



Original Article

Cultivation Scenario of Turmeric in India

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ABSTRACT

Turmeric has two species, which are cultivated in India. *Curcuma longa* is the most important economically accounting for about 96 per cent of the total area under turmeric and the remaining 4 per cent is under *Curcuma aromatica* grown in some small district of Andhra Pradesh and Tamil Nadu. India being one of the major producers of turmeric, contributes 90% to global production. In the year 2018-19, turmeric production was 389 thousand tonnes, with area and productivity 246 thousand hectares and 5646.34 kg/ha, respectively. The growth pattern of the area, production, and productivity of turmeric over the period of time indicate the growing contribution of production over the area expansion to the increased yield. In the international market, India is a net exporter of turmeric and earned 201,152 thousand US Dollars in 2020. In India, turmeric is cultivated in the states of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka. Turmeric production in the states of Andhra Pradesh and Tamil Nadu jointly account for 76 per cent of the total turmeric production in India. Curcumin is the active ingredient in turmeric, which has been shown to have a wide range of therapeutic effects. Turmeric requires hot and humid climate to thrive well and it generally grows on all type of soils but it thrives well in drained sandy loam to light black or red soils that are clayey in nature. Turmeric is second in export earnings of spices in India. Turmeric is exported to many countries particularly Bangladesh, Iran, Japan, Pakistan, South Africa, Sri Lanka, the USA, the UK and the UAE.

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INTRODUCTION

Turmeric (*Curcuma longa*), a flowering plant in the Zingiberaceae family, is widely used as a food coloring and is one of the principal ingredients in curry powder. Turmeric has long been used in both Ayurvedic and Chinese medicine as an anti-inflammatory, to treat digestive disorders and liver problems, and for the treatment of skin diseases and wound healing. The active ingredient in turmeric is curcumin, which has been the subject of numerous animal studies but as of yet, very few studies on people demonstrating various medicinal properties. Curcumin has been shown, for example, to stimulate the production of bile and to facilitate the emptying of the gallbladder. It has also demonstrated in animals a protective effect on the liver, anti-tumor action, and ability to reduce inflammation and fight certain infections. Turmeric (*Curcuma longa*) is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae, which is native to tropical South Asia. It needs temperatures between 20 and 30°C, and a considerable amount of annual rainfall to thrive. Plants are gathered annually for their rhizomes, and re-seeded from some of those rhizomes in the following season. *Curcuma longa* is the most important economically accounting for about 96% of the total area under turmeric and the remaining 4% is under *C. aromatica* grown in some small district of Andhra Pradesh and Tamilnadu. Turmeric is also used to give a yellow color to some prepared mustards. Turmeric's highest production is in India. Approximately 90% of world's total production is in India. India is the largest producer and exporter of turmeric in the world market. Turmeric production in India was 793.0 thousand tonnes with an area of 181.0 thousand hectares under its cultivation during the year 2009-10. In India, turmeric is cultivated in the states of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka. Turmeric production in the states of Andhra Pradesh and Tamil Nadu jointly account for 76 per cent of the total turmeric production in India. It may be concluded that the area, production and yield of turmeric in India fluctuated during the given period. The variations in price of turmeric and diseases besetting its cultivation were the main reasons for these fluctuations.

Export of Turmeric

Turmeric is second in export earnings of spices in India. It fetched Rs 4473.75 lakh as export earnings during April-June 2007. Turmeric is exported to many countries particularly Bangladesh, Iran, Japan, Pakistan, South Africa, Sri Lanka, the USA, the UK and the UAE. The share of turmeric in total spices exports was 18.9 per cent during the year 2000-01. Later, it decreased to 13.7 per cent during 2006-07. The export value of turmeric in total value of spices was higher (6.67%) during the year 2003-04. The reason for the variation in value was the fluctuation in price of turmeric in the world market. Still, India occupies a dominant position in turmeric export. If the government of India

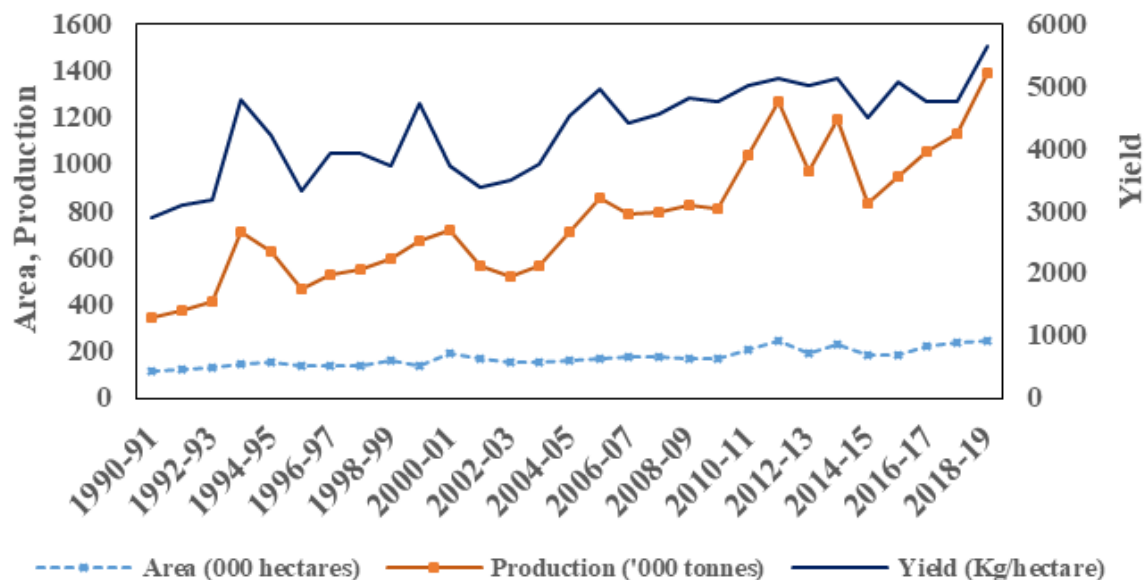
frames suitable policies to increase turmeric exports, no doubt, our nation will lead the world spices market.

Table 1: Area, production and yield of turmeric in India during 2000-01 to 2005-06

Year	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
1997-98	139.7	549.2	3931
1998-99	160.7	597.9	3721
1999-00	141.2	668.5	4734
2000-01	187.4	719.6	3839
2001-02	162.9	552.3	3389
2002-03	149.8	526.4	3512
2003-04	152.3	600.0	3939
2004-05	160.6	700.7	4363
2005-06	174.6	830.2	4755
2006-07	178.5	786.8	4408
2007-08	176.3	794.4	4532
2008-09	181.1	821.2	4535
2009-10	181.0	793.0	4382

Source: Spices Board, Cochin

Trend in Area, Production and Productivity of Turmeric in India, 1990-2019



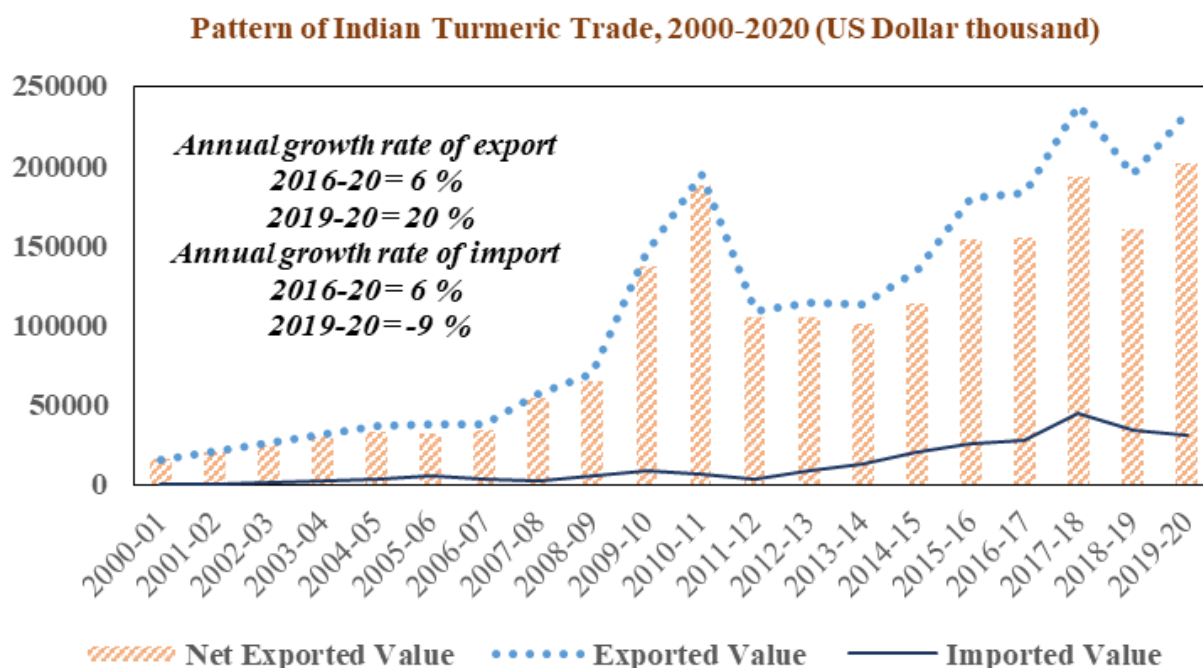


Figure 1. Progress in production and trade of Turmeric in India

Source: Department of Agriculture and Cooperation (Horticulture Division)

Table 2: Export earnings of spices and turmeric in India during 2000-01 to 2006-07

Year	Spices (tones)	Turmeric (tones)	Percent	Spices (lakhs)	Turmeric (lakhs)	Percent
2000-01	2,35,917	44,627	18.9	1,83,352.19	11,567.62	6.31
2001-02	2,43,203	37,778	15.5	1,94,054.88	9,037.71	4.68
2002-03	2,64,107	32,402	12.2	2,08,671.02	10,337.99	4.95
2003-04	2,54,382	34,500	13.5	1,91,160.50	12,751.88	6.67
2004-05	3,48,524	43,097	12.5	2,35,051.87	15,624.95	6.65
2005-06	3,50,306	46,405	13.2	2,62,762.46	15,286.02	5.82
2006-07	3,73,750	51,500	13.7	3,67,575.00	16,480.00	4.48

Source: Spices Board, Cochin

The performance of turmeric within the country in terms of area expansion and production and global performance can be visualized from figure 1. India being one of the major producers of turmeric, contributes 80% to global production. In the year 2018-19, turmeric production was 389 thousand tonnes with area and productivity 246 thousand hectares and 5646.34 kg/ha, respectively. The growth pattern of the area, production, and productivity of turmeric over the period of time indicate the growing contribution of production over the area expansion to the increased yield. In the international market, India is a net exporter of turmeric and earned 201,152 thousand

US Dollars in 2020. The USA is the largest consumer of Indian turmeric, imported 22 percent of the total exported value and followed by Bangladesh (18%), Iran (6%), and UAE (5%) in the last year. Some of the other importing countries are Malaysia, UK, Morocco, Germany and Japan. As already mentioned, the COVID-19 pandemic particularly elevated turmeric sales in the form of fresh and dried. Also, turmeric is used as one of the common ingredients in daily uses grocery for example as turmeric jaggery. The sale has been also appreciable in the international market i.e. the exported value of the turmeric jumped to 20 per cent in the last year as compared with 6% growth in 2016-20. This opportunity can be utilized further by introducing some new innovative products and recipes. In this way, northeastern states can also benefit large that discuss briefly below.

Opportunity for north-eastern states to prosper by turmeric cultivation and marketing North-eastern states, particularly Mizoram and Sikkim are recognized as abnormally high productivity states in turmeric cultivation because of their higher yield. Also, they have the advantage of recognition for organic production. In addition, under the National Mission for Sustainable Agriculture (NMSA), the Ministry of Agriculture and Farmers Welfare launched Central Sector Scheme, Mission Organic Value Chain Development for North East Region (MOVCD-NER) to support the development of value chain starting from input supply, certification, to the creation of facilities for aggregation and processing of the product. There are 33 clusters in Manipur operating under MOVCD-NER, also Assam and Sikkim have better geographic coverage of FPOs (Farmer Producer Organizations). By promoting such practices in other north-eastern states, they can exploit this niche market in near future.

Another important policy step i.e. “One District One Product” under Centrally Sponsored Scheme PMFME (PM Formalization of Micro food processing Enterprises Scheme), Turmeric is listed in the selected product in all of the North-eastern states, this is an additional scope under which states can be encouraged to adopt cluster approach and group approaches such as FPOs, SHGs (Self Help Groups) and producer cooperatives. This will help to bring the win-win situation to both farmers and the microenterprises. Also, except Assam, the spread of formal/organized food processing units are scanty, the innovation center for developing value-added products from the traditional knowledge can be encouraged so that in the long run the product can be easily scaled up.

Origin and Distribution

It is believed that turmeric originates from South or Southeast Asia, from western India. It is widely cultivated in India, China, Java and Haiti. Turmeric's highest production is in India. Approximately 90% of world's total production is in India. India is the major exporter of Turmeric. Other major turmeric producing countries are

India, Taiwan, Various Pacific islands, Central and Latin American countries, Thailand and other Southeast Asian countries.

Parts Used

The aboveground and underground roots, or rhizomes, are used in medicinal and food preparations. These are generally boiled and then dried, turning into the familiar yellow powder. Curcumin from turmeric, as well as other substances in this herb, have antioxidant properties, which some claim may be as strong as vitamins C and E.

Available Forms

Turmeric is commercially available in the following forms: Capsules containing powder, Fluid, extract, Tincture. Bromelain enhances the absorption and anti-inflammatory effects of curcumin, the best studied active ingredient of turmeric; therefore, bromelain is often formulated with turmeric products.

Medicinal Uses

Turmeric has long been used in both Ayurvedic and Chinese medicine as an anti-inflammatory, to treat digestive disorders and liver problems, and for the treatment of skin diseases and wound healing. Curcumin is the active ingredient in turmeric which has been shown to have a wide range of therapeutic effects. Curcumin is known for its antitumor, antioxidant, anti-amyloid and anti-inflammatory properties. Turmeric (*Curcuma longa*) is also known as tumeric or curcumin. Curcumin has been used to stimulate the production of bile and to facilitate the emptying of the gallbladder. Curcumin is one of the active ingredients in turmeric, induces the flow of bile, which helps break down fats.

Osteoarthritis

Turmeric may help to relieve the symptoms of osteoarthritis due to its ability to reduce inflammation. People are using an Ayurvedic formula of herbs and minerals containing turmeric as well as *Withania somnifera* (winter cherry), *Boswellia serrata* (Boswellia), and zinc which will help to reduce the pain and disability.

Atherosclerosis

Turmeric may prove helpful in preventing the buildup of atherosclerosis (blockage of arteries that can eventually cause a heart attack or stroke). In animal, an extract of turmeric lowered cholesterol levels and inhibited the oxidation of LDL ("bad") cholesterol. Oxidized LDL deposits in the walls of blood vessels and contributes to the formation of atherosclerotic plaque. Turmeric may also prevent platelet build up along

the walls of an injured blood vessel. Platelets collecting at the site of a damaged blood vessel cause blood clots to form and blockage of the artery as well.

Cancer

Animal studies suggest that curcumin has potential in the treatment of various forms of cancer, including prostate, breast, skin, and colon. Laboratory studies suggest that curcuminoids, the active components of turmeric, may reduce the destructive activity of Intestinal worms, parasites or roundworms.

Liver Disease

Animal studies provide evidence that turmeric can protect the liver from a number of damaging substances such as carbon tetrachloride and acetaminophen (also called paracetamol, this medication, used commonly for headache and pain, can cause liver damage if taken in large quantities or in someone who drinks alcohol regularly.) Turmeric accomplishes this, in part, by helping to clear such toxins from the body and by protecting the liver from damage.

Bacterial Infection

Turmeric's volatile oil functions as an external antibiotic, preventing bacterial infection in wounds.

Wounds

In animal studies, turmeric applied to wounds hastens the healing process.

Mosquito Repellent

A mixture of the volatile oils of turmeric, citronella, and hairy basil, with the addition of vanillin (an extract of vanilla bean that is generally used for flavoring or perfumes), may be an alternative to D.E.E.T., one of the most common chemical repellents commercially available.

Eye Disorder

For the cure of Uveitis disease in men and women (inflammation of the uvea, the middle layer of the eye between the sclera [white outer coat of the eye] and the retina [the back of the eye]) suggests that curcumin may prove to be as effective as corticosteroids, the type of medication generally prescribed for this eye disorder. The uvea contains many of the blood vessels that nourish the eye. Inflammation of this area, therefore, can affect the cornea, the retina, the sclera, and other important parts of the eye.

To heal many health disorders like liver problems, digestive disorders, treatment for skin diseases, wound healing, atherosclerosis, bacterial infection, and eye disorder turmeric has long been used in Medicinal as an anti-inflammatory.

Uses of Turmeric in Ayurvedic

The main organs that turmeric treats are the skin, heart, liver and lungs. Turmeric is used for epilepsy and bleeding disorders, skin diseases; to purify the body-mind is the most common use of Turmeric in Ayurveda. Turmeric reduces fevers, diarrhea, urinary disorders, and insanity, poisoning, cough, and lactation problems.

For Removing Pimples or Blackheads

Turmeric is very effective in removing blackhead. A pinch of turmeric powder mixed with one teaspoon of coriander juice is an effective remedy for pimples, blackheads and dry skin.

For Improve Skin Complexion

Make a paste of Besan, Dahi, pinch of turmeric powder, some drops of lemon, apply this paste on face. Keep until it dry. Daily use of it will definitely improve skin tone as well as removed blackheads.

For Cosmetic Products

Nowadays turmeric is extensively used in cosmetic products to prepare natural and herbal creams, lotion, hair dye and many other beauty products. As herb, turmeric has been used for centuries for seasoning, but through a series of complex extraction and isolation processes, it will soon be given further potential as a substance to support the medical as well as the cosmetics industries.

Use of Turmeric in Animals

The incredible health benefits of turmeric have become common knowledge in the past few years thanks to the rise in popularity of natural and alternative medicines. Scientific studies have shown that turmeric is a powerful antioxidant and anti-inflammatory as well as aiding in digestion and minor digestive disturbances, it promotes general wellbeing and helps the healing process of minor skin irritations. It is no wonder more and more health care professionals are recommending adding turmeric to your daily supplement intake. The most people don't know is that turmeric is great for our pets as well. That's right, whether you have a dog, cat, horse, goat, bird or alpaca, all our furred and feathered family members can also benefit from a daily dose of Turmeric.

In an animal study, extracts of turmeric root reduced secretion of acid from the stomach and protected against injuries such as inflammation along the stomach (gastritis) or intestinal walls and ulcers from certain medications, stress, or alcohol. It

has also demonstrated in animals a protective effect on the liver, anti-tumor action, and ability to reduce inflammation and fight certain infections.

Joint Pain & Inflammation

Joint pain is as common in animals as it is in humans, with dogs being the most susceptible to ailments such as arthritis. Turmeric's anti-inflammatory properties have shown to greatly reduce the pain and stiffness caused by joint inflammation. With one study suggesting Turmeric was as effective as Ibuprofen when it came to pain management.

Gut Health

Turmeric promotes healthy digestion by reducing inflammation within the intestines as well as aiding colon function by encouraging the production of good bacteria, minimizing bad bacteria and improving the intestine's ability to absorb beneficial nutrients. Turmeric is jam-packed with nutrients and minerals that will support your pets gut health.

Skin Irritations

The anti-inflammatory and anti-bacterial found in Turmeric have shown to work wonders on animals with skin irritations. Diet, stress and environmental factors are also significant causes of skin irritations in animals. The nutrients in Turmeric can reduce skin inflammation, fight infection by boosting the immune system and reduce stress hormones. Turmeric paste can also be used topically to aid the healing process of cuts and burns.

Cultivation

Cultural practices

Soil and climatic requirements: Turmeric requires hot and humid climate to thrive well and it generally grows on all type of soils but it thrives well in drained sandy loam to light black or red soils that are clayey in nature. The rootstalk is sown in around the spring season. Turmeric – requiring a hot, moist climate and thus primarily cultivated in Bangladesh, India, China, South America, and the East Indies – is asexually propagated from its rhizomes. During the growing season, the planted rhizome, referred to as the bulb, enlarges and produces several long, cylindrical and multi-branched secondary rhizomes called fingers. The plant grows to about 3 feet with light, green, lance-shaped leaves emerging from the planted rhizome. It takes about 9-11 months for production; the flowers arise from those leaves, and have a pale-yellow color, growing in groupings of three to five.

Improved varieties of turmeric

Some famous varieties of Turmeric are Local Haldi, China scented, Thodopuzha, Red streaked, Alleppey Turmeric (AFT). In which Alleppey is more popular in American Markets. It is deeper in color and more flavorful. In India there are many other popular varieties of turmeric like 'Alleppey Finger' in Kerala, 'Erode and Salem turmeric' in Tamil Nadu, 'Rajapore' and 'Sangli turmeric' in Maharashtra, 'Nizamabad Bulb' in Andhra Pradesh.

The varieties are categorized into three groups based on the duration of the crop

- Long duration types (9 months) - Tekurpet, Duggirala, Armur and Mydukuru
- Medium Duration types (8 months) - Kothapet, Krishna and Kesar
- Short duration types (7 months) - Amalapuram and Dindigram

Important high yielding varieties of turmeric grown in India

Andhra Pradesh: Amruthapani: Medium duration crop (8 months) highly resistant to leaf-spot but susceptible to leaf-blotch. Armoor: Long duration crop (9 months), resistant to leaf-blotch; popular variety. Duggirala: Long duration crop (9 months); tolerant to leaf-blotch; major regional variety. Tekurpeta: Long duration crop (9 months); resistant to leaf-blotch, popular variety.

West Bengal and Assam: Pattant: Reportedly better colour and aroma of varieties grown in region Suvarna,

Kerala: Alleppey: High colour variety; generally marketed as Alleppey turmeric. Wynad: Marketed as Alleppey turmeric.

Maharashtra: Rajapore, Karhadi, Waigon, Lokhandi: Major regional variety.

Bihar: Patna,

Tamil Nadu: Chinnanadan: Popular variety. Perianadan: Major regional variety; generally marketed as Madras type. CO-1: Drought and saline soil conditions. BSR-1: Waterlogged conditions,

Gujarat : Sugandham,

Manipur: Sudarshana,

Orissa: Roma (PTS-10)

A number of cultivars are available in the country and are known mostly by the name of locality where they are cultivated. Some of the popular cultivars are Duggirala, Tekurpeta, Sugandham, Amalapuram, Erode local, Alleppey, Moovattupuzha, and Lakadong. The improved varieties of turmeric and their salient features are given in the following table 3.

Table 3: Characteristics of improved turmeric varieties

Sr.No.	Variety	Mean yield (fresh)(t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential oil (%)
1	Suvarna	17.4	200	20.0	4.3	13.5	7.0
2	Suguna	29.3	190	12.0	7.3	13.5	6.0
3	Sudarsana	28.8	190	12.0	5.3	15.0	7.0
4	IISR Prabha	37.5	195	19.5	6.5	15.0	6.5
5	IISR Prathibha	39.1	188	6.2	6.5	16.2	6.2
6	Co-1	30.0	285	19.5	3.2	6.7	3.2
7	BSR-1	30.7	285	20.5	4.2	4.0	3.7
8	Krishna	9.2	240	16.4	2.8	3.8	2.0
9	Sugandham	15.0	210	23.3	3.1	11.0	2.7
10	Roma	20.7	250	31.0	9.3	13.2	4.2
11	Suroma	20.0	255	26.0	9.3	13.1	4.4
12	Ranga	29.0	250	24.8	6.3	13.5	4.4
13	Rasmi	31.3	240	23.0	6.4	13.4	4.4
14	Rajendra Sonia	42.0	225	18.0	8.4	-	5.0
	IISR Alleppey						
15	Supreme	35.4	210	19.3	6.0	16.0	4.0
16	IISR Kedaram	34.5	210	18.9	5.5	13.6	3.0

Source of planting material

Sr. nos. 1, 2, 3, 4, 5, 15 & 16: IISR Experimental Farm, Peruvannmuzhi - 673 528, Kozhikode District, Kerala.

Sr. nos. 6 and 7: Department of Spices and Plantation Crops, Faculty of Horticulture, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu.

Sr. no. 8: Maharashtra Agricultural University, Kasba Digranj -416 305, Maharashtra.

Sr. no. 9: Spices Research Station, Gujarat Agricultural University, Jagudan-382 701, Gujarat.

Sr. nos. 10, 11, 12 & 13: High Altitude Research Station, Orissa University of Agriculture and Technology, Pottangi - 764 039, Orissa.

Sr. no. 14: Department of Horticulture, Tirhut College of Agriculture, Rajendra Agricultural University, Dholi-843 121, Bihar

Land preparation: Two or three ploughings followed by planking are necessary to get fine seed bed. The field should be free from stubbles and weeds.

Seed rate: Turmeric is propagated through rhizomes. Fresh healthy and uniform sized rhizomes weighing 15-20 q/ha are sufficient to plant one hectare.



Sowing time: Crop is to be sown directly in the field by the end of April. It can also be planted by transplanting. For this rhizome should be sprouted in the nursery by planting them in close spacing and 35-45 days old seedlings should be transplanted in the field.



Method of planting: Healthy and disease-free rhizomes are planted in lines, keeping a distance of 30 cm in the rows and 20 cm between the plants. After planting, apply straw mulch @ 6.25 tonnes/ha. Keep the soil until the sprouting of rhizomes.

Fertilizer application: Turmeric responds favourably to organic manuring. Apply 25-30 tonnes/ha of well rotten FYM before planting. Turmeric does not need much nitrogen. A basal dose of 25 kg phosphorus and potassium can be drilled at planting.

Irrigation: Turmeric takes a long time to sprout and needs frequent irrigation. Apply light irrigation and frequent irrigation.

Weed control: In order to keep the crop free from weeds, 1 or 2 hoeing may be given.

Plant protection

Diseases

Leaf blotch: Leaf blotch is caused by *Taphrina maculans* and appears as small, oval, rectangular or irregular brown spots on either side of the leaves which soon become dirty yellow or dark brown. The leaves also turn yellow. In severe cases the plants present a scorched appearance and the rhizome yield is reduced. The disease can be controlled by spraying mancozeb 0.2%.

Leaf spot: Leaf spot is caused by *Colletotrichum capsici* and appears as brown spots of various sizes on the upper surface of the young leaves. The spots are irregular in shape and white or grey in the centre. Later, two or more spots may coalesce and form an irregular patch covering almost the whole leaf. The affected leaves eventually dry up. The rhizomes do not develop well. The disease can be controlled by spraying zineb 0.3% or Bordeaux mixture 1%.

Rhizome rot: The disease is caused by *Pythium graminicolum* or *P. aphanidermatum*. The collar region of the pseudostem becomes soft and water soaked, resulting in collapse of the plant and decay of rhizomes. Treating the seed rhizomes with mancozeb 0.3% for 30 minutes prior to storage and at the time of sowing prevents the disease. When the disease is noticed in the field, the beds should be drenched with mancozeb 0.3%.

Nematode pests: Root knot nematodes (*Meloidogyne* spp.) and burrowing nematode (*Radopholus similis*) are the two important nematodes causing damage to turmeric. Root lesion nematodes (*Pratylenchus* spp.) are of common occurrence in Andhra Pradesh. Wherever nematode problems are common, use only healthy, nematode-free planting material. Increasing the organic content of the soil also checks the multiplication of nematodes. *Pochonia chlamydosporia* can be applied to the beds at the time of sowing @ 20 g/bed (at 10⁶ cfu/g) for management of nematode problems.

Insect pests

Shoot borer: The shoot borer (*Conogethes punctiferalis*) is the most serious pest of turmeric. The larvae bore into pseudostems and feed on internal tissues. The presence of a bore-hole on the pseudostem through which frass is extruded and the withered central shoot is a characteristic symptom of pest infestation. The adult is a medium

sized moth with a wingspan of about 20 mm; the wings are orange- yellow with minute black spots. Fully-grown larvae are light brown with sparse hairs. Spraying malathion (0.1%) at 21-day intervals during July to October is effective in controlling the pest infestation. The spraying has to be initiated when the first symptom of pest attack is seen on the inner most leaf.

Rhizome scale: The rhizome scale (*Aspidiella hartii*) infests rhizomes in the field (at later stages of the crop) and in storage. Adult (female) scales are circular (about 1mm diameter) and light brown to grey and appear as encrustations on the rhizomes. They feed on sap and when the rhizomes are severely infested, they become shrivelled and desiccated affecting its germination. Treat seed material with quinalphos (0.075%) (for 20-30 minutes) before storage and also before sowing in case the infestation persists. Discard and do not store severely infested rhizomes.

Minor pests: Adults and larvae of leaf feeding beetles such as *Lema* spp. feed on leaves especially during the monsoon season and form elongated parallel feeding marks on them. The spraying of malathion (0.1%) undertaken for the management of shoot borer is sufficient to manage this pest.

The lacewing bug (*Stephanitis typicus*) infests the foliage causing them to turn pale and dry up. The pest infestation is more common during the post monsoon period especially in drier regions of the country. Spraying dimethoate (0.05%) is effective in managing the pest.

The turmeric thrips (*Panchaetothrips indicus*) infests the leaves causing them to roll, turn pale and gradually dry up. The pest infestation is more common during the post monsoon period especially in drier regions of the country. Spraying dimethoate (0.05%) is effective for the management of the pest.

Organic Production

For certified organic production, at least 18 months the crop should be under organic management i.e. 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.

In order to avoid contamination of organically cultivated plots from neighboring non-organic farms, a suitable buffer zone with definite border is to be maintained. Crop 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 neighboring 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.

Management practices

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. 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. Farmyard manure may be applied @ 40 t/ha along with vermi compost @ 5-10 t/ha and mulching with green leaves @ 12- 15 t ha⁻¹ at 45 days intervals. Based on soil test, application of lime/dolomite, rock phosphate and wood ash have to be done to get required quantity of phosphorus and potassium supplementation. 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. Further, supplementation of oil cakes like neem cake (2 t/ha), composted coir pith (5 t/ha) and suitable microbial cultures of *Azospirillum* and phosphate solubilizing bacteria will improve the fertility and yield.

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 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 other foliar diseases spraying of Bordeaux mixture 1% may be done restricting the quantity to 8 kg copper per hectare per annum. Application of quality neem cake mentioned earlier along with the bioagents *Pochonia chlamydosporia* will be useful to check the nematode population.

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. In cases where an ingredient of organic agriculture origin is not available in sufficient quality or quantity, the certification programme authorizes use of non-organic raw materials subject to periodic re-evaluation.

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 except when labeled or physically separated.

Certification and labeling are 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.

Harvesting

In India harvesting season of turmeric is December to March. The harvesting of this plant is done when the leaves of this plant start turning yellowish after 7 to 10 months of plantation. The yellowing of leaves and stems finally indicates that the rhizomes are mature and ready for harvesting, which is done by manually lifting the clusters of rhizomes from the soil. Soil, roots and leaf scales are removed from the rhizomes, and a portion is selected and stored for planting the next crop. The bulbs and fingers are segregated and transferred to curing and drying facilities.

Yield

On an average, it yields 150-200 q/ha of fresh rhizomes.

Turmeric Powder: The fingers and rhizomes of turmeric are boiled separately for 30-40 minutes until bubbles and white fumes come out, then drained and dried in the sun for 10 to 15 days, until they become dry and hard. The dry turmeric then cleaned and polished mechanically in a drum rotated by hand or by power to make powder. It is necessary to care raw turmeric rhizomes freshly unearth for its attractive yellow colour and the characterized aroma. Without proper care turmeric lacks both.

Part of turmeric used for culinary purpose: The rhizome or root of turmeric plant is used to make turmeric spice. The rhizome is boiled and then let to dry. The rough skins are removed and grounded to make a fine rich yellow turmeric powder. Turmeric is natural preservative. When added to Indian delicacies such as curry and rice, it gives a rich color and slight flavor to food. Turmeric combines well with spices such as chilli powder, coriander powder, cumin, and cinnamon.

Culinary uses: Turmeric is one of the principal ingredients of curry powder. It can be used as a substitute for saffron. In India, turmeric is used as a condiment. It is used to flavour and colour butter, cheese, margarine, pickles, mustard, liquor, fruit drinks, cakes, table jellies, fruit dishes, other foodstuffs and also as a food adjunct in many vegetables, meat and fish preparations. Turmeric oil and oleoresin is also used to impart the flavour in food and perfume industries. It adds a warm, mild aroma and distinctive yellow colour to foods.

Kunkuma: Kunkuma, a red powder made of turmeric and lime. Kunkuma is worn by Hindu woman as the 'bindi' dot, on the forehead at the point of the third eye; small dot of kunkuma worn on the forehead between the eyebrows, or in the middle of the forehead. The red color is a sign of marriage. The 'bindi' is also a beauty mark worn by Hindu women.

Processing

Curing

Fresh turmeric is cured for obtaining dry turmeric. The fingers are separated from mother rhizomes. Mother rhizomes are usually kept as seed material. Curing involves boiling of fresh rhizomes in water and drying in the sun.

In the traditional method of curing, the cleaned rhizomes are boiled in water just enough to immerse them. Boiling is stopped when froth comes out and white fumes appear giving out a typical odour. The boiling should last for 45-60 minutes when the rhizomes turn soft. The stage at which boiling is stopped largely influences the colour and aroma of the final product. Over cooking spoils, the colour of the final product while under-cooking renders the dried product brittle.

In the improved scientific method of curing, the cleaned fingers (approximately 50 kg) are taken in a perforated trough of 0.9 m x 0.5 m x 0.4 m size made of GI or MS sheet with extended parallel handle. The perforated trough containing the fingers is then immersed in a pan; 100 litres of water is poured into the trough so as to immerse the turmeric fingers. The whole mass is boiled till the fingers become soft. The cooked fingers are taken out of the pan by lifting the trough and draining the water into the pan. The water used for boiling turmeric rhizomes can be used for curing fresh samples. The processing of turmeric is to be done 2 or 3 days after harvesting. If there is delay in processing, the rhizomes should be stored under shade or covered with sawdust or coir dust ([Indian Institute of Spices Research](#)).

Drying

The cooked fingers are dried in the sun by spreading them in 5-7 cm thick layers on bamboo mats or drying floor. A thinner layer is not desirable, as the colour of the dried product may be adversely affected. During night time, the rhizomes should be heaped or covered with material which provides aeration. It may take 10-15 days for the rhizomes to become completely dry. Artificial drying, using cross-flow hot air at a maximum temperature of 60°C also gives a satisfactory product. In the case of sliced turmeric, artificial drying has clear advantages in giving a brighter coloured product than sun drying which tends to undergo surface bleaching. The yield of the dry product varies from 10-30% depending upon the variety and the location where the crop is grown ([Indian Institute of Spices Research](#)).

Polishing

Dried turmeric has a poor appearance and a 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. The improved method is by using a hand operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal mesh. When the drum filled with turmeric is rotated, polishing is affected by abrasion of the surface against the mesh as well as by mutual rubbing against each other as they roll inside the drum. Turmeric is also polished in power operated drums. The yield of polished turmeric from the raw material varies from 15-25% ([Indian Institute of Spices Research](#)).

Colouring

The colour of the processed turmeric influences the price of the produce. For an attractive product, turmeric powder (mixed with little water) may be sprinkled during the last phase of polishing ([Indian Institute of Spices Research](#)).



Preservation of seed rhizomes

Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves. The seed rhizomes can also be stored in pits with saw dust, sand along with leaves of *Strychnos nuxvomica* (kanjiram). The pits are to be covered with wooden planks with one or two openings for aeration. The rhizomes are to be dipped in quinalphos (0.075%) solution for 15 minutes if scale infestations are observed and in mancozeb (0.3%) to avoid storage losses due to fungi ([Indian Institute of Spices Research](#)).

Storage of turmeric powder

Turmeric's color properties are everlasting but flavour and aroma is loss quickly if not store properly. Store it in airtight containers away from sunlight. Store it in cool, dark, dry places.

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