black pepper is decided according to the general appearance of the produce, percentage of moisture, presence of light berries, pin heads, etc. In India, 21 'Agmark' grades under 8 groups are recognized. They are (1) Garbled Malabar black pepper (MG grade 1 and MG grade 2) (2) Ungarbled Malabar black pepper (MUG-1, MUG-2, MUG-3 and MUG-4) (3) Garbled light black pepper (GL Grade special, GL grade 1, GL grade 2 and GL grade 3) (4) Ungarbled Light Black Pepper (UGL grade 1, UGL grade 2) (5) Pin heads (PH grade special and PH grade 1) (6) Non-specified black pepper (NS grade), (7) Tellichery garbled (TGSB, TGEB and TG) and (8) Black pepper ground (standard and general).

Plant protection

Black pepper is affected by a number of diseases and pests, both insects and nematodes. Some of them are serious and cause not only loss of crop, but also plants and even entire plantations.

The chief nursery diseases are leaf rot and blight (*Rhizoctonia solanii*) and Phytophthora wilt (*Phytophthora capsici*). They are controlled by spraying with Bordeaux mixture.

In the field, the quick wilt and slow wilt are very serious problems. They can and have caused loss of entire plantations. While quick wilt is caused by the fungus *Phytophthora capsici*, slow wilt is caused by a combination of this fungus (*P. capsici*) and the nematodes *Rhadopholus similis* and/or *Melioidogyne incognita*.

Quick wilt is most severe during the south-west monsoon. The collar, leaves and roots are infected, the leaves and spikes are shed, and in severe cases, the vines wilt and ultimately die.

In slow wilt, in addition to the above, the roots are infected by the nematodes, leading to their decay, foliar yellowing, and finally wilting and slow death of vines.

For controlling the fungus, foliar spraying with Bordeaux mixture and basin drenching with copper oxychloride are practised. For controlling the nematodes, soil application of phorate 10g or carbofuran is done.

Some of the other diseases are pollu disease, leaf spot, stunted disease, and phyllody.

A number of pests also infect black pepper. They are pollu disease (*Longitarsus nigripennis*), thrips (*Liothrips karnyi*), scale insects (*Lepidosaphes piperis*, *Aspidiotus destructor*), and mealy bugs (*Ferisia virgata*).

Pollu beetle is the most important pest. The adults feed the growing shoots, leaves and spikes, the grubs bore into the berries making them hollow. It is more severe in midlands and plains. It is controlled by two sprayings of endosulphan or quinalphos, twice a year. The other pests are controlled by spraying with monocrotophos or dimethoate.

For effective plant protection, one of the best acts is good management of the gardens, timely weeding, organic manure application, phytosanitation (removing dead leaves, branches, proper training of vines), regulated shade, and if threat is perceived, prophylactic sprayings.

Sometimes, the two nematodes the burrowing nematode (*Radopholus similis*) and the root knot nematode (*Melioidogyne incognita*) also affect the pepper vines. Heavy infestations will be difficult to control, but normally, upto two soil application of carbofuran or phorate will control them.

Ginger

General, botany and agronomy

Ginger (*Zingiber officinale* Rose.: Zingiberaceae. 2n=22) is one of the important spices used all over the world. Ginger of commerce is the dried rhizome. Ginger has probably originated in the South Asia. The word Zingiber is probably derived from the Tamil word 'ingiver', meaning ginger rhizome. The Indo-Malayan region is a major centre of diversity of cultivated ginger. At present ginger is cultivated in almost all the tropical countries, notably in India, Taiwan, China, Philippines, Sierra Leone, Singapore, Jamaica, Fiji and Nigeria. India produces about 1,48,520 t ginger annually from about 53,300 ha and ranks first in production and export. Ginger is cultivated in almost all states in India. Kerala with 14,040 ha and production of 44,500 t ranks first in India in ginger production. Other major producing States are Orissa, Meghalaya, Himachal Pradesh, and Karnataka.

Ginger is a monocotyledonous, slender, perennial herb, but is grown as an annual crop. It grows 30-100cm tall with a robust branched rhizome (stem), borne horizontally near the surface of the soil, and bearing leafy shoots above ground. The shoots, leaves and stem emit pleasant aroma. The fleshy, sympodial

rhizome is hard, thick, somewhat laterally compressed and usually pale yellow or buff in colour. Rhizomes have nodes and internodes and the nodes have scale leaves.

Ginger inflorescence is a spike arising directly from the rhizome. It is 15-25cm long, cylindrical and fleshy. The bracts are appressed, ovate or elliptical, 2-3cm long and 1.5-2.0cm wide, one or two flowers are produced from the axils of each bract. Ginger doesn't set seed.

The genus *Zingiber* includes about 85 species occurring in South, South-east and East Asia. Eight species have been reported from Kerala. They are *Zingiber roseum* Rosc., *Z. nimmonii* Dalz., *Z. wightianum* Thev., *Z. zerumbet* (L.) Smith, *Z. neesamum* (Graham) Ramamoorthy (Syn. *Z. macrostachyum* Dalz.), *Z. cernuum* Dalz., *Z. purpureum* Rosc. (Syn. *Z. castumunmar* Dalz.) and *Z. officinale* Rosc.

All the *Zingiber* species have the same somatic chromosome number ($2n=22$). Apart from the cultivated ginger, some other species as *Z. zerumbet* and *Z. castumunmar* are valuable as medicinal plants.

Ginger grows well in a warm and humid climate and also in the subtropics. The crop is cultivated upto an altitude of 1500m above msl. The best elevation for its cultivation is 300-900m. Acidic to neutral soils rich in organic matter with good drainage and aeration are ideal for ginger cultivation.

About 1200-1800 kg/ha seed rhizome is recommended for planting. Individual planting units may be bits of 15-20g weight. The seed rhizomes are treated with a copper fungicide, followed by malathion (0.05%) before planting. Ginger is conventionally planted in raised beds of convenient length and 1m width. The optimum spacing is 20-25 x 15cm. A bed of 3x1m accommodates 40 plants. One hectare can accommodate about 110 Nos of 3x1m beds.

A basal dressing of 25-30 t FYM and 75:50:50kg/ha NPK fertilizers are recommended for this crop. Whole of P and half of K are applied at the time of planting. Half of N is applied 40 days after planting and the rest N and K_2O three months thereafter. Application of neem cake @ 2 t/ha as basal dose is also beneficial. Ginger needs heavy mulching. The first mulching is to be done at the time of planting with green leaves @ 12.5 t/ha and second mulching 45 days after planting with green leaves @ 5 t/ha. Hand weeding and earthing up of the beds must be done at least twice.

Ginger is usually planted during April-May after the first rains. It can be raised either as a monocrop or as an intercrop in coconut gardens or young rubber plantations, or along with banana or pineapple.

The average yield of ginger is 15-30 t/ha (fresh). Dry ginger recovery ranges 15-25%.

Variability

Several varieties are grown in the country including a few introduced ones. The important indigenous types are Ernad-cherad, Himachal, Maran, Karakkal, Kuruppampadi, Wayanad local, Sawthing laidum, Assam, Nadia, Bajpai, Nasarapattam, Zahirabad etc. All of them are noted for their high fresh yield and/or dry recovery. Among the introduced types, Rio-de-Janeiro, China and Jamaica are popular in Kerala. Till date, 5 improved cultivars have been released (Table 5).

Though 'Suprabha', Suruchi, and 'Suravi' are recommended for Orissa 'Suprabha' performs well in Kerala as well. 'IISR Varada' performs very well throughout Kerala.

Plant protection

The crop is infected by a number of diseases and pests, both insects and nematodes. The important diseases are soft

Table 5
Improved cultivars and their salient features

Variety	Pedigree	Released from	Average yield (fresh) t/ha	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	E. oil (%)
Suprabha	Clonal selection from 'Kunduli local'	High Altitude Research Station (Orissa University of Agriculture & Tech.) Pottangi, Orissa	16.6	229	20.5	4.4	8.9	1.9
Suruchi	"	-do-	11.6	218	23.5	3.8	10.0	2.0
Suravi	Induced mutant of 'Rudrapur local'	-do-	17.5	225	23.0	4.0	10.2	2.1
IISR Varada	Germplasm selection	Indian Institute of Spices Research, Kozhikode	22.6	200	19.5	3.29-4.5	6.73	1.75
Himagrini	Clonal selection	Dr. YS Parmar University of Horticulture & Forestry, Solan, HP	13-14	230	20.62	6.05	4.29	1.63

rot or rhizome rot (*Pythium* spp., mainly *P. aphanidermatum*), bacterial wilt (*Pseudomonas solanacearum*), leaf spot (*Phyllosticta zingiberi*) and storage rots.

Of these, rhizome rot is a serious disease. It begins with yellowing of leaves, infection and softening of the collar region, leading to rotting of roots and rhizomes. Use of disease free seed rhizomes and pretreatment of planting beds with mancozeb will reduce or even prevent infection.

Here also, following clean cultivation practices will help to prevent or at least reduce disease incidence.

The important insect pests are shoot borer (*Conogethes punctiferalis*) rhizome scale (*Aspidiella hartii*) and leaf roller (*Udaspes folus*).

If the crop is grown in nematode infested fields, or if seed material has been brought from infected areas, the ginger crop gets affected by the root knot nematode (*Meloidogyne incognita*) and/or the burrowing nematode (*Radopholus similis*).

Post-harvest technology

Products Dry ginger is the traditional ginger of commerce. The commodity is however, traded in a variety of forms around the world. Some of them are:

- (i) **Raw ginger** The fresh harvest; used for flavouring food.
- (ii) **Dry ginger** Prepared by peeling off partially the outer skin of raw ginger and then sun drying for 10-12 days to a moisture level of 10%.
- (iii) **Bleached dry ginger** Prepared by dipping dry ginger in 2% fresh slaked lime solution followed by sun drying.
- (iv) **Ginger powder** Pulverized dry ginger to a mesh size of 50-60.
- (v) **Ginger oil** Obtained by steam distillation of dry ginger powder or fresh ginger; contains 1.25-2.5% oil, a sesquiterpene; zingiberane is the principal constituent of the oil, others are β sesquiphellandrene and citral.
- (vi) **Ginger oleoresin** Acetone, alcohol or ethylene dichloride extract of dry/fresh ginger; yield varies from 4-6%; gingerol is the main constituent.
- (vii) **Gingerale** Used as a soft drink or soft drink additive; prepared from dry ginger syrup by fermenting and/or adding sugar.
- (viii) **Ginger candy** Raw ginger pieces in sugar syrup.
- (ix) **Ginger beer** Syrup of dry ginger and hops in hot water enriched with sugar, cooled and fermented with yeast; citric acid is added and kept for few days; the supernatant is taken out, sealed in bottles and marketed.
- (x) **Brine ginger** Fresh ginger in salt solution.
- (xi) **Ginger wine** A combination of ginger, sugar, chillies and water fermented and added charred sugar and citric acid.
- (xii) **Ginger squash** Squash prepared from equal volume of ginger juice and lime juice.
- (xiii) **Salted ginger** Prepared from fresh ginger (harvested at 4-5 months stage) having very low fibre, harvested ginger is soaked in citric acid and common salt for 14 days maintaining pH of 2.5-2.8 and 18-20 specific gravity; the skin is removed after 14 days and packed for using as salted ginger; has attractive baby pink colour, good flavour and tender nature.

More than 100 items are made with ginger in various countries. Imaginative product development can help in promoting ginger production. Ginger bread, ginger cake, ginger biscuit, ginger tea, ginger vinegar, etc. are all such value added products.

Grades AGMARK regulation recognizes 17 grades of ginger and ginger powder depending on size of the rhizome, colour, smell, pungency, calcium content, contamination rate, etc.

Turmeric

General, botany and agronomy

Turmeric (*Curcuma longa* L.; Syn. *C. domestica*. Family Zingiberaceae; $2n=3x=63$ chromosomes) is an ancient and sacred spice of India. It is used as spice, dye and in cosmetics in addition to its use in several religious ceremonies. India produces about 3,90,000 t turmeric from about 12,400 ha. Andhra Pradesh, Tamil Nadu, Karnataka, Orissa and Kerala are the leading growing states in India.

India is believed to be the home of turmeric. From here, it would have spread to Far East and Polynesian Islands under the influence of Hinduism.

The genus *Curcuma* is Indo-Malayan in distribution. It includes about 100 rhizomatous herb species. About 25 species are known from Kerala and adjoining areas.

In addition to *C. longa* (turmeric), the following are some important species.

- (i) *C. amada* (mango ginger): cultivated to a limited extent for its mango-flavoured rhizomes, it is used as vegetable and in making chutneys and pickles.
- (ii) *C. angustifolia* (Indian arrow root): occurs wild in many parts of India, the rhizome is a source of starch.

- (iii) *C. zedoaria*: occurs in wild; also occasionally cultivated; starch is extracted from rhizome; also used in toiletry and native medicine.
- (iv) *C. aromatica*: cultivated to a limited extent; used in native medicine and also extensively in toiletry items.
- (v) *C. decipiens* (kuzhikuva): used for making starch.

Turmeric is an erect, perennial herb, but grown as an annual crop. The plant consists of a leafy aerial shoot and underground rhizome with primary, secondary and occasionally tertiary fingers and the whole forming a compact clump. Rhizomes grow sympodially and are orange brown, pale yellow or reddish yellow in colour. The leafy shoots are 0.75-1 m in height and bear 6-10 long single leaves with the leaf sheath forming a pseudostem. Inflorescence is a spike. One or two flowers arise from only the axils of the lower bracts. It is a naturally cross pollinated plant. Seed setting is low and seeds are viable.

Turmeric prefers a warm, humid climate having a rainfall of about 1500 mm and temperature of 20-30°C. It grows from almost sea level to 1200 m above msl in well drained sandy, clayey loam or red loamy soils.

Whole or split mother rhizome or finger rhizomes are used for planting. The seed rate is 2500 kg/ha. The seeds are treated with a copper fungicide and insecticide before storage and also during planting time. Turmeric is planted in raised beds of 1 m width and convenient length or in ridges and furrows at a spacing of 30x25 cm. Turmeric needs manuring and mulching. A basal dose of FYM @ 40 t/ha may be incorporated at the time of land preparation. Further, a fertilizer dose of 60:50:120 kg NPK/ha is to be applied. The entire dose of K_2O and half of P_2O_5 are applied as basal dose. Half the N is given about 45 days after planting and the other half with the remaining dose of P_2O_5 is given 3 months after planting. The beds are earthed up after each fertilizer application.

The crop is mulched after planting with green leaves @ 12-15 t/ha. This is repeated a second time with the same quantity of green leaves after the second fertilizer application.

Turmeric comes up well under sparse shade also. It can be grown as intercrop in coconut gardens or as mixed crop with red grams, chillies, colocasia, vegetables and cereals like maize, ragi, etc. It can be grown as a rainfed crop or an irrigated crop depending on location. In case of irrigated crop, depending on weather and soil conditions, 15-40 irrigations may be necessary at intervals of 7-10 days. The crop takes 7-9 months for reaching maturity. Average yield of fresh rhizomes under good management is 25-30 t/ha.

Variety diversity

The crop shows moderate degree of variability. About 60 varieties have been so far collected from the country. Some of the important ones are 'Duggirala', 'Tekurpet', 'Sugandham', 'Amalapuram', 'Alleppey', 'Rajapuri', 'Mydukku' and Wayanad local. Based on maturity group, the varieties are

classified as short duration (7 months eg. Kasturi) medium duration (8 months eg. Kothapeta) and long duration (9 months eg. Duggirala, Tekurpet, Mydukku, Armoor). Varieties like Edapalayam, Thodupuzha, Wayanad local and Sugandham, are rich in curcumin, which is the most important single ingredient of turmeric.

Various research institutions, all of them working under the All India Co-ordinated Spices Improvement Project of ICAR, have so far released 14 cultivars (Table 6).

Plant protection

Compared to black pepper and ginger turmeric is infected by only a lower number of diseases and pests.

The important diseases are rhizome rot (*Pythium aphanidermatum*, *P. graminicolum*), leaf spot (*Colletotrichum capsici*), and storage rot (*Sclerotium rolfsii*).

Treating the rhizomes with mancozeb and use of healthy disease free seed material will help prevent infection.

Shoot borer (*Conogetus punctiferalis*) and rhizome scale (*Aspidiella hartii*) also infect turmeric, but they are not very important.

Post-harvest technology

Processing and grading Harvested turmeric is washed to remove the adhering soil, the fingers are separated and cooked in boiling water for 40-60 min under slight alkaline condition (100g of sodium bicarbonate or sodium carbonate in 100 l water). They are sun-dried for 10-15 days. For boiling turmeric, copper galvanized iron or earthen vessels are used usually. The dry turmeric recovery is 15-30% depending on dry matter content of varieties, which is influenced by variety, location, cultural practices etc. The dried product is polished manually by rubbing them on concrete flooring or mechanically in power-operated drum. Turmeric powder is added to the drum as powder or emulsion for giving bright colour to the product.

Cured turmeric is sorted as 'finger', 'round', 'split', etc. and marked under its varietal/trade name such as 'Alleppey', 'Erode', 'Duggirala', 'Nizamabad', 'Rajapuri', 'Cuddapah', etc.

Powder is pulverised dry fingers to a very fine powder.

Oil is obtained by steam distillation of turmeric powder.

Turmeric contains 3-5% volatile oil. It is an orange yellow liquid with peppery and aromatic odour. But it is not put to any use currently.

Oleoresin is obtained by solvent extraction of ground turmeric. Content varies from 7-15%. Curcumin is obtained by solvent extraction of powder or whole turmeric. It ranges from 2-10%.

Grades Depending on the colour of the rhizomes, hardness and smoothness of the cured rhizomes, pungency, aroma and moisture content, four grades are recognized, 'special', 'good', 'fair' and 'NS'.

Table 6
Improved varieties (cultivars) and salient features

Name	Origin	Released by	av. yield (fresh) t/ha	Duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	E. oil (%)	Remark (%)
Krishna	Clonal selection from Tekurpet	MAU, Kasha Digraj	9.2	240	16.4	2.8	3.8	2.0	Suitable for Maharashtra. Tolerant to major pests.
Sugandham	Germplasm selection	GAU, Jagudan	15.0	210	23.3	3.1	11.0	2.7	Suitable for Gujarat. Tolerant to pests.
BSR-1	Mutant of Erode local	TNAU, Coimbatore	30.7	285	20.5	4.2	4.0	3.7	Suitable for drought prone areas and problem soils of Tamil Nadu
CO-1	Mutant of Erode local	TNAU, Coimbatore	30.5	285	19.5	3.2	6.7	3.7	Suitable for Tamil Nadu Tolerant to drought
BSR-2		TNAU Coimbatore	Not available						
Suvarana (PCT-8)	Germplasm selection	IISR, Kozhikode	17.4	200	20.0	4.3	13.5	7.0	Suitable for Kerala Karnataka & Andhra Pradesh
Suguna (PCT-13)	A germplasm selection	-do-	29.3	190	12.0	7.3*	13.5	6.0	Suitable for Kerala, Andhra Pradesh; short duration variety
Sudarsana (PCT-14)	-do-	-do-	28.8	190	12.0	5.3*	15.0	7.0	-do-
IISR prabha	Open pollinated progeny selection	-do-	37.47	205	19.5	6.52	15.0	6.5	Suitable for Kerala & Tamil Nadu. High curcumin type
IISR Prathibha	-do-	-do-	39.12	225	18.5	6.21	16.2	6.2	-do-
Roma (PTS-10)	Clonal selection	OUAT, Pottangi, Orissa	20.7	250	31.0	9.3*	13.2	4.2	Suitable for Orissa, Tamil Nadu, Himachal Pradesh, Andhra Pradesh & Kerala
Suroma (PTS-24)	-do-	-do-	20.0	253.0	26.0	9.3	13.1	4.4	Suitable for Orissa, Tamil Nadu & Himachal Pradesh
Rasmi (PTS-9)	Germ plasm selection	-do-	31.3	240	23.0	6.4	13.4	4.4	Suited to Orissa, Tamil Nadu, Andhra pradesh & Kerala
Rajendra Sonia (RH-10)	Germplasm selection	RAU Dholi, Bihar	4.8	225	18.0	8.4		5.0	Suited to North Bihar

Turmeric powder is also graded on the basis of moisture content, total ash, acid insoluble ash, lead content (ppm), starch and chromate test.

Product diversification

Turmeric oil should prove useful in perfumes and medicine. At present, efforts are being made to diversify the use of turmeric oil. Another important area of diversification is in pickle making.

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