TURMERIC PRODUCTION IN INDIA : TRENDS AND DECOMPOSITION ANALYSIS

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Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in
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By
BANDEWAR AISHWARYA SRINIVAS

AGRICULTURAL ECONOMICS AND STATISTICS SECTION

COLLEGE OF AGRICULTURE, NAGPUR

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444104

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DECLARATION OF STUDENT

I hereby declare that, the experimental work and its interpretation of the thesis entitled **"TURMERIC PRODUCTION IN INDIA : TRENDS AND DECOMPOSITION ANALYSIS"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Nagpur (**Bandewar Aishwarya Srinivas**)

Date: 02 /06 /2021 Enrolment No:- RR-3213

CERTIFICATE

This is to certify that thesis entitled **"TURMERIC RODUCTION IN INDIA : TRENDS AND DECOMPOSITION ANALYSIS"** submitted in partial fulfilment of the requirement for the degree of **"Master of Science in Agriculture (Agricultural Economics)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Bandewar Aishwarya Srinivas** under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

Place: Nagpur

Date: 02/06/2021

(Dr. U. T. Dangore)

Chairman,

Advisory Committee

Countersigned

Associate Dean, College of Agriculture, Nagpur
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE INCLUDING EXTERNAL EXAMINER (AFTER VIVA -VOCE)

1. Chairman	**(Dr. U.T. Dangore)**	_____
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3. Member	**(Dr. R.S. Waghmare)**	_____
4. Member	**(Dr. V.U. Raut)**	_____
5. External Member	**(Dr. N.T. Bagde)**	_____

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%	percentage
*	Significant at 5 per cent
**	Significant at 1 per cent
/	Per
BCE	Before Common Era
AD	Anno Domini
CDVI	Cuddy Della Valle's Index
CV	Coefficient of Variation
cm	Centimeter
et al.	Et alia (and associate)
etc	Et cetera
Fig	Figure
g	Gram
GDP	Gross Domestic Product
ha.	Hectare
i.e.	That is
Kg	Kilogram
mg	Milligram
mcg	Microgram
NHM	National Horticulture Mission
No.	Number
p.a.	per Annum
R^2	Coefficient of determination
Sr.No	Serial Number
USD	United States dollar
Var.	Variety
Viz;	Videlicet (Namely)

(D) THESIS ABSTRACT

a)Title of the thesis	:	**"TURMERIC PRODUCTION IN INDIA : TRENDS AND DECOMPOSITION ANALYSIS"**
b)Full name of student	:	**Bandewar Aishwarya Srinivas**
c)Name and address of Major Advisor	:	**Dr. U.T. Dangore** Assistant Professor , Agricultural Economics & Statistics Section, College of Agriculture, Nagpur
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j)Signature, Name and address of forwarding authority	:	

Professor and Head of Section Agricultural Economics and Statistics Section
College of Agriculture,
Nagpur.

ABSTRACT

The present study entitled "Turmeric Production in India : Trends and Decomposition analysis" was carried out with the objectives to workout the state wise growth rate of area, production and productivity of turmeric in India, to estimate state wise instability of turmeric in India, to study state wise trends of area, production and productivity of turmeric in India and to study the relative contribution of area and yield on production of turmeric in India. The study was based on the secondary data of area, production and productivity of turmeric in India. The complete data on turmeric available for all states of India from 2000-01 to 2019-20 was split into two sub-periods i.e. period I (2000-01 to 2009-10) and period II (2010-11 to 2019-20). The growth rates were calculated by exponential function and instability by coefficient of variation and Cuddy Della Valle's instability index. The relative contribution of area and yield to change in output was estimated by using Minhas decomposition model. The state wise analysis was carried out for the period I, period II and for overall period.

The results showed that, the compound growth rates for area was positive for all the states except Andhra Pradesh, Odisha and Kerala during Period I, Rajasthan during period II and Odisha and Kerala at overall period. At overall level the compound growth rate of area and production of turmeric was the highest in Madhya Pradesh. Whereas, for productivity it was highest in Maharashtra state. The compound growth rate of production was highest in Madhya Pradesh and productivity was highest in Maharashtra.

The highest coefficient of variation for area and production was observed in Madhya Pradesh. Whereas, for productivity it was observed in Maharashtra. The highest Cuddy Della Valle instability index for area and production was observed in Madhya Pradesh. Whereas, for productivity it was observed in Maharashtra. The highest average area, production and productivity was observed in Andhra Pradesh. The average area under cultivation of turmeric for last twenty

year was 194,020 hectares, production was 865,560 tonne and productivity was 4442.20 kg per hectare.

For all most all the states the Cubic functions were best fitted, except for Andhra Pradesh, Maharashtra and Kerala. The $R^{2.}$ Was estimated in the range of 0.22 to 0.95 for area, 0.120 to 0.972 for production and 0.35 to 0.96 for productivity.

The decomposition analysis for India was estimated the largest area effect on turmeric production. It was observed that for both the periods yield effect was more pronounce than area effect and interaction effect.

Chapter I

INTRODUCTION

1.1 Background information

In a developing country like India, agriculture even at present is the backbone of Indian economy. The geographical position of our country has been very congenial to agricultural activities. The physical factors existing in India like its climate, soil, and relief have become very helpful for the cultivation of so many crops. Agriculture has been and will continue to be the lifeline of Indian economy. The share of agriculture in GDP increased to 19.9 per cent in 2020-21 from 17.8 per cent in 2019-20. The last time the contribution of the agriculture sector in GDP was at 20 per cent was in 2003-04. India produces a variety of crops belonging to cereals, pulses, oilseeds, fruits and vegetables, spices and condiments, fibers, sugars, etc.

India has a glorious past, pleasant present and a bright future with respect to production and export of spices. Pepper, cardamom, chillies, turmeric and ginger are some of the important spices produced in India. India is a great exporter of spices. India is popularly known as the “Spice Bowl of the World” as a wide variety of spices with premium quality is grown in the country since ancient times. Turmeric is known in India since the ancient times. It is one of the important spices which plays an important role in the national economy and is also one among the five important major spices of India. It is known as “Indian Saffron “also known as “*Golden Spice of Life*” . Turmeric (*Curcuma longa*), belongs to family Zingiberaceae, is native to Southeast Asia and is grown commercially in that region, primarily in India.

Turmeric is one of the key ingredients in many Asian dishes, imparting a mustard-like, earthy aroma and pungent, slightly bitter flavor to foods. It is used mostly in savory dishes, but also is used in some sweet dishes, such as the cake *sfouf*. In India, turmeric leaf is used to prepare special sweet dishes, *patoleo*, by layering rice flour

and coconut-jaggery mixture on the leaf, then closing and steaming it in a special utensil (*chondro*). Most turmeric is used in the form of rhizome powder to impart a golden yellow color. It is used in many products such as canned beverages, baked products, dairy products, ice cream, yogurt, yellow cakes, orange juice, biscuits, popcorn color, cereals, sauces and gelatin. It is a principal ingredient in curry powders. Although typically used in its dried, powdered form, turmeric also is used fresh, like ginger. It has numerous uses in East Asian recipes, such as a pickle that contains large chunks of fresh soft turmeric.

Turmeric is a common spice and major ingredient in curry powder. Curcumin is a major component of Turmeric, and the activities of turmeric are commonly attributed to curcuminoids (curcumin and closely related substances). Curcumin gives turmeric its yellow colour. Turmeric dietary supplements are made from the dried rhizome and typically contain a mixture of curcuminods. It is also made into a paste for skin conditions as it has Anti-bacterial property. In India it was traditionally used for disorder of the skin, upper respiratory tract**,** joints and digestive system. Today, Turmeric is promoted as a dietary supplement for a variety of conditions, including arthritis, digestive disorders, respiratory Infections, allergies, liver diseases, depression, and many others. In 2019, The European Medicines Agency concluded that, turmeric herbal teas, or other forms taken by mouth, on the basis of their long-standing traditional use, could be used to relieve mild digestive problems, such as feelings of fullness and flatulence.

1.2. Botanical description

Turmeric (*Curcuma longa)* belongs to family Zingiberaceae. Most commercially grown varieties are Alleppy finger from Kerala, Erode and Salem turmeric from Tamil Nadu, Rajapore, Sangli and Waigaon turmeric from Maharashtra and Duggirala from Andhra Pradesh. The main characteristics of these varieties are described below.

Variety Allepy Finger- It is one of the popular variety of Kerala. It has the highest colour content and deepest flavour. Allepy turmeric is a deep orange-yellow in color and has a flavour very close to fresh turmeric root. This is the best variety to use in cooking when the true flavour of turmeric is desired. Its curcumin content on an average is 5 per cent and may be as high as 6.5 per cent.

Variety Erode turmeric- It is one of the popular cultivars of Tamil Nadu with good market acceptability. Plants are vigorous and tall with good yield potential (30-32 t/ha). Fingers are short, slightly bent with a deep orange inner core, with a moderate curing percentage. Its curcumin content is 3.9 per cent.

Variety Salem turmeric- It is another popular cultivar of Tamil Nadu,The plants are vigorous and tall. Rhizomes are bigger and the fingers are longer than in Erode local (4 cm). Its yield potential is comparable with Erode local but rich in curcumin content (4.75 per cent) and moderate in curing percentage.

Variety Rajapore turmeric- It is one of the popular cultivar of Maharashtra and considered to be the most premium quality which is available in India. On grinding cleaned, graded and polished Rajapuri turmeric finger & powder, we get a saffron yellow shaded and a strong flavored turmeric powder which is a characteristic of this quality. curcumin content is around 3.5- 4 per cent.

Variety Sangli turmeric- It is another popular cultivar of Maharashtra, it has more thick and fleshy rhizomes with less wrinkles and thin peel. It is thick and bold with saffron colour and mustardy aroma. curcumin content is around 3.42 to 5.78 per cent.

Variety Waigaon turmeric- It is a unique variety cultivated in Samudrapur tehsil of Wardha district, which matures in short period and grown under rain fed condition. It is dark mustard yellow in colour. curcumin content is around 5-7 per cent.

Variety Duggirala turmeric- It is the pupular cultivar of Andhra Pradesh. It has larger rhizomes of good quality and is more suitable for heavy black soils. Its curcumin content is around 3 per cent.

1.3 Nutritional value

The turmeric on shelves and in spice cabinets is made of the ground roots of the plant. The bright yellow colour of processed turmeric has inspired many cultures to use it as a dye. Ground turmeric is also a major ingredient in curry powder. 100 grams of turmeric contains 312 calories, 3.3 gm total fat, 1.8 gm saturated fat, 27 gm sodium, 67 gm carbohydrate, 23 gm dietary fiber, 3.2 gm sugar, 9.7 gm protein. Vitamins like Betaine 9.7 mg, choline 49.2 mg, folate 20 mcg, Niacin 1.350 mg, pantothenic acid 0.542 mg, Riboflavin 0.150 mg, Thiamin 0.058 mg. Minerals like 168 mg calcium, 1.300 mg copper, 55 mg Iron, 208 mg Magnesium, 19.800 mg Manganese, 299 mg Phosphprous, 2080 mg Potassium, 6.2 mcg selenium, 27 mcg Sodium, 4.50 mg Zinc.

1.4 World scenario

Turmeric is widely cultivated in different countries such as India, China, Myanmar, Nigeria, Bangladesh, Pakistan, Srilanka, Taiwan, Burma, Indonesia, etc. Among these countries, India occupies first position in export with an of area of 251.39 thousand hectares and also a production of 926.11 thousand metric tonnes during 2019-20 (National Horticultural Board 2020). Major producers are Thailand, Central and Latin America, Taiwan and other Southeast Asian countries. The global production of turmeric is around 11 lakh tones per annum. India is the largest producer and consumer of turmeric in the world. India dominates the world production scenario by contributing 80 per cent followed by China 8 per cent, Myanmar 4 per cent and Nigeria and Bangladesh together contributing to 6 per cent of the global production. India is the global leader in value added products of turmeric and exports. Other major exporters are Thailand, other

Southeast Asian countries, Central and Latin America and Taiwan. United Arab Emirates (UAE) is the major importer of turmeric from India accounting for 18 per cent.

1.5 Indian scenario

In India, turmeric is grown in 18 states out of which Major Turmeric producing states from the south eastern are Telangana, Andhra Pradesh, Tamil nadu and Karnataka and from the Eastern are Odisha & West Bengal, and from the western are Maharashtra. In Tamil nadu a city named Erode is known as “Turmeric City”. In India during 2019-20 about 251.39 thousand hectare area was covered under Turmeric with a production of 926.11 metric tonnes. (National Horticultural Board 2020). Telangana state produced the largest volume of turmeric in fiscal year 2019 across India.

In Telangana during year 2019-20, area covered under turmeric was 55,000 hectares with a production of 307 thousand tonnes followed by Odisha and Karnataka. Maharashtra state covers an area of 17,340 hectares with production of 40,140 tonnes.

The export value of spices was 231.17 billion Indian rupees in 2019-20. India accounts for 75 per cent of global spice production.

1.6 Origin of turmeric

Origin of turmeric was about 4000 years ago to the vedic culture in India, it probably reached China by 700 AD, East Africa by 800 AD, West Africa by 1200 AD, and Jamaica in the 18 century. In 1280, macro polo described this spice, as a vegetable that exhibited qualities so similar to that of saffron. Historically, Turmeric was used in Ayurveda and other traditional Indian medical system, as well as Eastern Asian medical systems such as traditional Chinese medicine. In recent years turmeric has attracted quite a bit of interest for its natural healing properties, but it has actually been used medicinally for over 4,500 years. Analyses of pots discovered near New Delhi

uncovered residue from turmeric, ginger and garlic that dates back as early as 2500 BCE. It was around 500 BCE that turmeric emerged as an important part of Ayurvedic medicine.

Turmeric grows wild in the forests of South and Southeast Asia, where it is collected for use in classical Indian medicine (Siddha or Ayurveda). In Eastern India, the plant is used as one of the nine components of nabapatrika along with young plantain or banana plant, taro leaves, barley (jayanti), woodapple (bilva), pomegranate (darimba), saraca indica, manaka (Arum), or manakochu, and rice paddy. The Haldi ceremony called gaye holud in Bengal (literally "yellow on the body") is a ceremony observed during wedding celebrations of people of Indian culture all throughout the Indian subcontinent.

1.7 Importance of study

The demand for agricultural products has been increasing day by day. This is due to the rise in the population accompanied by rising level of income. The problem is whether the supply of Agricultural product has become responding to the rising demand for them become crucial. Recent studies shows that, the farmers are shifting from physical production to production in monetary returns, that is, they have become income conscious. Hence the farmers response to a set of prices of different crop is distribution of an area among the different crop.

India has a large human power, good soil, climate and high agricultural production. When a price of particular commodity goes down and the other relevant things remain unchanged one expect that the farmer shifts some acreage from that crop. However, price is not only the element that effect under crop but there are certain other factors like rainfall, yield risk, prices of other related crops etc. which may influence effect.

However the slow growth of agriculture as compare to other

sectors is a serious issue from the point of view of rural development and poverty, both of which are heavily dependent on agricultural growth. Due to the climate, production in India is very high and it becomes imperative for us to study the changes in the trends of area, production and productivity, along with the relative contribution of area and yield to change in the output of turmeric in India.

This study therefore attempted to find out the Turmeric production in India which includes trends and Decomposition analysis during the study period with the following specific objectives.

1.8 Objectives

1. To estimate state wise growth rate of area, production and productivity of turmeric in India.
2. To workout state wise instability of turmeric.
3. To assess trends in area, production and productivity.
4. To estimate relative contribution of area and yield to change in the output of turmeric in India.

1.9 Hypothesis

1. Growth rate of area, production and productivity of turmeric are positive.
2. Area, production and productivity of turmeric is in linear trend.

1.10 Scope of study

Agriculture is and shall continue to be most important sector of Indian Economy and also for Maharashtra state. It being the largest economic activity, serves as the index of economy development. The study on growth and instability of turmeric assures important in this context. Result of this study would help the policy makers to formulate policies pertaining to the various aspects of increasing turmeric

production. The analysis of crop production is not only important for planning future spices production growth strategy of the region but also for financial position of the forever.

1.11 Limitations of the study

The present study is focused on a single crop Turmeric. The study is based on the secondary data obtained from various published sources. The analysis is limited to the available stock of data on the various aspects of study. The validity of results is, therefore, based on the degree of reliability of the secondary data obtained. However, an attempt has been made to have an in depth analysis of the data by adopting suitable analytical techniques to arrive at meaningful conclusions. The present research was conducted in India and restricted to turmeric crop.

Chapter II

REVIEW OF LITERATURE

The review of literature is one of the important aspects in the research process which helps the researcher to get acquainted with the subject matter under study and channelize future efforts in desirable direction. It provide necessary guidelines and help the researchers to delineate his research problem.

The main purpose of the study is to estimate state wise growth rate of area, production and productivity of turmeric in India, to workout state wise instability of turmeric, to access trends in area, production and productivity and to estimate relative contribution of area and yield to change in the output of turmeric in India. Several research workers have worked on the problem in different region. This chapter take brief account of research work in growth, instability, trend and decomposition of output growth of turmeric in India.

The literature reviewed in the present study is divided into the following subsections.

2.1 Growth performance of crop.

2.2 Instability in crop production.

2.3 Trends in area, production and productivity.

2.4 Decomposition of output growth.

2.1 Growth performance of crop.

Angles and Hosamani (2002) studied the growth in area, production and productivity of turmeric in selected south Indian states. They examined the performance of turmeric in terms of area, production and productivity in important states of south India viz. Andhra Pradesh, Tamil Nadu, Karnataka and Kerala. These states contributed around 80 percent of turmeric produced in India.

Secondary data was used for the study, considering the period from 1979-80 to 1998-99. Exponential form of growth function was used for the analysis. All the states registered significant growth in area, production and productivity except area in case of Tamil Nadu and Kerala, production in Tamil Nadu and productivity in Karnataka. Evolving location specific varieties, adaptation of modern cultural practices and intensive cultivation were some of the suggestions for enhancing productivity of turmeric.

Angles and Hosamani (2006) studied the impact of globalisation on Indian turmeric trade and production. The growth in export of turmeric were significant in total quantity, total value and unit value, because of the high demand coupled with inflation. They observed that, the growth rates of production in all the periods were found to be higher than productivity and area. In all the periods, it was seen that, turmeric had the productivity lead growth. The growth coefficients of post-liberalization were found to be non-significant. It was interesting to note that, the growth in area, production and productivity were found to be higher in pre-liberalization period compared to overall and post-liberalization period. However, a lower growth in area was observed in post-liberalization period which might be due to stability of area under turmeric in which there is no scope to allocate more area under fresh planting. In the case of turmeric, India is virtually a monopoly supplier to the world with a share of about 76 per cent of the total global output and 90 per cent of the global trade. Favourable weather conditions prevailing in major turmeric growing areas (Andhra Pradesh, Tamil Nadu, Odisha, Karnataka and West Bengal) and the important steps taken by the Spices Board such as providing drying sheets to small and marginal growers of turmeric and other spices for drying under hygienic conditions, providing subsidies for the small and marginal farmers for the construction of concrete drying yards and for the construction of warehouse including educational programmes for growers on improved methods which led to increased productivity of turmeric. Besides this, high yielding varieties released over the years

had their own contribution.

Goudra *et al.* (2011) studied growth rate scenario of chilli *(capsicum annum* L.) in north Karnataka. The Compound growth rate (CGR) of area, production, and productivity of chilli was worked out for all the districts of Northern Karnataka and North Karnataka as a whole and the results were presented Northern Karnataka as a whole registered positive compound growth rate for area (13.76), production (13.88), productivity (12.20). These registered values were non significant at both at ten and five percent level of significance. The result revealed that, the area, production and productivity under chilli decreased in the North Karnataka with highest instability across all the districts of the state, and also there is wide range of variation in the area, production, and yield. This is mainly because of changing in cropping pattern of the farmer, varied rainfall pattern, severe influence of pest and diseases and also widely influenced by the fluctuation in the prices of chilli.

Hasan *et al.* (2013) studied trends of changing growth rate of major spices in Bangladesh. The performance of spices sector was immensely better during the post policy implementation period, than that of pre policy period. During the post policy implementation period, growth rate of area, production, and yield grew at the higher rate than that of pre policy implementation period. The main sources of increasing spices production in post policy implementation period noticed mainly due to area expansion and yield increased through variety substitution

Naik and Hosamani (2013) evaluated the growth and export dimensions of Indian turmeric. The results of the study revealed that, the growth rates of productions were higher than of productivity and area indicating the productivity-led growth. During pre-WTO period the growth rates in area, production and productivity of turmeric were 3.45 per cent, 8.09 per cent and 4. 48 per cent, respectively whereas, in the post- WTO period the growth rates of area, production and productivity

of turmeric were 1.89 per cent, 3.67 per cent and 1.75 per cent, respectively .In the overall period (1974-75 to 2009-10) the growth rates in area, production and productivity of turmeric were 2.67 per cent, 5.63 per cent and 2.89 per cent, respectively.

Govindasamy (2014) reported information on production and export performance of turmeric in India.. The estimated compound growth rate of area under Turmeric was positive which was estimated to be 2.34 per cent per annum. The annual common growth rate of production was positive of 4.55 per cent per annum during reference period. The estimated compound growth rate for productivity of Turmeric was 2.15 per cent.

Soumya *et al.* (2014) studied the growth and instability in production and export of selected spices of India. The empirical results showed that, area, production and productivity of pepper showed negative growth rate at national level. Pepper registered a positive but non-significant growth rate in terms of volume of export. At national level area under cumin showed only a meagre growth rate while production, productivity and export showed significant positive growth rate. Area, production and export of coriander showed significant and positive growth rate while productivity showed non-significant positive growth rate at national level. Area, production and productivity were found to be stable while export was found to be unstable in case of pepper. Similarly, at all India level, in case of cumin, area, production and productivity were found to be stable while export was found to be unstable. In case of coriander, area and productivity were found to be stable while production and export was found to be unstable.

Anju Jacob and Elsamma Job (2015) studied pepper production and export from India: . The compound growth rate analysis revealed that, there was a decrease in the growth rate of area,production and productivity of pepper in Kerala. The export value showed a growth rate of 19.68 per cent during 2005-06 to 2013-14 and export quantity showed a negative growth rate of 2.87 during the same period. The

incidence of pest and disease was found to be the major reason for the decrease in the production of pepper.

Boyal *et al.* (2015) studied the growth and instability in area, production and productivity of fenugreek in Rajasthan. Growth rates of area and production in fenugreek was observed positive and significant in Kota and Jhunjhunu districts of period I and overall period. Growth rates of production in fenugreek was found negative in Sikar district during period I and in Kota and Sikar districts during period II due to negative growth in area of fenugreek seed spice. Growth rate of productivity in fenugreek was recorded positive and significant only in Kota district during all three periods.

Boyal *et al*. (2015) studied growth and instability in production of cumin in Rajasthan. They studied that, the spices production in India was 5744 thousand MT from an area of about 3070 thousand hectares in the year 2012-13. Growth rate of cumin production was found positive and significant only in Barmer district during period I and negative growth rates were recorded in Jalore, Jodhpur districts and Rajasthan during period I, Barmer district and Rajasthan during period II and Jalore districts during overall period. The growth rates of area were significantly increased only in Barmer and Jodhpur districts during period I and overall period. Almost negative growth rates in productivity were observed from selected districts and Rajasthan during period I (except Barmer district), period II(except Jodhpur district) and overall period(except Jalore district).

Ganesan (2015) evaluated growth and instability in area, production & productivity of turmeric in selected states in India. The results revealed that, all the selected states registered significant growth in area, production and yield of turmeric, except in the case of area in Andhra Pradesh and Orissa, production in Andhra Pradesh, Karnataka and Orissa and yield in Andhra Pradesh, Karnataka, Orissa and Kerala.

Govindasamy (2015) studied production and export performance of cardamom in India. The author observed that, the area indices were maximum at 102.04 during the reference period the estimated Compound Growth Rate of area under cardamom was negative which was estimated to be -0.32 per cent per annum. The indices of production of cardamom reached maximum during the year 2005-06 with 119.65 per cent. The annual Compound Growth Rate was negative with the magnitude of -4.12 per cent per annum during the reference period. The indices for productivity were maximum in 2005-06 135.69 per cent and minimum in 2011-12 87.94 per cent. The indices were less than 100 years 2009-10, and 2010-11. The estimate Compound Growth Rate for negative productivity of cardamom was -0.88 per cent. The total production of Cardamom increased during the reference period was about 4177860 Million tonnes of which 10.45 per cent was due to increased in productivity, 88.28 per cent was due to interaction of both area and productivity.

Joshi and Singh (2015) studied an empirical analysis of growth and instability in major spices in India. The study has observed that, almost all the spices have recorded a positive and significant growth rate in all the sub-periods. Sub-period II (1990-91 to 1999-00) is comparatively stable in terms of area, production and productivity in all the spices which also recorded a higher growth rates. Sub-period III (2000-01 to 2012-13) however witnessed fluctuations in growth rate in most of the spices. Variations in weather and price fluctuations were observed as the main factors affecting growth and instabil-ity in spices in India. So, plans should be formulated to make spice sector more research oriented to prevent it from vagaries of weather and also plan should be oriented towards creation of efficient markets.

Naik and Hosamani (2015) studied the growth and instability analysis of turmeric in India. The results of the growth rate analysis revealed that, the growths in area, production and productivity were found to be higher during pre- World Trade Organisation (WTO) period

Whereas, in the case of Karnataka, the growth rate for production and yield were found to be higher during post-WTO period. that, during pre-WTO period the growth rates in area, production and productivity of turmeric were 3.45 per cent, 8.09 per cent and 4. 48 per cent respectively with an average value of 104971 ha area, 299486 tonnes of production and 2688 kg/ha productivity and found to be significant at one per cent level of significance. Whereas, in the post-WTO period the growth rates of area, production and productivity of turmeric were 1.99 per cent, 3.96 per cent and 1.94 per cent respectively with an average value of 163806 ha area, 686337 tonnes of production and 4165 kg/ha productivity and found significant at one per cent level of significance.

Rajanbabu (2015) studied growth and Instability in production of Indian Spices. He found that, growth rate for spices demand in the world is around 3.19 per cent just above the population growth rate. Almost all the states in the country produce one or other spices. Among the 15 spices producing states, 8 states recorded positive sign growth in all the indicators during the period under review. It is important to note that Kerala has shown negative growth in all the indicators. Therefore, government needs to make concerted efforts for increasing the productivity of spices. India can withstand competition only by increasing productivity and reducing cost of cultivation per unit of production. The growth of spices production will lead to a significant growth in on-farm employment opportunities as spices are labour intensive crops.

Boyal and Mehra (2016) studied growth rates of major seed spices in Rajasthan and export performance from India. This study has made an attempt to analyze the past trend of export of Indian spices industry. Analysis of past trend implies the spices industry has an inconsistent growth. The results revealed that the growth in area and production of major seed spices in Rajasthan was found to be positive, while growth in productivity of cumin in Jodhpur and Rajasthan were

found to be negative and fenugreek productivity was also found negative in Sikar district. The exports growth of selected seed spices in terms of quantity and value were found to be increasing.

Patil and Kerur (2016) studied growth and instability in onion and garlic in Indian. markets.. The study revealed that, for onion, area, production and productivity CGR was highest in the last ten years. There was a positive growth in area and productivity of onion in India and Karnataka. Attempt has to be made in order to see that, popularization of improved varieties, quality seed production and distribution, expansion of area in nontraditional pockets and contract production for export. Productivity of garlic expressed the negative trend which can be enhanced through improved cultural practices, distribution of planting materials, disease control measures, and selection of appropriate crop according to agro climatic conditions and irrigation facilities.

Daya Suvagiya *et al*. (2017) studied growth performance of major spices in Gujarat state. The study reveals that, growth performance of major spice crops was found to be significant increase in production (11.35% / annum) and yield (3.82% / annum) in Gujarat during 1994-95 to 2012-13. The area under spices increased at the highest rate (10.37%/ annum) in Saurashtra region while the highest rate of increase in production (22.95 % / annum) and yield (14.33%/ annum) was observed in South Gujarat region. The district of Porbandar, Dang and Narmada registered the highest rate of growth, respectively in area, production and yield of species. The negative and significant growth of productivity of spices, in Junagadh and Porbandar districts and non significant growth in Saurashtra region shows the matter of concern for the region.

Patel *et al*. (2017) studied growth rate of chilli production in Raigarh district of Chhattisgarh. The present study has analysed the growth rate of chilli production in Raigarh district of Chhattisgarh. Knowledge of the growth trend in area, production and productivity of a

crop is an important ingredient of perspective planning and policy decisions. In Raigarh district, growth rates of area, production and productivity has increased due to very suitable climatic condition, good market availability, timely availability of quality inputs and the effective extension work. But, in Chhattisgarh, decreasing trend is seen growth rate of area whereas production and productivity had been positive. The figures clearly indicate that, production of this crop is not only increasing due to increase in area under crop but productivity of chilli is also contributing to the production significantly. Thus, the government must come forward to concentrate more on chilli production through research and development, which has more scope for export earnings.

Ganga Devi and Jadav (2018) studied the growth performance in area, production, productivity and export of spices in India. They studied the compound growth rate and instability index in area, production and productivity over last ten years were analyzed based on secondary data collected from the website www.indiastats.com. India has achieved positive growth rate in production (1.79%) and productivity (3.04%) over the years. It also indicates that increasing trend in productivity leads to increase in production. In case of area the negative growth rate was found over the years due to diversification of agricultural field crops. Furthermore, the study showed low variability index in productivity. The spices crops recorded positive higher growth in export and a very less growth in import over last years in terms of value earned.

Singh *et al.* (2018) studied the growth in onion crop production in India under WTO regime. The results of the study revealed that the area, production and productivity of onion in India has increased during the entire period of study. The highest growth rate in area was registered by Maharashtra (6.94 per cent) followed by Rajasthan (6.33 per cent). During pre-WTO period the highest growth in area under onion was registered by Rajasthan (4.68%) followed by Karnataka (4.27%) while during post-WTO period highest growth rate in area was

observed in Maharashtra (10.33%) followed by Madhya Pradesh (9.82%). In Tamil Nadu it was non-significant during pre-WTO period and onion production in Uttar Pradesh (1.11%) was non-significant but positive and has been declined during post-WTO period. The highest growth rate in onion production during pre and post-WTO period was in Bihar (15.40%) and Madhya Pradesh (13.30%), respectively. While during overall period it was registered highest in Rajasthan (9.62%). The highest increase in onion productivity was in Andhra-Pradesh (3.27%) followed by Rajasthan (3.09%) during entire period and declined in Tamil Nadu and Uttar Pradesh at the rate of -0.05and -0.02 per cent per annum, During pre-WTO period, the significant positive growth rates were observed in Andhra Pradesh, Bihar and Rajasthan. While in Uttar Pradesh, onion productivity has non-significant declined positively. During post-WTO period, significant positive annual growth rates were observed in Maharashtra, (1.18%), Karnataka, (7.69%), Bihar, (6.53%), Andhra Pradesh (1.14%), Madhya Pradesh (3.71%), Rajasthan (6.68%) and Uttar-Pradesh (2.00%).

Meena *et al.* (2018) studied production and export performance of major seed spices in India during pre and post-WTO period. During overall period all the seed spices made significant positive and higher growth than total spices, consequently per cent share of seed spices in spice economy of India has increased over the period. As result of increase in area coupled with yield improvement made faster growth in production. Cumin and fenugreek registered high growth in period 1 and coriander made faster growth in period 3. Seed spices production sown slower growth in period 2 than period 1 and 3.

Muthupandi *et al.* (2018) studied production and export performance of spices from India. They observed that, compound growth rate in respect of area, production and productivity of Chilli. When comparing the area during the year 2014-15 and 2015-16, the area under total spices found to be increased only to the tune of 5.26 per cent. The production figures in respect of total spices in India found

to show only 12.46 per cent increase during the year 2015-16 over the year 2014-15. Whereas, the area under Chilli during the year 2015-16 is found to show a decreasing trend over the year 2014-15. The decrease in area was taken away by the Coriander, Fennel and Fenugreek whose area were found to be increased during the 2015-16 which are respectively accounted for 13 per cent; 96 per cent and 85 per cent. The production of Chilli also reduced during the year 2015-16.

Potnuru *et al.* (2018) studied growth performance of area, production and productivity of ginger in India – An economic analysis. The performance of ginger was examined by estimating the growth rates and instability index of area, production and productivity of ginger. The results revealed that, compound growth rates for area, production and productivity for period of 20 years were found to be positive and significant at both 1 per cent and 5 per cent level of probability.

Sajjan *et al.* (2018) studied the growth performance of area, production and productivity of turmeric in India: An economic analysis. The results revealed that, compound growth rates for area, production and productivity for period of 20 years were found positive and significant at both 1 per cent and 5 per cent level of probability.

Sachin Kumar *et al*. (2019) studied growth trends in area, production and yield of garlic in Haryana vis-à-vis India. The analysis of growth is usually used in economic studies to find out the trend of a particular variable over a period of time and used for making policy decisions. The growth in the area, production and yield of garlic in Haryana vis-à-vis India was estimated using the compound growth function. In Haryana growth rates showed a significant positive growth in area, production and yield under garlic. Likewise, India as a whole country also showed a significant positive growth in area, production and yield under garlic.Maximum area in India under garlic was cultivated in 2016-17 i.e. 321 thousand hectares while minimum area under garlic was cultivated in 2000-01 which was 74.9 thousand hectares. In case of production, Maximum production of garlic in 2016-

17 i.e. 1693 thousand metric tonnes. Maximum yield under garlic was taken in year 2010-11 i.e. Six metric tonne per hectare.

Gade *et al.* (2020) studied growth and instability in area, production and yield of Chilli in India. Analysis shows compound growth rate of area of chilli in India was negative and significant, whereas production and yield was positive and significant.

The above review represented growth rate of area, production and productivity of crop. Angles and Hosamani concluded that, all the states registered significant growth of turmeric in area, production and productivity except area in case of Tamil Nadu and Kerala, production in Tamil Nadu and productivity in Karnataka. Ganesan concluded that, all the selected state registered significant growth in area, production and yield of turmeric except in case of area in Andhra Pradesh and Orissa, Production in Andhra Pradesh, Karnataka and Orissa and yield in Andhra Pradesh, Karnataka, Orissa and Kerala. Srividyarani concluded that, compound growth rates of area, production and productivity for period of 20 years were found positive and significant at both 1 per cent and 5 per cent level of probability.

2.2 Instability in crop production

Angles and Hosamani (2005) studied the instability in area, production and productivity of turmeric in selected south Indian states. The instability in area and productivity of turmeric indicated that, the area in the case of Andhra Pradesh and Tamil Nadu showed instability, while Kerala showed stability. But, in the case of yield, except Karnataka all other states showed instability.

Angles and Hosamani. (2006) studied the impact of globalisation on Indian turmeric trade and production. The coefficients of variations were worked out for turmeric production and trade in India for the three periods to analyse the extent of instability. It was observed that, the area was almost stable in all the periods compared to productivity and production. The area devoted to turmeric crop in important states over

the years remained almost same. The release of new varieties and innovative cultural practices developed in the recent years were responsible for the variations in productivity which affected the levels of production in different years.

Naik and Hosamani (2013) evaluated the growth and export dimensions of turmeric. The instability index for area during post-WTO period (7.45%) was lower compared to pre-WTO period (7.92%) and overall period (8.34%). Instability index for production of turmeric was also lower in post-WTO period (10.09%) than both pre-WTO period (18.64%) and overall period (16.64%). Similarly, the instability index for yield of turmeric in post-WTO period (9.69%) was lower than both pre-WTO period (12.44%) and overall period (12.68 %). These fluctuations in yield of turmeric were mainly influenced by the rainfall and other climatic factors.

Soumya *et al.* (2014) studied the growth and instability in production and export of selected spices of India. The study concluded that, area, production and productivity were found to be stable while export was found to be unstable in case of pepper. Similarly, at all India level, in case of cumin, area, production and productivity were found to be stable while export was found to be unstable. In case of coriander, area and productivity were found to be stable while production and export was found to be unstable.

Anju Jacob and Elsamma Job (2015) studied pepper production and export from India:. The export quantity and value of pepper exemplified high instability where as the instability in area, production and productivity of pepper were comparatively low. Other pepper producing countries like Vietnam, Srilanka etc. are posing serious challenge to Indian pepper export in the International market. Appropriate measures should be taken to stabilize the prices in domestic and international markets. The supply of pepper should be regulated in order to prevent fall in price. As majority of pepper growing farmers are small and marginal farmers, incentives should be given to

prevent them from shifting to other crops.

Boyal *et al.* (2015) studied the growth and instability in area, production and productivity of fenugreek in Rajasthan. The magnitude of instability in production of fenugreek crop was higher compared to area and productivity in the selected districts as well as in the state as a whole except Jhunjhunu district during period I and in Kota district during period II and overall period (in all the three measures) where the variation in area was more. It implied that the destabilizing effect was more on production than that of area and productivity of fenugreek.

Boyal *et al*. (2015) studied growth and instability in production of cumin in Rajasthan. The magnitude of instability in cumin crop was higher in production as compared to productivity and area except barmer district during period I, where the variation in productivity was more. This showed that the destabilizing effect was more on production compared to area and productivity.

Ganesan (2015) evaluated growth and instability in area, production & productivity of turmeric in selected states in India. The results revealed from the analysis that, the instability in area was reduced in Andhra Pradesh, production instability was reduced in Andhra Pradesh and Tamil Nadu, yield instability was reduced in Tamil Nadu and Karnataka. It can be concluded from the above analysis that liberalization measures introduced in 1991 is a mixed bag and its impact on agriculture sector, particularly on Turmeric Cultivation would vary from state to state.

Joshi and Singh (2015) studied an empirical analysis of growth and instability in major spices in India. They observed that, the area instability first declined to 7.15 per cent in the second sub-period but further increases to 11.48 per cent in the third sub-period. It, however, needs to be notice that the yield insta-bility in turmeric reduces almost to 50 per cent in third sub-period from the previous sub-period. The fluctuations in yield of turmeric were mainly influenced by the rainfall

and other climatic factors. Favorable weather conditions prevailing in the major turmeric growing areas in the country (Andhra Pradesh, Tamil Nadu, Odisha, Karnataka and West Bengal) and the important steps taken by the Spices Board, such as providing drying sheets to small and marginal growers of turmeric and other spices for drying under hygienic conditions, providing subsidies for the small and marginal farmers for the construction of concrete drying yards and warehouses, organization of training programmes for growers on improved technologies, have led to increased productivity of turmeric in this period. Besides, release of high-yielding varieties over the years also has made a significant contribution.

Naik and Hosamani (2015) studied the growth and instability analysis of turmeric in India. The instability index for area during pre-WTO period (15.88%) was lower compared to post-WTO period (40.52%) and overall period (37.21%). Similarly instability index for production of turmeric was also lower in pre-WTO period (54.54%) than both post-WTO period (69.00%) and overall period (79.04%). Whereas, the instability index for yield of turmeric in post-WTO period (24.18%) was lower than both pre-WTO period (51.53%) and overall period (63.45%). This indicated that, the farmers perceived the high profitability of turmeric production but they were not encouraged by the spice producing and marketing agencies. This may be due to stability in yield of turmeric during post-WTO period.

Rajanbabu (2015) studied growth and instability in production of Indian Spices. The production of spices in India has increased substantially over the years due to the growing importance of the crop in both domestic and international market. The instability index of area of cultivation, production, and productivity of spices were order of 7.22, 13.34 and 8.07 respectively. It shows that the spices production became stable with the passage of time. The growth of spices production will lead to a significant growth in on farm employment opportunities as spices are labour intensive crops. Further, there is

substantial scope for value addition in spices.

Patil and Kerur (2016) studied growth and instability analysis of onion and garlic in India. markets. They concluded that, the instability index in the Karnataka state were extreme variations that is with respect to area it was 17.81 per cent, production to be 37.17 per cent and productivity was 38.03 per cent. Instability index indicated that in case of area it was 32.85 per cent, production 39.18 and productivity was around 13.93 per cent at the country level. The variation in area and production was high which was only due to the majority of the farmers are shifting from garlic crop to other commercial crop. Since the garlic crop is highly susceptible towards the diseases and it is difficult to control the disease. It was also observed that instability was at par in production and productivity. Variation in production was due to the cultivation practices with different varieties of garlic that were produced in the state.

Bagalkoti *et al.* (2019) studied instability analysis of productivity and production of cardamom. The study was conducted for the period of 1980-81 to 2014-15. The instability in the production, productivity of cardamom was estimated using coefficient of variation and Cuddy Della Valle index. The results revealed that CV of production and productivity of cardamom was 30.69 per cent and 35.69 per cent respectively. The Cuddy-Della Valle Index resulted that the instability of cardamom production over the periods was 12.62 per cent and the productivity was 11.25 per cent.

Gade *et al.* (2020) studied growth and instability in area, production and yield of chilli in India. The instability in area, production and yield was estimated by Cuddy-Della Valle Instability Index. Coefficient of Variation of chilli area was found to be 0.09 per cent i.e. low variability and Cuddy-Della Valle instability Index (CDI) 0.07 per cent that was also low instability. Coefficient of variation of chilli production and yield was observed to be 0.26 per cent and 0.30 per cent, respectively and that was highly instable. Cuddy-Della Valle

instability Index (CDI) for production and yield was observed to be 0.13 per cent and 0.12 per cent respectively. Here it is observed that, area consist lower instability rate, were production as well as yield shows higher instability rate.

Subin Thomas *et al.* (2020) studied economics of growth and instability of green cardamom in India: Kerala, Tamil Nadu, Karnataka. The study was focused on the growth rate and instability in area, production and productivity in India (Kerala, Tamil Nadu and Karnataka). During pre-WTO period, instability in area, production and productivity of Karnataka is the lowest among the above three states of India. During the post-WTO period the instability was recorded highest in Tamil Nadu in terms of area in relation to other states. Contrary to this, Kerala recorded lowest instability in area, production and productivity respectively. During the overall study period, green cardamom area registered in Karnataka and Tamil Nadu instability which is higher when compared to the pre-WTO and post-WTO periods. Lowest instability in green cardamom area registered under Kerala during the overall period (1986-87 to 2017-18).

Above review represented instability in crop production. Angles and Hosamani concluded that, the area in case of Andhra Pradesh and Tamil Nadu showed instability in turmeric, while Kerala showed stability but in case of yield, except Karnataka all other states showed instability. Naik and Hosamani concluded that, the instability index of area, production and productivity of turmeric during post WTO period was lower compared to pre WTO period and Overall period. Ganesan concluded that, the instability of turmeric in area was reduced in Andhra Pradesh, production instability was reduced in Andhra Pradesh and Tamil Nadu and yield instability of turmeric was reduced in Tamil Nadu and Karnataka.

2.3 Trends in area, production and productivity

Govindasamy (2014) reported information on production and

export performance of turmeric in India. The area indices worked out for Turmeric showed a fluctuating trend. General trend of production indicated that it had increased from 462900 tonnes during the year 1995-96 to 1167000 thousand tonnes in year 2012-13 with some fluctuation is in the intervening year. The production of Turmeric was maximum during the year 2012-13 with 1167000 tonnes. the productivity trend of India shows that it has increased from 3323 kg per hectare in the year 1995-96 to 5329 kg per hectare during 2012-13, with some fluctuation in the intervening year. The productivity of Turmeric reached the highest during the period 5329 kg per hectares.

Singh (2015) studied trend analysis of onion (*Allium cepa*) exports from India. The study includes trend of exports of onion from India are analyzed by empirically fitting different types of trend curves to annual export data of onion from the year 1950-2015. Six types of trend curves like Linear, Logarithmic, Quadratic, Cubic, S-curve and exponential curves are fitted to the data. It is evident from the result that, the cubic curve fits the data best followed by exponential, then quadratic, linear, logarithmic and the S curve with R square values 0.903, 0.868, 0.839, 0.610, 0.332 and 0.218 respectively. The parameters of the different models were significant at 1% or 5% level of significance.

Govindasamy (2015) studied production and export performance of cardamom in India. Area, production and productivity of Cardamom has constant trend of reference period. Kerala is the pre dominate production of Cardamom in India after Karnataka and Tamil Nadu. Export of Cardamom had increasing trend. But, it is not enough, so Government of India should be steps taken by way of an increasing area (or) an increasing productivity of Cardamom by way of many subsidies (Fertilizer, Pesticides, High yielding Varieties of seeds) given by the farmers.

Manoharan and Ramalakshmi (2015) studied the trends of area, production and productivity of garlic in dindigul district, India. The trend,

growth rate and magnitude of variability of major garlic producing districts in Tamil Nadu was studied, where both Erode and Nilgiris showed positive trend but without significance From this, it is evident that there is insignificant increase in garlic production in these districts. The garlic production is increasing at the rate of 2.56 per cent per annum and 1.63 per cent per annum for Nilgiris and Erode districts respectively. From this, it is evident that there is insignificant increase in garlic production in these districts. The garlic production is increasing at the rate of 2.56 per cent per annum and 1.63 per cent per annum for Nilgiris and Erode districts respectively.

Sharma (2015) studied trends of area, production and productivity of spices in the northeastern region. The R^2 Value of Exponential function for all three aspects, viz; area, production and productivity for major spices in the NE region were higher than linear and quadratic functions. Hence the exponential functional form was selected for fitting trend of area, production and productivity of major spices in NE region of India. The value of a and b in the exponential functional form for area, production and productivity were positive and significant for major spices. This indicated that,the acceleration in growth of area production and productivity of the major spices.

Sathish *et al.* (2017) studied an analysis of growth rate and trend of chilli in Telangana. The necessary assumption of randomness of residuals was checked using one sample run test. The results unconcealed that linear and compound growth rates of area, production and productivity of chilli in Telangana were ascertained to be in considerably increasing trend throughout the study. Among all the trend models, polynomial trend was found to be the best fitted one for all the aspects of Telangana state. The analysis forecast chilli production for the year 2018 to be 308.66 t. These projections can facilitate formulation of appropriate policies and steps to be taken to improve the crop production further.

Choudhary and Kalita (2018) studied trends of area, production

and productivity of turmeric in Assam, They observed that, R^2 values of quadratic function for all the three aspects of turmeric crop, viz., area, production and productivity for all fruit crops were higher than linear and exponential functions. Hence, the quadratic functional form was selected for fitting the trend of area, production and productivity of turmeric crop based on the fitted trend of production The „C‟ value in the quadratic functional form for area, production and productivity of turmeric crop, which were positive and significant This implies the acceleration of growth of area, production and productivity of the crop in the State.

Mishra *et al*. (2018) studied the statistical investigation of production performance of cumin in India. For this study parametric models were explored to trace the trends of the production and trade behaviour. To workout the trends in area, production and yield of cumin different parametric model like polynomial, logarithmic, compound, growth, and exponential models are attempted. among the competitive models the best model is selected on the basis of the maximum R2 value, In all data series of area, production and productivity of cumin in major states and whole India, non-linear patterns are revealed that, area and production series of Gujarat and Rajasthan fitted well with quadratic model and cubic model respectively. Productivity of both states and all data series of whole India follow the linear trend. Positive nature of third coefficient indicates increasing in recent past in area and production of cumin in Rajasthan. Linear trend in productivity indicates that there is no change in productivity of cumin over the study period.

Siti Mir‟atul Khasanah *et al.* (2019) studied trend analysis of red chili price-formation models. The study found a rising trend in prices in the Sleman Regency from January 2014 to December 2016. The results reveal a trend in red chili prices at the farmer level in Sleman Regency. The trend can be expressed by Y = 11,747 + 321X. The results of the analysis show that the trend line has an increasing tendency. That indicates that overall the price of red chili increased

from year to year. The factors significantly influencing the red chili prices was the price of cayenne pepper. The production cost of chili, the price of tomatoes, and the price of chili for the previous 2 months had only partial and nonsignificant effects.

Baviskar *et al.* (2020) studied trends and decomposition of wheat production in western Maharashtra. The results revealed that, among the parametric models fitted to the area, production and productivity under wheat crop, the maximum R^2 was observed in the case of cubic model in all the districts of Western Maharashtra region including region as a whole in comparison to that of other parametric models. the trend in area, production and productivity the highest R2 was observed in Dhule district i.e. 91 per cent, 99 per cent and 86 per cent respectively in comparison to that of other districts of Western Maharashtra region. However, the region as a whole recorded highest R^2 in productivity i.e. 59 per cent than area and production.

Pusadekar *et al.* (2020) studied the Trend and decomposition analysis of groundnut in gujrat. The trend have been fitted on the time series data. The slope of the curve is given by the value associated with year (x). Trend analysis provides the rate of change of particular variables during the period of reference and the direction of change but it fails to provide the rate of change per annum. The trend in area, production and productivity of groundnut in Gujarat was estimated and presented . It is seen that, the cubic function was best fitted to area, production as well as productivity. The cubic functions were best fitted by considering the highest value of R2.

The above review represented trends in area, production and productivity. Abhishek Singh concluded that, the cubic curve fits the data best followed by exponential, then quadratic, linear, logarithmic and S curve with R square value 0.903, 0.868, 0.839, 0.610 and 0.218 respectively. Sharma concluded that the R^2 value of exponential function of all three aspects viz; area, production and productivity for major spices in the North Eastern region were higher than linear and

quadratic function. Chaudhary and Kalita concluded that, R^2 value of quadratic function for all three aspects of turmeric crop viz; area, production and productivity for all fruit crop were higher than linear and exponential, the „c" value in the quadratic function form for area, production and productivity of turmeric crop which were positive and significant.

2.4 Decomposition of output growth

Minhas and Vaidyanathan (1965) studied growth of crop output in India. They conducted one of the first major studies using decomposition model to identify the sources of change in growth of crop output in India for the period 1951-54 to 1958-61. They decomposed the growth of crop production into four components. In their study, they observed that area and yield contributed significantly in the growth of total output, whereas a small part of increase was attributed to change in cropping pattern and to interaction term between yield and cropping pattern. Subequently, in 1966 Minhas improved upon his earlier four-component model by adding interaction terms to seven-component model.

Tayade *et al.* (2013) studied decomposition analysis of agricultural growth. The study revealed that, the area effect was most stronger factor for increasing production of jowar in all the districts and except Akola district i.e. -305.22 per cent. At overall period, the result were clearly indicates that the yield effect was most responsible for production of cotton in all districts of Amravati division as a whole. During overall period, the area effect was most responsible factor for increasing soybean production in Amravati division i.e. 46.98 per cent with positive yield and interaction effect i.e. 1.91 and 51.41 per cent respectively.

Govindasamy (2014) reported information on production and export performance of turmeric in India. The study included the effect of production, area and interaction of Turmeric production in India

during the period 1995-96 to 2012-2013 area calculated. The total production of Turmeric increased during the reference period was about 79700 Million tonnes of which 37.64% was due to increase in productivity; 39.63% was due to interaction between both area and productivity. Area effect is more than yield effect in the case of change in total production in Turmeric. The area effect was maximum in Kerala 100 which was followed by west Bengal 76.74 and Karnataka 65.97 respetivel. The Interaction effect was maximum in Andhra Pradesh 24.76 which was followed by Orissa 17.50 and Assam 7.27 respectively.

Govindasamy (2015) studied production and export performance of cardamom in India. The Effect of production, area and interaction of Cardamom production in India during 2000-01 to 2011-12 are calculated. The total production of Cardamom increased during the reference period was about 4177860 Million tonnes of which 10.45 per cent was due to increased in productivity, 88.28 per cent was due to interaction of both area and productivity. Area effect is more than yield effect in the case of change in total in production in Cardamom.

Vikram sandeep *et al.* (2015) studied the decomposition analysis and acreage response of chickpea in western Vidarbha. During period I , the result clearly indicate that the area effect 65.00 per cent was most responsible for increasing the production of chickpea in Amravati division with yield effect 12.57 per cent and interaction effect 21.99 per cent. Interaction effect was positive for all the districts and Amravati division. The Yavatmal district has recorded highest area effect i.e. 72.48 per cent. Akola district showed all the effect nearer to be proportional and in other area effect has played a driving force in the differential production of chickpea in Amravati Division during first period. during period II, it was noticed that yield effect has got domination over the area effect. During overall period, interaction effect was found most responsible factors for increasing chickpea production in Amravati division i.e. 55.69 per cent with positive yield and area

effect i.e., 6.78 per cent and 37.44 per cent, respectively. Highest area effect was recorded in Buldhana district i.e. 58.25 per cent with both yield and interaction effect i.e. 6.88 and 34.87 per cent, respectively. And it is also recorded that highest interaction effect and lowest yield effect was found in Yavatmal district i.e. 65.24 per cent and 6.61 per cent, respectively.

Vikram Sandeep *et al.* (2016) studied the decomposition analysis and acreage response of pigeonpea in western Vidarbha. The study revealed that, during period I, the result clearly indicate that the area effect 83.04 per cent was most responsible for increasing the production of pigeonpea in Amravati division with yield effect 9.24 per cent and interaction effect 7.91 per cent. Interaction effect was positive for all the districts except Akola which shows interaction effect of -24.19 per cent with yield effect -25.27 per cent and the district has recorded highest area effect i.e. 149.16 per cent. In all the districts yield effect was also found negative only in the Akola district. during period II, it was noticed that yield effect (79.23%) was responsible for increasing production of pigeonpea, whereas area and interaction effect was 23.52 and -3.16 per cent respectively During overall period, area effect (56.61%) was found most responsible factors for increasing pigeonpea production in Amravati division with positive yield and interaction effect i.e. 18.91 and 23.75 per cent respectively. Highest area effect was recorded in Buldhana district (103.02%). The highest interaction effect and yield effect was found in Akola district 28.24 and 42.93 per cent respectively.

Chaudhari and Singh (2017) studied growth and decomposition analysis of mango and sapota in South Gujarat. The study revealed that, in case of mango yield was the most responsible factor in production in Bharuch (45.36%), Dang (35.55%), Narmada (48.06%) and Tapi (38.95%) district whereas contribution of area was 57.99 per cent, 53.57 per cent and 42.44 per cent in Navsari, Surat and Valsad district, respectively. At the South Gujarat region level increase in area

was the most responsible factor in increase in production of mango followed by yield. Further depicted that in most of districts area played a major role in production of sapota. The area effect worked out in Tapi, Dang, Narmada, Surat and Bharuch district, respectively. In Valsad and Navsari district yield was more responsible factor for production of sapota. The yield was most contributing factor in production of sapota followed by area at South Gujarat region level.

Sharma *et al*. (2017) studied growth rates and decomposition analysis of onion production in Rajasthan state of India. The study revealed that, during the period of 1986-1995 and 1996-2005 an increase in output for onion was mainly due to increase in yield with the respective yield contribution towards productivity for these crops of 49.29 and 84.82 per cent. The area effect was the major driving force for onion output growth in 2006-2015. About 50.54 % growth in onion was due to area effect which more than offset the yield effect of 30.33 % in onion. In India, the main source of output growth of onion 85.37 per cent (period 1986-1995), 59.48 per cent during 1996-2005 and 60.25 per cent during 2006- 2015 was due to yield effect. The decomposition analysis of the growth of onion crops over the entire study period (1986 to 2015) revealed that growth in production of onion was mainly due to yield effect 56.69 per cent.

Latika devi *et al.* (2017) studied pulse production in India : trend and decomposition analysis. The study revealed that, during 1995-2005, all the three effects are positive and yield effect is very high accounting for 93.96 per cent. However, in the next period (2006-2014), the area and interaction effect was negative, indicating the production increase was solely due to yield effect. When the entire time period is considered (1995-2014), all three effects were found to be positive and yield and area effects contribute 88 and 8 per cent respectively towards the increase in total production.

Shende *et al.* (2017) studied growth dynamics and acreage response of paddy in eastern Vidarbha zone of Maharashtra. The study

revealed that, during period I, area effect -28.35 per cent was responsible for decreasing the production of paddy in Bhandara district with yield effect 122.5 per cent and interaction effect 5.77 per cent and in Gadchiroli district with yield effect 107.2 per cent and interaction effect 1.9 per cent. And also for Chandrapur district area effect was -23.89 per cent which was responsible for decreasing the production of paddy Interaction effect was positive for all the districts In all the districts yield effect was also shown positive. In all district yield effect had played a driving force in the differential production of paddy in during I period. In the contrary during period II, it was noticed that yield effect has got domination over the area effect. In Bhandara district area effect was found 17.93 per cent whereas yield effect was 75.81 per cent and interaction effect was 13.12 per cent. In all the districts yield effect has got higher record *i.e.* more than 60 per cent. It is also recorded in this period that interaction effect is positive in all the districts in eastern Vidarbha region of Maharashtra. During overall period, area effect was found most responsible factors for increasing paddy production in all district of eastern Vidarbha region. Highest area effect was recorded in Chandrapur district with both negative yield and interaction effect. Bhandara district also recorded negative yield in this overall 30 years period .where remaining districts has got all the positive effect. And it is also recorded that highest interaction effect was found in Bhandara district and yield effect was found in Gadchiroli district.

Jain *et al.* (2019) studied decomposition analysis of major cereal crops in different agroclimatic regions of Chhattisgarh. The study revealed that, the yield effect is dominating over area effect in all the agro climatic regions. The contribution of yield towards increase in the production of paddy and maize crop was found to be higher than area in all the agro climatic regions and in the state. In case of wheat crop, yield effect is dominating over area effect in all the agro climatic regions and in the whole state, except Bastar Plateau in which contribution of area towards increase in the production is more than

yield. Yield effect of paddy is higher than other two crops, and area effect of wheat is higher than paddy and maize.

Devgowda *et al.* (2019) studied effect of area and yield on the production of pulses in India. The study revealed that, during Period Ⅰ (1990-00) masoor showed negative effect by yield, gram arhar total pulses showed negative effect by area and except gram all other pulses showed negative interaction effect on production. Period Ⅱ where horse gram showed negative effect of yield, masoor showed negative effect of area and interaction effect on production of pulses. In Period Ⅲ where all pulses showed positive effect in yield, except gram and moong all other pulses showed negative effect of area and all pulses indicated negative interaction effect except gram on production. For overall period negative effect of yield indicated by horse gram, negative area and interaction effect by moong and udid. Over all study concluded that yield effect is higher than area effect fallowed by interaction effect in pulse production.

Shilpa *et al.* (2019) studied trends, growth and variability of Apple in Himachal Pradesh:1973-2016. The study was conducted for two period i.e. Period-I (1973-74 to 1990-91) and Period-II (1991-92 to 2015-16). The results revealed that, production variation in all areas in Himachal Pradesh during P-I was due to area effect except marginal areas, whereas P-II was marked by yield effect in all apple growing areas on the account of varietal improvement. But, the overall increase in production was due to area expansion except marginal areas. Therefore, efforts should be made to improve the technology as well as extension of the technology to the farms through different research and extension agencies in the state to improve productivity of apple.

Baviskar *et al.* (2020) studied trends and decomposition of wheat production in western Maharashtra. The results revealed that, during period-I, area effect was the most responsible factor for change in production in Ahmednagar district i.e. 1265.31 per cent. On the other

hand, in Nashik district yield effect was the most powerful factor for change in the production of wheat with 154.53 per cent. As regard to region as whole area effect (74.99 per cent) was found most responsible for change in production in the region. During period II, it was observed that, area effect (858.76 per cent) playing major role in change in the production of wheat in Pune district and the yield effect was negative -892.16 per cent per annum. In this period area effect was the most responsible to change in production for all the districts and region as whole i.e. 82.42 per cent. . At overall period, the area effect was the most responsible factor for change in production of wheat in Dhule district i.e. 89.20 per cent with a yield interaction effect 7.60 and yield effect 3.20 per cent. As regard to region as whole area effect almost show positive 56.07 per cent and played major role for the change in production of wheat in Western Maharashtra region and interaction effect almost show negative i.e. -2.93, respectively.

Chavhan *et al.* (2020) studied decomposition analysis of cereal production in Nagpur division. The study revealed that, for crop wheat, during period I, in Wardha district yield effect 72.60 per cent per annum and interaction effect 4.54 per cent per annum. Chandrapur and Gadchiroli district the yield effect was not existence -275.86 and -206.35 per cent per annum respectively. In overall period Gadchiroli showed the highest area effect 596.45 as compare to period I. The Bhandara district showed the highest yield effect i.e. 157.55. Whereas, for crop rice, during period I, the Gadchiroli district has the highest area effect i.e. 979.29. As compare to period I and period II Chandrapur district show the highest yield effect i.e. 151.92 in period II where Nagpur division as whole the period II showed the highest area effect i.e. 201.58.

Ninawe (2020) studied decomposition analysis and acreage response of soybean in Amravati division. The study revealed that, during period I, in all the districts of Amravati division area, yield and interaction effects were positive. The lowest area effect was found in

the Yavatmal district and highest area effect and lowest yield effect was found in Akola district and Buldhana district. The highest yield effect found in Amravati division as a whole and the lowest interaction effect were found in Akola. Thus over all area effect has played a driving force in the differential production of Soybean in Amravati Division during period I. Domination of area effect on yield and interaction effect continues in period II, except for Buldhana and Akola district where interaction effect was higher than area effect. During period III area effect, yield effect, and interaction effect was calculated in whole Amravati division and highest area effect, yield effect, and interaction effect was recorded in district Buldhana and Amravati. Domination of yield effect on area effect and interaction effect was shown. During overall period, interaction effect has recorded domination over area and yield effect.

Pusadekar *et al.* (2020) studied trend and decomposition analysis of groundnut in gujrat. The relative contribution of area and yield to change in output was estimated by using Minhas decomposition model. The per cent contribution of area, yield and their interaction for changing production of groundnut in Gujarat for two periods and overall period was estimated. It is evident from findings that, during period I yield effect was the most responsible factor for changing production in Gujarat i.e. 78.00 per cent whereas area effect was 16.94 per cent and interaction effect was 5.06 per cent. Similar results were seen during period II with yield effect 165.65 per cent as the most responsible factor but area effect and interaction effect were found to be negative i.e. -32.11 and -33.54 per cent respectively. While in case of overall period area effect was seen as the most responsible factor for changing the production in Gujarat i.e. 503.97 per cent with yield effect.

The above review represents decomposition of production growth. Govindasamy concluded that, area effect is more than yield effect in the case of change in total production in turmeric. Chaudhary

and Narendra Singh concluded that, at the South Gujrat region level increase in area was the most responsible factor in increase in production of mango followed by yield. The yield was most contributing factor in production of of sapota. Hemant Sharma *et al.* concluded that area effect was the major driving force for onion output growth. The growth in production of onion was mainly due to yield effect. Shilpa *et al*. concluded that, production variation in all areas in Himachal Pradesh during period I was due to area effect except marginal areas whereas in period II was marked by yield effect in all apple growing area. The overall increase in production was due to area expansion except in marginal area.

Chapter III

METHODOLOGY

The object of any investigation is to draw the useful conclusion in the light of objectives of the study in order to arrive the meaningful conclusions, it is essential for the investigator to adopt appropriate method and procedure, keeping this in view, this chapter has devoted to explain the methodology adopted to fulfill the objectives of the study.

The study has been undertaken to examine the turmeric crop and estimate the relative contribution of area and yield on production and growth pattern of area, production and productivity factors for their roles in cultivators decision making about cropping pattern. The study further attempts to assess the direction. The statistical tool and techniques employed in this study are also highlighted. The whole chapter is presented under the following sub-heading.

3.1 Selection of area

3.2 Period of selection

3.3 Source of data

3.4 Analytical tools

3.1 Selection of area

Turmeric is grown in many states of India. However, the major turmeric growing states are Andhra Pradesh, Odisha, Tamil Nadu, West Bengal, Assam, Maharashtra, Karnataka, Kerala and Madhya Pradesh. These nine major states were selected for analysis. These nine states contribute about 80 per cent of the total turmeric area, production and productivity of turmeric crop.

The data of area, production and productivity of Telangana state has been included in the Andhra Pradesh state, since Telangana state was awarded separate statehood on 2nd June, 2014.

3.2 Period of study

The data were collected on area, production and productivity of turmeric grown in India pertaining to the period from 2000-01 to 2019-20 (20 years) for the analysis of growth and instability, the entire study period was split into two sub-periods and overall as follows.

Period I 2000-01 to 2009-10

Period II 2010-11 to 2019-20

Overall 2000-01 to 2019-20

3.3 Sources of data

The state-wise time series data on area, production and productivity were collected from various Government publications, Ministry of Agriculture and Farmers Welfare, National Horticulture Board (NHB), Horticulture Statistics at a glance 2019.

3.4 Analytical tools

The present study was based on time series secondary data of Turmeric growing states of India. The analysis was done on the following aspects.

3.4.1 Growth rate analysis

3.4.2 Instability analysis

3.4.3 Trend analysis

3.4.4 Decomposition of output growth

3.4.1 Growth rate analysis

The compound growth rates of area, production and productivity of turmeric were estimated for period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20) and overall period (2000-01 to 2019-20).

The state wise compound growth rates of area, production and productivity were estimated by using following exponential model.

$$Y = a.b^{t} \quad \ldots\ldots(1)$$

Where,

Y = Area / Production / Productivity

t = Time Variable

b = Regression coefficient

a= Intercept

The equation was estimated after transforming (1) as follows,

$$\text{Log } Y = \text{Log } a + t \text{ Log } b \quad \ldots\ldots(2)$$

Then, the per cent compound growth rates „r‟ were computed by using the following formula

$$CGR\ (r) = [\text{Antilog } (\log b) - 1] \times 100 \quad \ldots\ldots(3)$$

Where,

r = Compound growth rate.

The significance of the regression coefficient was tested by using student‟s t-test.

3.4.2 Instability analysis

To measure the instability in area, production and productivity, an index of instability was used as a measure of variability through Coefficient of Variation (CV) and Cuddy Della Valle's Instability Index (CDVI).

- **Coefficient of variation (CV)**

Coefficient of variation (CV) = $\frac{\sigma}{\bar{x}} \times 100$

Where,

σ = S = Standard deviation

$$S = \sqrt{\frac{\sum (X - \bar{X})^2}{n}}$$

$\bar{x}$= Arithmetic mean

x = Variable

n = Number of observations

The simple Coefficient of variation (CV) often contains the trend component and thus over estimates the level of instability in time series data characterized by long term trends and Cuddy Della Valle's instability was estimated as follows.

- **Cuddy Della Valle's Instability Index (CDVI)**

It was used to measure instability of turmeric which is close to approximation of the average year to year percent variation adjusted for trend. The algebraic form of it was,

Instability Index = $CV\sqrt{(1 - R^2)}$

Where,

CV = Simple estimates of coefficient of variation in per cent

R^2= Coefficient of determination from a time trend regression adjusted by the number of degree of freedom.

3.4.3 Trend analysis

The trend in area, production and productivity of turmeric was computed for the series data of last 20 years, i.e. 2000-01 to 2019-20. To trace the path of process different parametric trend functions as given in the table below were used. Among the competitive trend functions, the best functions were selected based in their goodness of fit (measured in terms of R^2 value and significance of the coefficients).

Table 3.1 List of different parametric models with their equations

Sr. No.	Name of Function	Equation
1.	Linear	$Y_t = a+b_t$
2.	Logarithmic	Log Y_t = Log a+Log b_t
3	Inverse	Y = f(x); $Y=f^{-1}f(x)$
4.	Quadratic	$Y_t = a+b_t+c_t^2$
5.	Cubic	$Y_t = a+b_t+c_t^2+d_t^3$
6.	Compound	$Y = b_0*(x^b1)$
7.	Power	$Y = b_0*(b_1x)$
8.	Square root	$Y = a+b*\sqrt{x}$
9.	Growth	$Y_t = a+bc$
10	Exponential	$Log(y) = b_0+b_1X$

Where,

a, b and t represents constant, coefficient and time respectively in the function

3.4.4 Decomposition analysis

To measure the relative contribution of area, yield to the total output of the turmeric crop, Minhas (1964) three factor decomposition analysis model was used, which is given below

$$P_o = A_o \times Y_o \text{ and}$$

$$P_n = A_n \times Y_n \text{ ----------(1)}$$

A_o, P_o and Y_o are area, production and productivity in base year and A_n, P_n and Y_n are values of the respective variable in n^{th} year item respectively.

Where,

A_o and A_n = Area

Y_o and Y_n = yield in the base year and n^{th} year respectively.

$P_n - P_o = \Delta P$

$A_n - A_o = \Delta A$

$Y_n - Y_o = \Delta Y$ ---------- (2)

For equation (1) and (2) we can write

$$P_o + \Delta P = (A_o + \Delta A)(Y_o + \Delta Y)$$

Hence,

$$P = \frac{A_o \Delta Y}{\Delta P} \times 100 + \frac{Y_o \Delta A}{\Delta P} \times 100 + \frac{\Delta Y \Delta A}{\Delta P} 100$$

Production = Yield effect + area effect + interaction effect

Thus, the total change in production can be decomposed into area effect, yield effect and the interaction effect due to change in yield and area.

Chapter IV

RESULTS AND DISCUSSION

The present investigation had been undertaken with a view to study "Turmeric production in India : Trends and decomposition analysis". Keeping in view the objectives of the study, the data collected from various sources were analyzed for a period 2000-01 to 2019-20 using suitable analytical techniques. The results obtained from this study have been presented and discussed critically in this chapter under four major and other sub heading.

4.1 Growth performance in turmeric

4.2 Instability in turmeric

4.3 Trends in area, production and productivity

4.4 Decomposition analysis in turmeric production

4.1 Growth performance in turmeric

In this study, the growth in area, production and productivity of turmeric were estimated using compound growth rates as indicated in the methodology chapter. In this analysis, the general growth performances of the turmeric in India and that of nine major turmeric growing states were examined by fitting exponential growth function with time normalization on area, production and productivity. The growth performance of the turmeric pertaining two periods and overall is discussed separately for each region as under.

4.1.1 Growth rates of area of turmeric in India

The state wise compound growth rates of area of turmeric in India for two periods and overall were worked out and presented in Table 4.1.

Table 4.1 State wise growth rates of area under turmeric in India

(Per cent)

Sr.No.	Name of States	Period I	Period II	Overall
1.	Andhra Pradesh	-0.59	0.32	0.59
2.	Odisha	-0.11	24.79	-5.32
3.	Karnataka	7.86	4.35	6.27**
4.	Tamil Nadu	4.43	-10.24	1.99
5.	West Bengal	2.20*	1.80**	2.17**
6.	Assam	2.05**	1.25**	2.53**
7.	Maharashtra	0.15	6.19	5.28**
8.	Madhya Pradesh	5.56**	34.88**	12.30**
9.	Kerala	-3.66	0.35	-1.86
	India	0.86	2.57	2.24**

Note: Period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20) and Overall period (2000-01 to 2019-20).

Note: **Significant at 1 % level, *Significant at 5 % level.

(CGR: per cent per annum)

The data presented in Table 4.1 revealed that, in period I almost all the states show positive growth rates in area except Andhra Pradesh (-0.59 per cent), Odisha (-0.11 per cent) and Kerala (-3.66 per cent). Karnataka showed the highest positive growth rate of (7.86 per cent) followed by Madhya Pradesh (5.56 per cent) and Tamil Nadu (4.43 per cent). West Bengal, Assam and Maharashtra also showed positive growth rates of 2.20 per cent, 2.05 per cent, 0.15 per cent per annum respectively. Assam and Madhya Pradesh were positively significant at 1 per cent level and West Bengal was positively significant at 5 per cent level. Andhra Pradesh, Odisha, Karnataka,

Tamil Nadu, Maharashtra and Kerala were non significant.

However, in period II all the states showed positive growth rate in area except Tamil Nadu (-10.24 per cent). Madhya Pradesh showed the highest positive growth rate (34.88 per cent) and was positively significant at 1 per cent level, followed by Odisha (24.79 per cent). Maharashtra (6.19 per cent), Karnataka (4.35 per cent), Kerala (0.35 per cent) and Andhra Pradesh (0.32 per cent) all the states showed positive growth rate. West Bengal (1.80 per cent) and Assam (1.25 per cent) also showed positive growth rate and were positively significant at 1 per cent level. Andhra Pradesh, Odisha, Karnataka, Tamil Nadu, Maharashtra and Kerala were non significant.

At the overall 20 years, the compound growth rate of area was positive in all the states except Odisha (-5.32 per cent) and Kerala (-1.86 per cent). Madhya Pradesh showed the highest positive growth rate (12.30 per cent) followed by Karnataka (6.27 per cent), Maharashtra (5.88 per cent), Assam (2.53 per cent) and West Bengal (2.17 per cent) and were positively significant at 1 per cent level. Tamil Nadu and Andhra Pradesh also showed positive growth rate of 1.99 per cent and 0.59 per cent per annum respectively. Andhra Pradesh, Odisha, Tamil Nadu and Kerala were non significant.

In case of India as whole country, the growth rates were positive in both the periods as well as in overall. In period I, the growth rate was 0.86 per cent and in period II it was 2.57 per cent per annum. In the overall period the growth rate was 2.24 per cent per annum and was positively significant at 1 per cent level.

The results of this study leads to the conclusion that, the compound growth rate of area was found to be positive in most of the states except Odisha (-0.11 per cent). The highest positive growth rate was found in Madhya Pradesh i.e 34.88 per cent and was positively significant at 1 per cent level in period II. In whole country there was a positive growth rate of 2.24 per cent and was positively significant at 1

per cent level. Hence, the hypothesis is accepted.

Hence, it is concluded that turmeric area is increasing. Attempt has to be made in order to see that, popularization of improved varieties, quality seed production, expansion of area in non-traditional pockets.

4.1.2 Growth rate of production of turmeric in India

The state wise compound growth rates of production of turmeric in India for two periods and overall were worked out and presented in Table 4.2.

Table 4.2 State wise growth rates of production of turmeric in India

(Per cent)

Sr.No.	Name of States	Period I	Period II	Overall
1.	Andhra Pradesh	3.62	-2.11	0.77
2.	Odisha	6.41	-4.57	-2.70
3.	Karnataka	8.59*	4.26	6.56**
4.	Tamil Nadu	6.48	-14.23	0.86
5.	West Bengal	6.70**	1.67**	4.58**
6.	Assam	2.50**	6.82**	5.97**
7.	Maharashtra	-0.04	14.34	13.21**
8.	Madhya Pradesh	4.88**	59.46**	16.32**
9.	Kerala	-1.59	1.36	-0.49
	India	4.23*	-0.82	3.20**

Note: Period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20) and Overall period (2000-01 to 2019-20).

Note: **Significant at 1 % level, *Significant at 5 % level.

(CGR: per cent per annum)

It could be seen from Table 4.2 that, during period I, the growth rate of production was the highest in Karnataka (8.59 per cent) and is

positively significant at 5 per cent level, followed by West Bengal (6.70 per cent), Tamil Nadu (6.48 per cent), Odisha (6.41 per cent), Madhya Pradesh (4.88 per cent), Andhra Pradesh (3.62 per cent) and Assam (2.50 per cent) all these states showed positive growth rate. West Bengal, Assam and Madhya Pradesh were positively significant at 1 per cent level. Maharashtra (-0.04 per cent) and Kerala (-1.59 per cent) showed negative growth rate. Andhra Pradesh, Odisha, Tamil Nadu, Maharashtra and Kerala were non significant.

During period II, Madhya Pradesh showed the highest growth rate of production i.e. 59.46 per cent and was positively significant at 1 per cent level, followed by Maharashtra (14.34 per cent). Assam and West Bengal also showed positive growth rate of 6.82 per cent and 1.67 per cent per annum respectively and were positively significant at 1 per cent level. Karnataka (4.26 per cent) and Kerala (1.36 per cent) also showed positive growth rate. The remaining 3 states i.e. Andhra Pradesh, Odisha and Tamil Nadu showed negative growth rate of -2.11 per cent , -4.57 per cent , -14.23 per cent respectively. Except Madhya Pradesh, Assam and West Bengal all the other states were non significant.

Whereas, at the overall period, the compound growth rate of production was highest in Madhya Pradesh (16.32 per cent) followed by Maharashtra (13.21 per cent), Karnataka (6.56 per cent), Assam (5.97 per cent) and West Bengal (4.58 per cent) which were positively significant at 1 per cent level. Tamil Nadu and Andhra Pradesh also showed positive growth rate of 0.86 per cent and 0.77 per cent respectively. Odisha and Kerala showed negative growth rate of -2.70 per cent and -0.49 per cent respectively. Andhra Pradesh, Odisha, Tamil Nadu and Kerala were non significant.

In case of growth rate of turmeric production in whole country, the period I and overall period showed positive growth rate of 4.23 per cent and 3.20 per cent respectively and were positively significant at 5 per cent and 1 per cent respectively. Period II showed negative growth

rate of -0.82 per cent and was non significant.

The results of this study leads to the conclusion that, the compound growth rate of production was highest in Madhya Pradesh (59.46 per cent) and was positively significant at 1 per cent level. Andhra Pradesh showed slight growth rate of 0.77 per cent. In whole country there was a positive growth rate of 4.23 per cent and was positively significant at 1 per cent level. Hence, the hypothesis is accepted.

Hence, it concluded that, turmeric production have a much better growth rate in country due to very suitable climatic condition, good market availability, timely availability of quality inputs and effective extension work. The government must come forward to concentrate more on turmeric production through research and development.

4.1.3 Growth rates of productivity of turmeric in India

The data were used for analyzing growth performance of productivity of turmeric in India for period I, period II and at overall level and presented in Table 4.3.

It is revealed from the Table 4.3 that, during period I, the growth rate of productivity was positive in all the states except for Kerala (-2.90 per cent). The highest growth rate was found in Andhra Pradesh (6.79 per cent) followed by Madhya Pradesh (4.25 per cent), West Bengal (2.67 per cent) and they were positively significant at 1 per cent level. Tamil Nadu, Odisha, Karnataka, Maharashtra and Assam also showed positive growth rates i.e. 2.43 per cent, 1.32 per cent, 0.95 per cent, 0.56 per cent and 0.21 per cent per annum respectively. Odisha and Maharashtra were positively significant at 5 per cent level. Karnataka, Tamil Nadu, Assam and Kerala were non significant.

During period II, the compound growth rate of productivity was highest in Madhya Pradesh (21.77 per cent) followed by Maharashtra

(21.05 per cent), Assam (6.41 per cent) and Kerala (5.15 per cent), Where, Madhya Pradesh, Assam and Kerala were positively significant at 1 per cent level. Andhra Pradesh, Karnataka and West Bengal also showed positive growth rates i.e. 3.32 per cent, 0.58 per cent, 0.54 per cent per annum respectively. These three states along with Maharashtra were non significant. Odisha (-8.84 per cent) and Tamil Nadu (-4.49 per cent) showed negative growth rates and were non significant.

Table 4.3 State wise growth rate of productivity of turmeric in India

(Per cent)

Sr.No.	Name of States	Period I	Period II	Overall
1.	Andhra Pradesh	6.79**	3.32	5.04**
2.	Odisha	1.32*	-8.84	1.80
3.	Karnataka	0.95	0.58	0.81**
4.	Tamil Nadu	2.43	-4.49	-1.13
5.	West Bengal	2.67**	0.54	2.39**
6.	Assam	0.21	6.41**	3.29**
7.	Maharashtra	0.56*	21.05	9.62**
8.	Madhya Pradesh	4.25**	21.77**	7.44**
9.	Kerala	-2.90	5.15**	1.70*
	India	3.34*	-3.31	0.93

Note: Period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20) and Overall period (2000-01 to 2019-20).

Note: **Significant at 1 % level, *Significant at 5 % level.

(CGR: per cent per annum)

Whereas, at the overall period, the compound growth rate of productivity was positive for all the states except Tamil Nadu (-1.13 per cent). The growth rate was highest in Maharashtra (9.62 per cent) followed by Madhya Pradesh (7.44 per cent), Andhra Pradesh (5.04

per cent), Assam (3.29 per cent), West Bengal (2.39 per cent), Karnataka (0.81 per cent) and they were positively significant at 1 per cent. Odisha and Kerala also showed positive growth rates i.e. 1.80 per cent and 1.70 per cent per annum respectively. Where, Kerala is positively significant at 5 per cent level. Odisha and Tamil Nadu were non significant.

In case of whole country the growth rates were positive at period I and over all period i.e 3.34 per cent and 0.93 per cent per annum respectively and period I was positively significant at 1 per cent level. Period II showed negative growth rate of -3.31 per cent per annum. Period II and overall period were non significant.

The results of this study leads to the conclusion that, the compound growth rate of productivity was found to be positive in most of the states except Tamil Nadu (-1.13 per cent). The highest growth rate was found in Madhya Pradesh i.e. 21.77 per cent and was positively significant at 1 per cent. Hence, the hypothesis is accepted.

Hence, it is concluded that turmeric appears to be important crop in India. As the area under this crop is increased, the production has the positive growth rate and leads to higher productivity of the crop. Therefore, there is need to concentrate this crop for policy makers and researchers. The results obtained are in close agreement with the findings of Ganesan (2015) he revealed that, all the selected states registered significant growth in area, production and yield of turmeric except in case of area in Andhra Pradesh and Odisha, production in Andhra Pradesh and Odisha and yield in Orissa.

4.2 Instability in turmeric

One should not be obvious of instability by taking the growth rate only, because the growth rate will explain only the rate of growth over the period, whereas, instability judge, whether the growth performance is stable or unstable for the period for the pertinent variable. In order to know the instability in area, production and

productivity of crop, the fluctuation measured with the help of coefficient of variation and mean. The simple coefficient of variation (CV) often contains the trend component and thus overestimates the level of instability in the time series data characterized by long term trend. To overcome this problem, this study used the instability index given by Cuddy Della Valle (1978) which corrects the coefficient of variation. To facilitate better understanding of the magnitude and pattern of changes in the cropped area, level of production and productivity of crop in the different turmeric growing states, instability of area, production and productivity of turmeric crop have been worked out as for Period I (2000-01 to 2009-10), Period II (2010-11 to 2019-20) and Overall period (2000-01 to 2019-20).

4.2.1 Instability of area of turmeric in India

State wise coefficient of variation and Cuddy Della Valle Instability Index of area of turmeric in India was estimated and presented in Table 4.4.

It is seen from the Table 4.4 that, during period I, the coefficient of variation as well as Cuddy Della Valle Instability Index of area was lowest in Maharashtra (1.69 and 1.63 per cent respectively) and highest in Karnataka (40.91 and 30.68 per cent respectively) followed by Tamil Nadu (25.15 and 21.88 per cent respectively). As a whole country, India recorded low instability in area i.e. 8.16 per cent (CV) and 7.79 per cent (CDVI).

During period II, the coefficient of variation of area was lowest in Assam (4.88 per cent) followed by Kerala (4.89 per cent). Whereas the lowest Cuddy Della Valle Instability Index was observed in West Bengal (2.92 per cent) followed by Assam (3.12 per cent). The highest coefficient of variation was observed in Madhya Pradesh (117.41 per cent). Whereas the highest Cuddy Della Valle Instability Index was observed in Odisha (74.11 per cent). Considering India as a whole, the low instability was observed in area i.e. 12.13 per cent (CV) and 9.19

per cent (CDVI).

At overall period, the coefficient of variation for area under turmeric cultivation was observed lowest in Andhra Pradesh (23.46 per cent) whereas, the lowest Cuddy Della Valle Instability Index was observed in Assam (8.47 per cent). The highest coefficient of variation and Cuddy Della Valle Instability Index was observed in Madhya Pradesh (148.98 per cent and 112.63 per cent respectively). Considering India as a whole, the low instability was observed in area i.e. 26.99 per cent (CV) and 15.32 per cent (CDVI).

Table 4.4 State wise area instability indices of turmeric in India

Sr.No.	Name of States	Particular	Period I	Period II	Overall
1.	Andhra Pradesh	CV	8.42	7.58	23.46
		CDVI	8.18	7.51	21.60
2.	Odisha	CV	4.34	88.03	55.48
		CDVI	4.32	74.11	53.75
3.	Karnataka	CV	40.91	29.72	48.21
		CDVI	30.68	25.01	29.39
4.	Tamil Nadu	CV	25.15	44.28	48.39
		CDVI	21.88	31.22	46.81
5.	West Bengal	CV	10.41	6.18	25.56
		CDVI	7.88	2.92	9.99
6.	Assam	CV	8.20	4.88	26.48
		CDVI	5.18	3.12	8.47
7.	Maharashtra	CV	1.69	27.31	44.12
		CDVI	1.63	20.67	24.98
8.	Madhya Pradesh	CV	16.66	117.41	148.98
		CDVI	4.12	67.38	112.63
9.	Kerala	CV	15.46	4.89	26.82
		CDVI	10.31	4.77	17.90
	India	CV	8.16	12.13	26.99
		CDVI	7.79	9.19	15.32

Note: CV-Coefficient of variation (per cent per annum).

CDVI - Cuddy Della Valle Instability Index (per cent per annum)

State wise average area under turmeric cultivation in India was estimated and presented in Table 4.5

Table 4.5 Average area under turmeric cultivation in India

(Area in '000 ha)

Sr.No.	States	Period I	Period II	Overall
1.	Andhra Pradesh	63.03	68.47	65.75
2.	Odisha	24.72	15.07	19.89
3.	Karnataka	9.68	17.36	13.52
4.	Tamil Nadu	26.35	39.71	33.03
5.	West Bengal	13.45	16.72	15.08
6.	Assam	12.45	16.41	14.43
7.	Maharashtra	6.83	12.69	9.70
8.	Madhya Pradesh	1.09	5.12	3.11
9.	Kerala	3.12	2.54	2.83
	India	170.55	217.48	194.02

It is seen from Table 4.5 that, in period I and in overall period, the highest average area under turmeric cultivation was observed in Andhra Pradesh followed by Tamil Nadu and Odisha i.e. 63030, 26350 and 24720 hectare in period I, and 65750, 33030, 19890 hectares in overall period respectively. Whereas in period II the highest average area was observed in Andhra Pradesh followed by Tamil Nadu and Karnataka i.e. 68470, 39710 and 17360 respectively.

4.2.2 Instability of production of turmeric in India

State wise coefficient of variation and Cuddy Della Valle Instability Index of production of turmeric in India was estimated and presented in Table 4.6.

It is seen from the Table 4.6 that, during period I, the coefficient of variation as well as Cuddy Della Valle Instability Index of production was lowest in Maharashtra (3.16 and 3.16 per cent respectively). The highest coefficient of variation as well as Cuddy Della Valle Instability Index was observed in Odisha (57.24 and 49.11 per cent respectively). As a whole country, India recorded low instability in production i.e. 16.83 per cent (CV) and 11.83 per cent (CDVI).

Table 4.6 State wise production instability indices of turmeric in India

Sr.No.	Name of States	Particular	Period I	Period II	Overall
1.	Andhra Pradesh	CV	20.42	13.22	27.32
		CDVI	17.99	11.33	26.72
2.	Odisha	CV	57.24	94.92	74.81
		CDVI	49.11	86.48	73.84
3.	Karnataka	CV	39.03	33.96	51.04
		CDVI	28.27	29.84	32.40
4.	Tamil Nadu	CV	30.63	64.82	60.97
		CDVI	25.53	46.62	60.59
5.	West Bengal	CV	21.38	5.52	33.13
		CDVI	7.41	2.38	8.75
6.	Assam	CV	8.83	20.25	41.98
		CDVI	4.37	5.95	13.31
7.	Maharashtra	CV	3.16	101.62	141.18
		CDVI	3.16	98.91	120.01
8.	Madhya Pradesh	CV	14.79	148.10	208.01
		CDVI	5.14	86.14	162.10
9.	Kerala	CV	18.88	10.63	26.62
		CDVI	18.26	9.71	25.98
	India	CV	16.87	11.36	30.89
		CDVI	11.83	11.06	19.59

Note: CV-Coefficient of variation (per cent per annum).

CDVI-Cuddy Della Valle Instability Index (per cent per annum).

During period II, the coefficient of variation as well as Cuddy Della Valle Instability Index of production was observed lowest in West Bengal (5.52 and 2.38 per cent respectively). The highest coefficient of variation was observed in Madhya Pradesh (148.10 per cent) whereas the highest Cuddy Della Valle Instability Index was observed in Maharashtra (98.91 per cent). Considering India as a whole, the low instability was observed in production i.e. 11.36 per cent (CV) and 11.06 per cent (CDVI).

At overall period, the coefficient of variation for production under turmeric was observed lowest in Kerala (26.62 per cent) whereas, the lowest Cuddy Della Valle Instability Index was observed in West Bengal (8.75 per cent). The highest coefficient of variation as well as Cuddy Della Valle Instability Index was observed in Madhya Pradesh (208.01 and 162.10 per cent respectively).

Considering India as a whole, the moderate instability was observed in production i.e. 30.89 per cent (CV) and 19.59 per cent (CDVI).

State wise average production of turmeric in India was estimated and presented in Table 4.7.

It is seen from the Table 4.7 that, in period I, period II as well as overall period, the highest production of turmeric cultivation was observed in Andhra Pradesh followed by Tamil Nadu and Karnataka i.e. 375010, 133360, 51020 tonne in period I, 400980, 191930, 95290 tonne in period II and 387990, 162640, 73150 tonne in overall period respectively.

Table 4.7 Average production of turmeric cultivation in India

(Production in '000 tonne)

Sr.No.	States	Period I	Period II	Overall
1.	Andhra Pradesh	375.01	400.98	387.99
2.	Odisha	72.16	55.51	63.83
3.	Karnataka	51.02	95.29	73.15
4.	Tamil Nadu	133.36	191.93	162.64
5.	West Bengal	27.65	43.06	35.35
6.	Assam	8.80	16.66	12.73
7.	Maharashtra	8.49	56.10	32.29
8.	Madhya Pradesh	1.23	15.44	8.34
9.	Kerala	7.38	6.86	7.12
	India	712.93	1018.19	865.56

4.2.2 Instability of productivity of turmeric in India

State wise coefficient of variation and Cuddy Della Valle Instability Index of productivity of turmeric in India was estimated and presented in Table 4.8.

It is seen from the Table 4.8 that, during period I, the coefficient of variation as well as Cuddy Della Valle Instability Index of productivity was lowest in Assam (1.78 and 1.66 per cent respectively). The highest coefficient of variation was observed in Andhra pradesh (20.82 per cent) whereas, the highest Cuddy Della Valle Instability Index was observed in Tamil Nadu (10.02 per cent). As a whole country, India recorded low instability in productivity i.e. 12.86 per cent (CV) and 8.61 per cent (CDVI).

Table 4.8 State wise productivity instability indices of turmeric in India

Sr.No.	Name of States	Particular	Period I	Period II	Overall
1.	Andhra Pradesh	CV	20.82	20.89	38.32
		CDVI	9.15	19.17	20.48
2.	Odisha	CV	6.57	94.02	94.92
		CDVI	5.05	92.23	91.26
3.	Karnataka	CV	6.42	7.91	23.26
		CDVI	5.82	7.71	18.94
4.	Tamil Nadu	CV	12.18	19.24	26.98
		CDVI	10.02	12.81	24.89
5.	West Bengal	CV	8.89	6.33	26.34
		CDVI	4.44	6.15	11.72
6.	Assam	CV	1.78	19.34	31.53
		CDVI	1.66	5.25	15.16
7.	Maharashtra	CV	2.42	112.46	139.27
		CDVI	1.70	103.66	119.26
8.	Madhya Pradesh	CV	13.35	77.14	83.58
		CDVI	6.33	43.62	60.87
9.	Kerala	CV	12.18	17.83	28.32
		CDVI	8.63	10.64	23.03
	India	CV	12.86	11.76	25.50
		CDVI	8.61	6.71	23.54

Note: CV-Coefficient of variation (per cent per annum).

CDVI -Cuddy Della Vale Instability Index (per cent per annum).

During period II, the coefficient of variation of productivity was observed lowest in West Bengal (6.33 per cent) whereas, the lowest Cuddy Della Valle Instability Index was observed in Assam (5.25 per cent). The highest coefficient of variation as well as Cuddy Della Valle Instability Index was observed in Maharashtra i.e. 112.46 per cent and 103.66 per cent respectively. Considering India as a whole, the low instability was observed in productivity i.e. 11.76 per cent (CV) and

6.71 per cent (CDVI).

At overall period, the coefficient of variation of productivity was lowest in Karnataka (23.26 per cent) whereas, the lowest Cuddy Della Valle Instability Index was observed in West Bengal (11.72 per cent). The highest coefficient of variation as well as Cuddy Della Valle Instability Index was observed in Maharashtra i.e. 139.27 per cent and 119.26 per cent respectively. Considering India as a whole, the moderate instability was observed in productivity i.e. 25.50 per cent (CV) and 23.54 per cent (CDVI).

State wise average productivity of turmeric in India was estimated and presented in Table 4.9.

Table 4.9 Average productivity of turmeric cultivation in India

(Productivity in kg/hectare)

Sr.No.	States	Period I	Period II	Overall
1.	Andhra Pradesh	6369.60	10401.00	8385.30
2.	Odisha	2455.60	5133.20	3794.40
3.	Karnataka	4896.80	5325.30	5111.05
4.	Tamil Nadu	5005.00	4496.90	4750.95
5.	West Bengal	1945.50	2525.20	2235.35
6.	Assam	700.10	985.70	842.90
7.	Maharashtra	1269.90	5494.30	3382.10
8.	Madhya Pradesh	755.80	1698.60	1227.200
9.	Kerala	2035.20	2484.70	2259.95
	India	4167.00	4717.40	4442.20

It is seen from Table 4.9 that, during period I, the average productivity of turmeric was highest in Andhra Pradesh followed by

Tamil Nadu and Karnataka i.e. 6369.60, 5005.00 and 4896.80 respectively.

In period II the average productivity was highest in Andhra Pradesh followed by Maharashtra and Karnataka i.e. 10401.00, 5494.30 and 5325.30. Whereas, in overall period the highest average productivity was observed in Andhra Pradesh followed by Karnataka and Tamil Nadu i.e. 8385.30, 5111.05 and 4750.95 respectively. The results obtained are in close agreement with the findings of Angles and Hosamani (2005), they concluded that, the area in case of Andhra Pradesh and Tamil Nadu show instability in turmeric while Kerala show stability.

4.3 Trends in area, production and productivity of turmeric in India

To synthesis the data of turmeric regarding area, production and productivity, a better statistical tool has been used in this section. The results of this analysis provided growth trends in cubic, exponential and logarithmic forms. For the purpose of giving main area in India a state wise turmeric growing picture of the trend in area, production and productivity of turmeric have been fitted on the time series data. The slope of the curve is given by the value associated with year (x). Trend analysis provides the rate of change of particular variables during the period of reference and the direction of change but it fails to provide the rate of change per annum.

The trends in area, production and productivity of turmeric in India was estimated and presented in Table 4.10. It is seen from the Table 4.10 that, for all most all the states the cubic functions were best fitted except for Andhra Pradesh, Maharashtra and Kerala. In case of Andhra Pradesh productivity, Maharashtra production and productivity, the exponential functions were best fitted, whereas in case of Kerala area the logarithmic function was best fitted by considering the highest values of the R^2 (Appendix). Hence the hypothesis is rejected.

It was evident from Table 4.10 that, for area, the highest value of R^2 was observed in Assam i.e. 0.95 followed by Madhya Pradesh (0.89) and West Bengal (0.88) whereas, the lowest R^2 was observed in Andhra Pradesh i.e. 0.22. The R^2 was estimated in the range of 0.22 to 0.95 for area. For production the highest R^2 was observed in West Bengal i.e. 0.972 followed by Assam (0.971) and Madhya Pradesh (0.881) whereas, the lowest R^2 was observed in Odisha i.e. 0.120. The R^2 was estimated in the range of 0.120 to 0.972 for production. For productivity, the highest value of R^2 was observed in Assam i.e. 0.96 followed by Madhya Pradesh (0.86) and West Bengal (0.84) whereas, the lowest R^2 was observed in Karnataka i.e. 0.35. The R^2 was estimated in the range of 0.35 to 0.96 for productivity.

In case of country as a whole, the R^2 for area, production and productivity was 0.75 , 0.72 and 0.74 respectively.

Table 4.10 Trends in area, production and productivity of turmeric in India

Sr.No	States	Particulars	Functions	Constants	Coefficients			R Square
				a	b_1	b_2	b_3	
1.	Andhra Pradesh	Area	Cubic	66996.2	-1430.6	141.704	-2.9735	0.221
		Production	Cubic	231118	52538.4	-4464.8	111.528	0.306
		Productivity	Exponential	4753.86	0.0492			0.777
2.	Odisha	Area	Cubic	16214.2	6405.15	-1001.7	36.3569	0.520
		Production	Cubic	27435.2	15887.0	-1345.6	28.4253	0.120
		Productivity	Cubic	6156.95	-2452.2	345.146	-11.856	0.385
3.	Karnataka	Area	Cubic	4076.93	1817.56	-156.22	5.7946	0.668
		Production	Cubic	10435.5	14775.0	-1386.8	48.3416	0.657
		Productivity	Cubic	4459.54	146.866	-11.892	0.3701	0.355
4.	Tamil Nadu	Area	Cubic	31912.1	-6413.6	1152.76	-43.974	0.507
		Production	Cubic	134373	-23079	5229.05	-217.58	0.404
		Productivity	Cubic	3936.26	367.252	-27.411	0.4045	0.487
5.	West Bengal	Area	Cubic	13279.3	-408.38	79.3821	-2.4025	0.882
		Production	Cubic	20116.2	470.535	186.051	-7.4370	0.972
		Productivity	Cubic	1621.06	51.2295	3.0606	-0.1645	0.844

Continued.....

Sr.No	States	Particulars	Functions	Constants	Coefficients			R Square
				a	b_1	b_2	b_3	
6.	Assam	Area	Cubic	12290.1	-494.97	101.829	-3.2979	0.950
		Production	Cubic	8835.71	-545.98	92.5149	-1.6547	0.971
		Productivity	Cubic	709.604	-7.6565	0.2266	0.0822	0.962
7.	Maharashtra	Area	Cubic	6755.56	-56.765	10.4422	0.9547	0.784
		Production	Exponential	4977.08	0.1181			0.392
		Productivity	Exponential	757.698	0.0919			0.381
8.	Madhya Pradesh	Area	Cubic	-1977.6	1917.06	-285.62	11.7653	0.890
		Production	Cubic	-9515.0	7122.27	-1088.0	44.9887	0.881
		Productivity	Cubic	21.7862	413.898	-59.213	2.4293	0.863
9.	Kerala	Area	Logarithmic	3851.72	-481.97			0.748
		Production	Cubic	9526.08	-1016.7	119.885	-4.2423	0.434
		Productivity	Cubic	2616.68	-225.81	20.3375	-0.4101	0.651
	India	Area	Cubic	175629	-4749.4	665.239	-12.337	0.752
		Production	Cubic	614781	-14480	7137.30	-281.80	0.721
		Productivity	Cubic	3367.14	109.623	12.9684	-0.8784	0.749

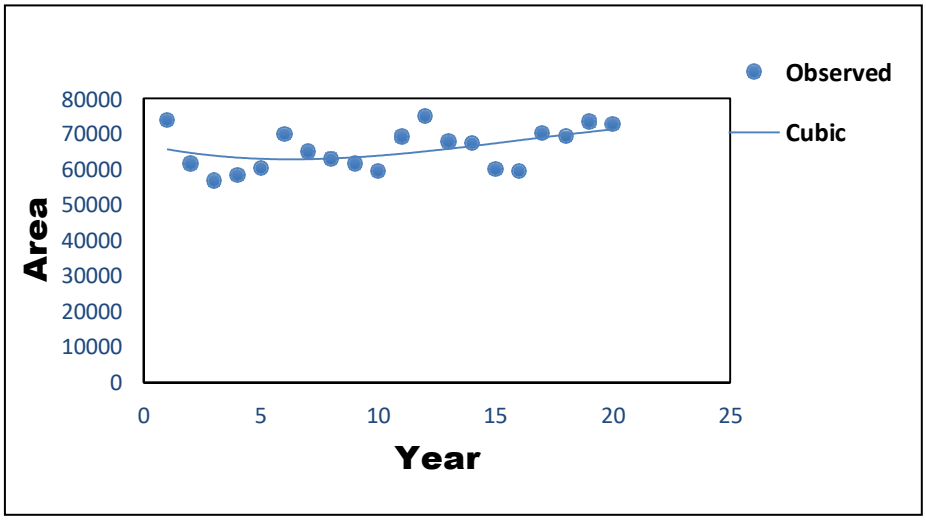

Fig 4.1 Trend in area under turmeric in Andhra Pradesh

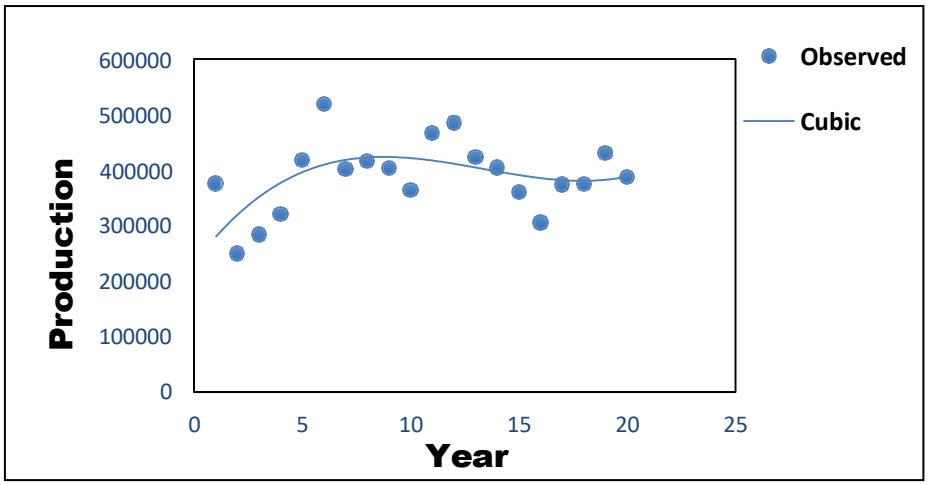

Fig 4.2 Trend in production of turmeric in Andhra Pradesh

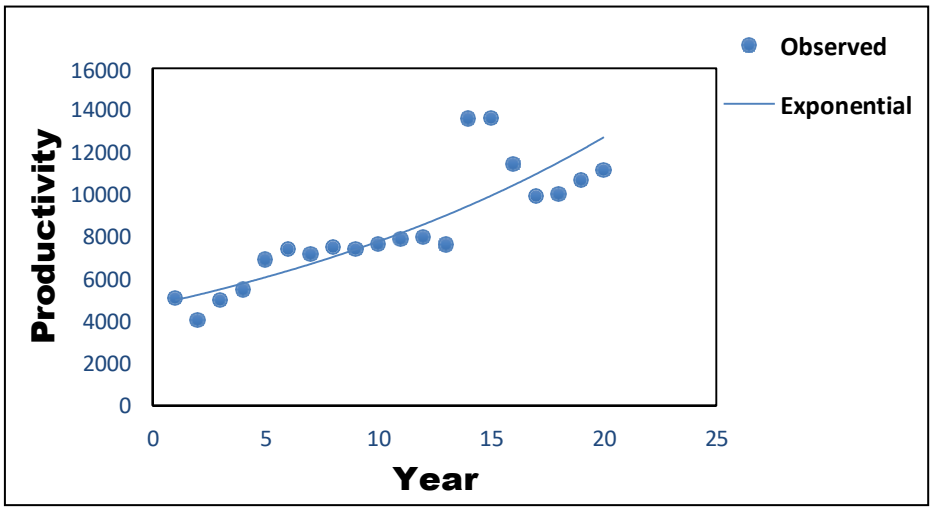

Fig 4.3 Trend in productivity of turmeric in Andhra Pradesh

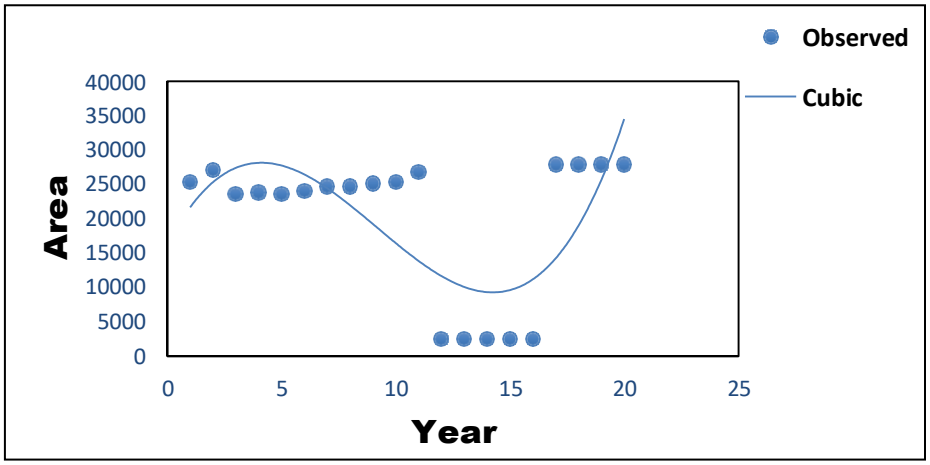

Fig 4.4 Trend in area of turmeric in Odisha

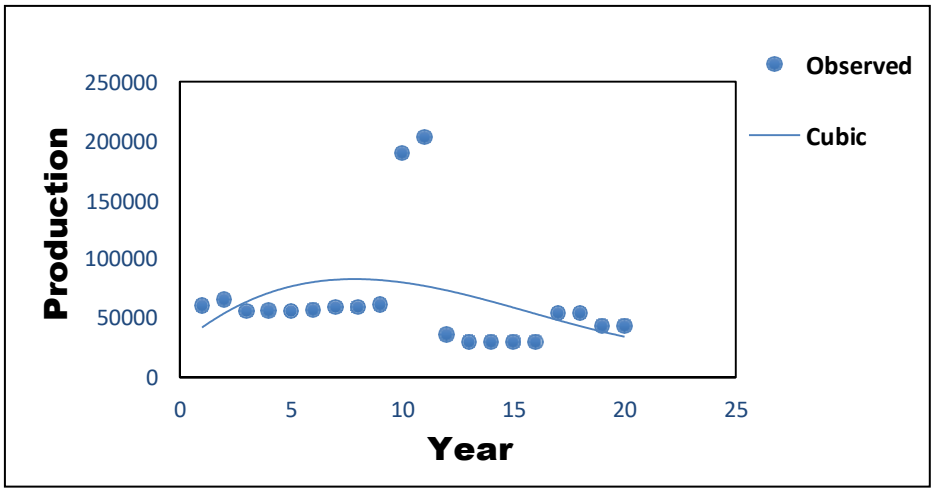

Fig 4.5 Trend in production of turmeric in Odisha

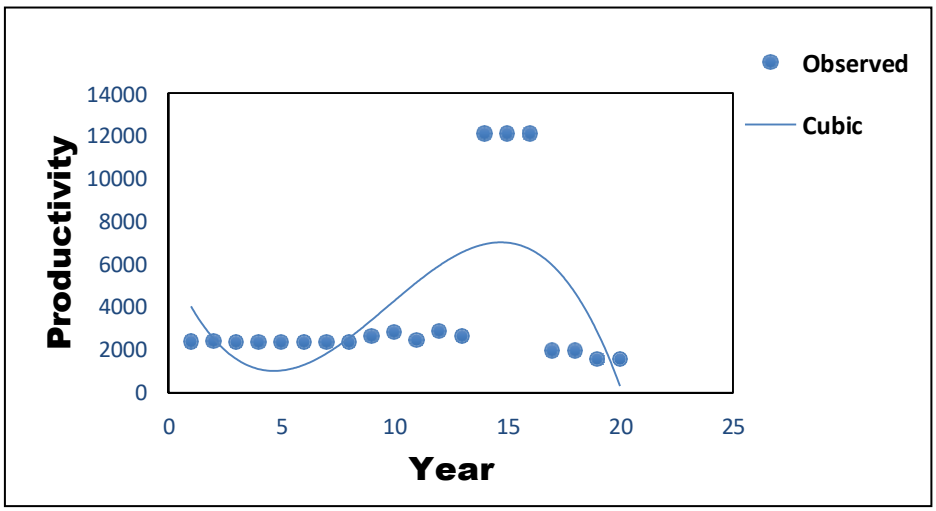

Fig 4.6 Trend in productivity of turmeric in Odisha

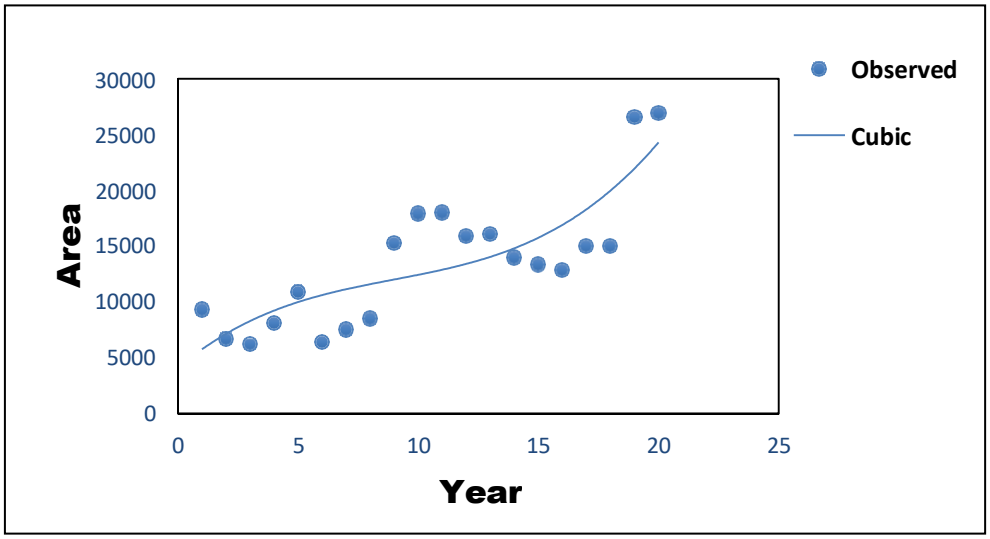

Fig 4.7 Trend in area of turmeric in Karnataka

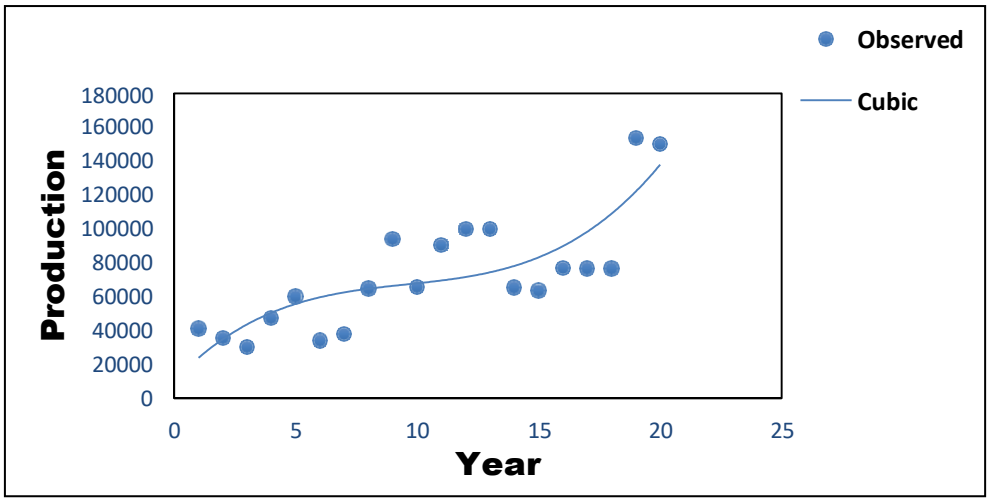

Fig 4.8 Trend in production of turmeric in Karnataka

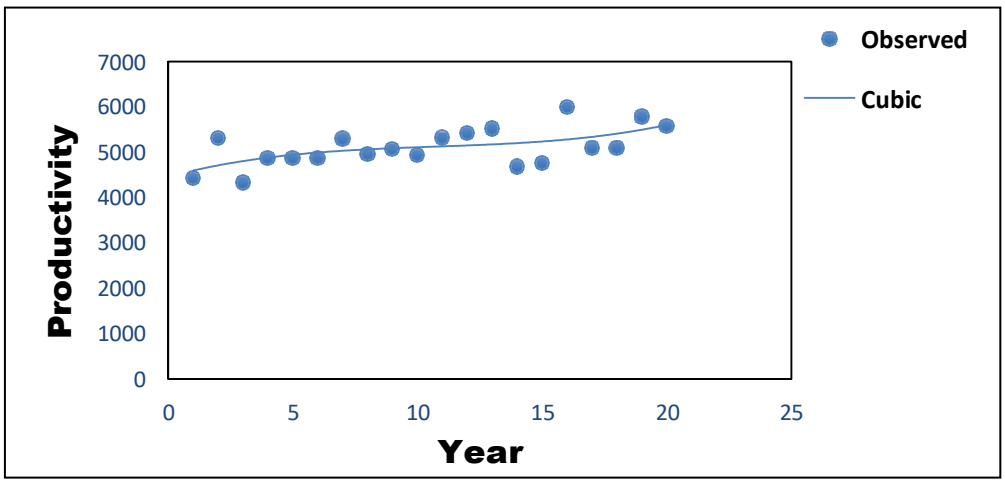

Fig 4.9 Trend in productivity of turmeric in Karnataka

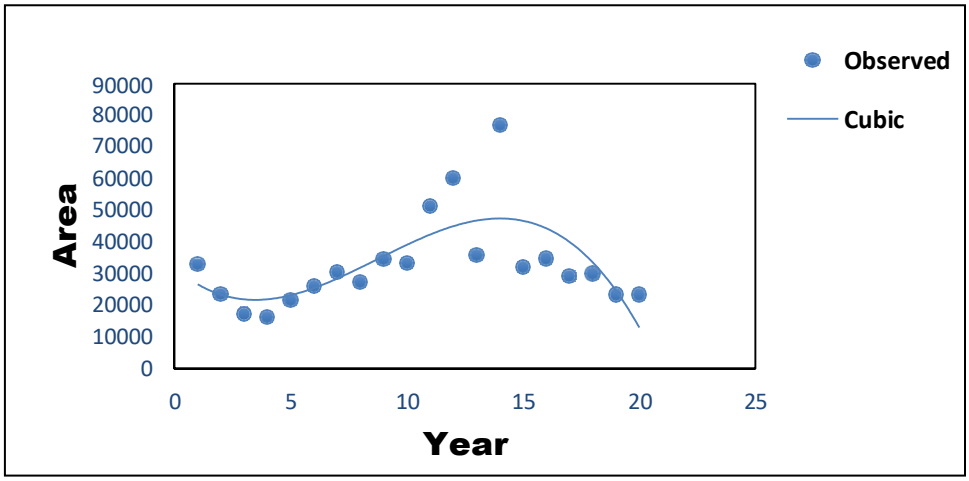

Fig 4.10 Trend in area of turmeric in Tamil Nadu

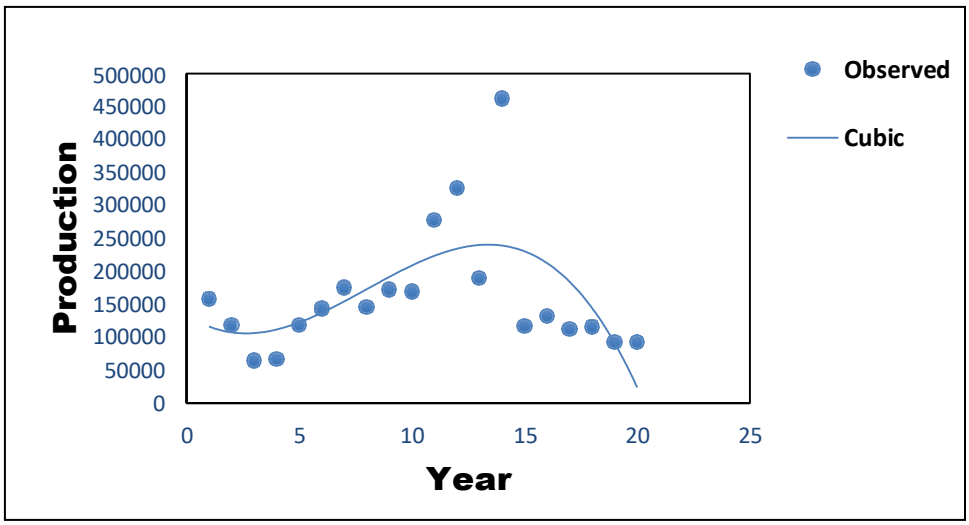

Fig 4.11 Trend in production of turmeric in Tamil Nadu

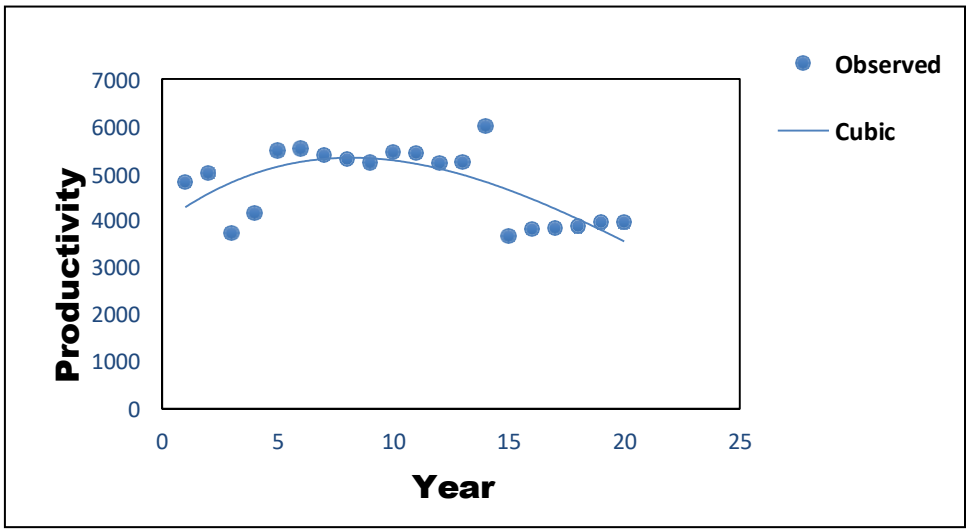

Fig 4.12 Trend in productivity of turmeric in Tamil Nadu

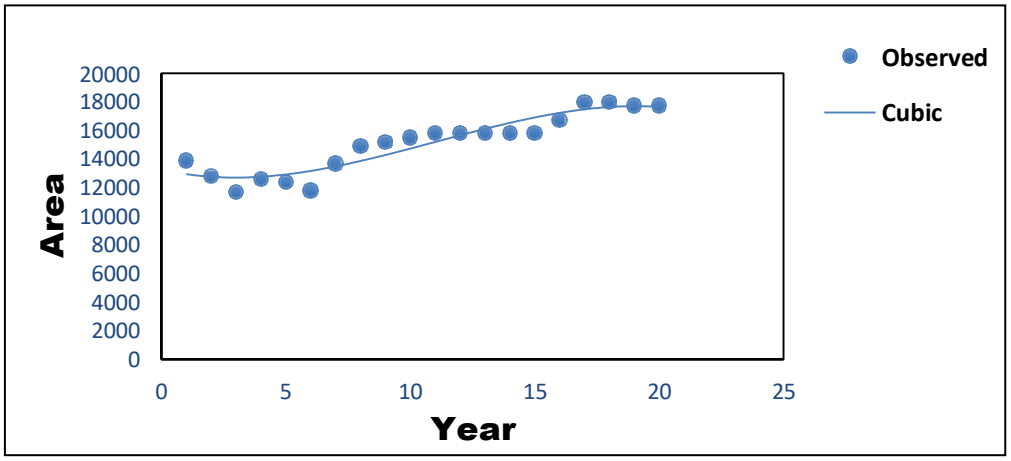

Fig 4.13 Trend in area of turmeric in West Bengal

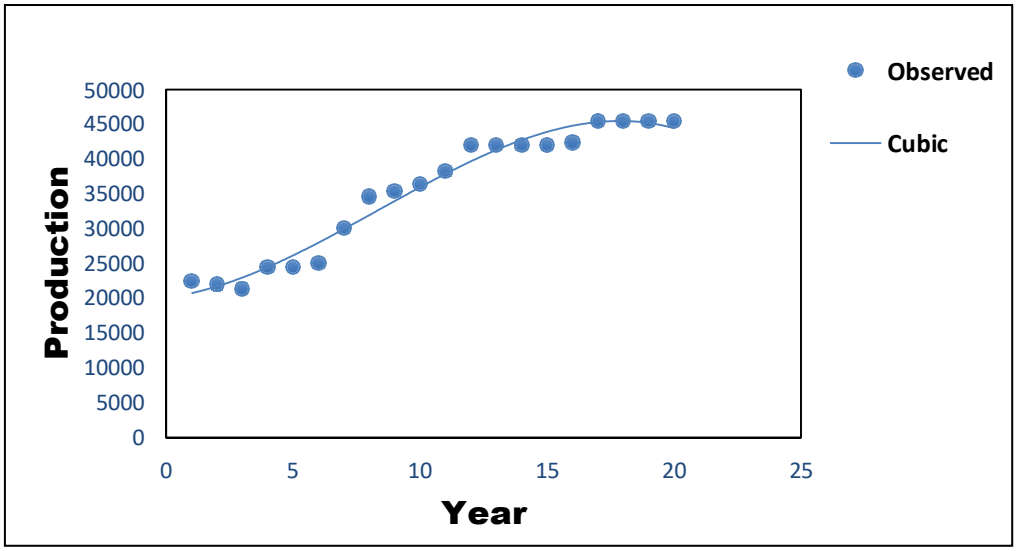

Fig 4.14 Trend in production of turmeric in West Bengal

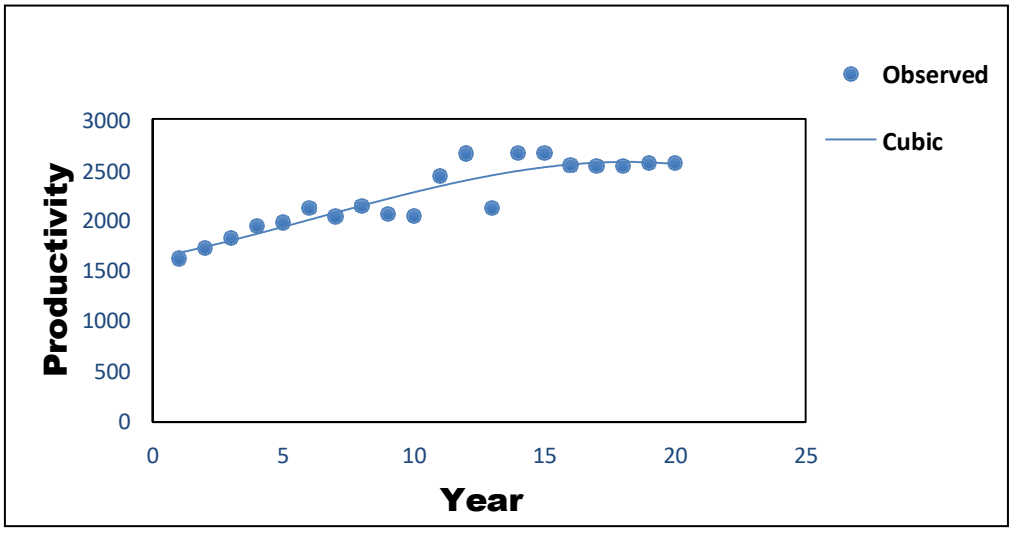

Fig 4.15 Trend in productivity of turmeric in West Bengal

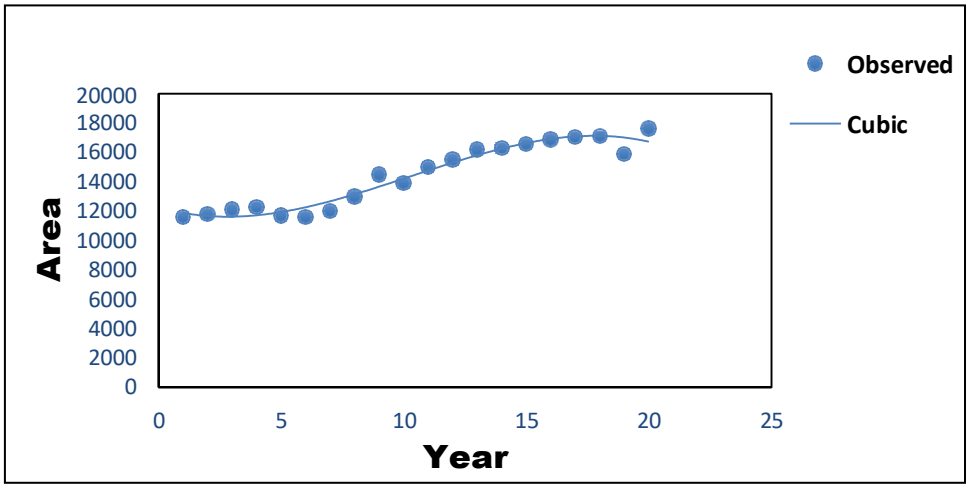

Fig 4.16 Trend in area of turmeric in Assam

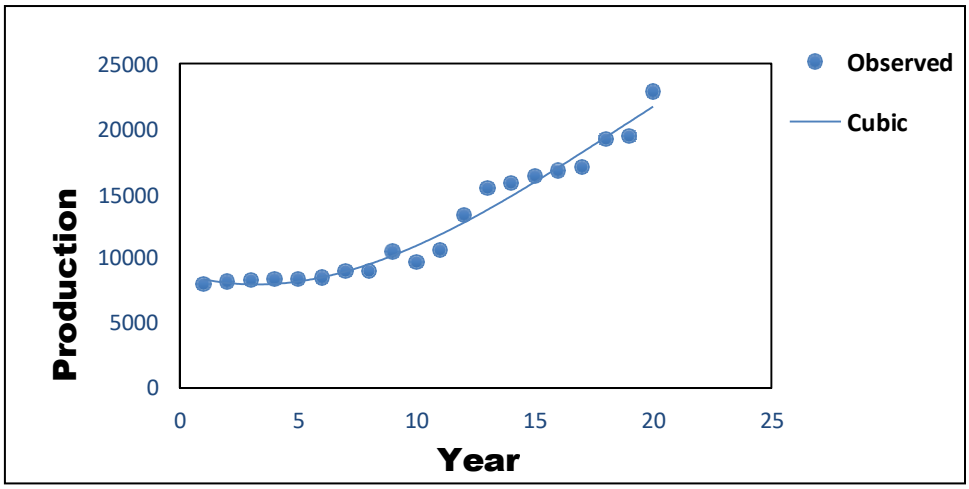

Fig 4.17 Trend in production of turmeric in Assam

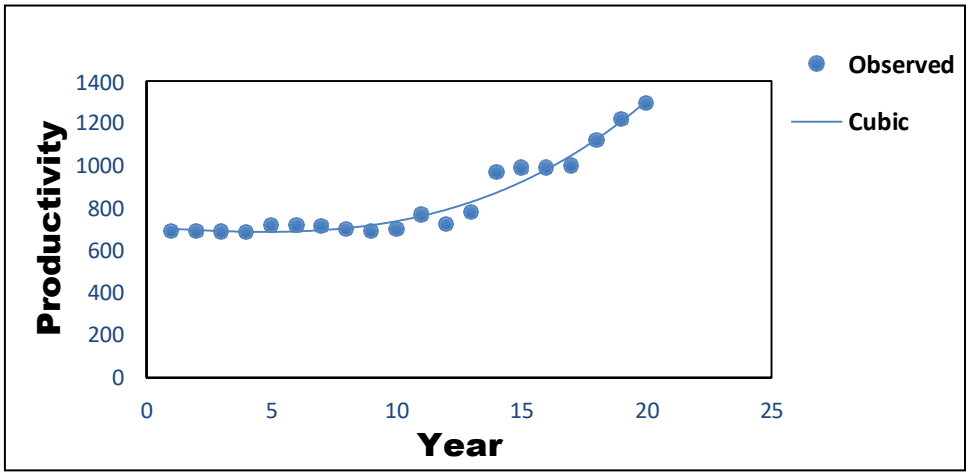

Fig 4.18 Trend in productivity of turmeric in Assam

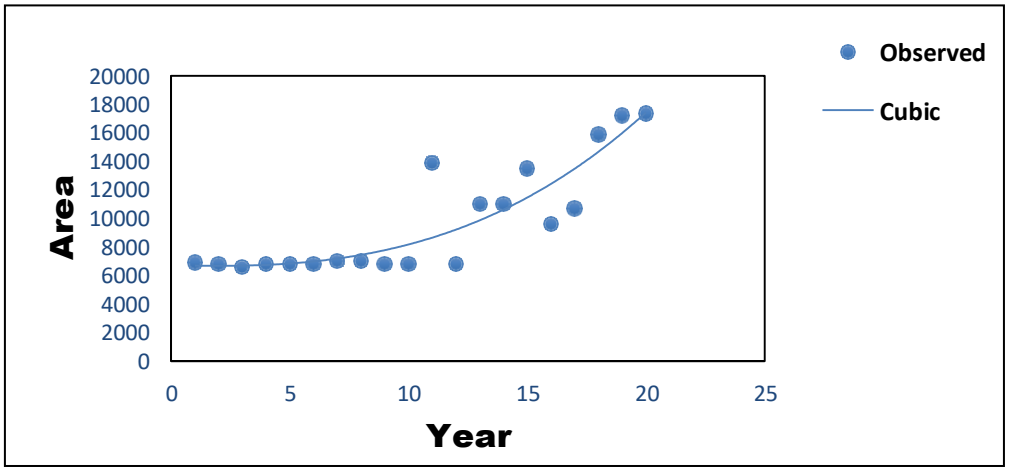

Fig 4.19 Trend in area of turmeric in Maharashtra

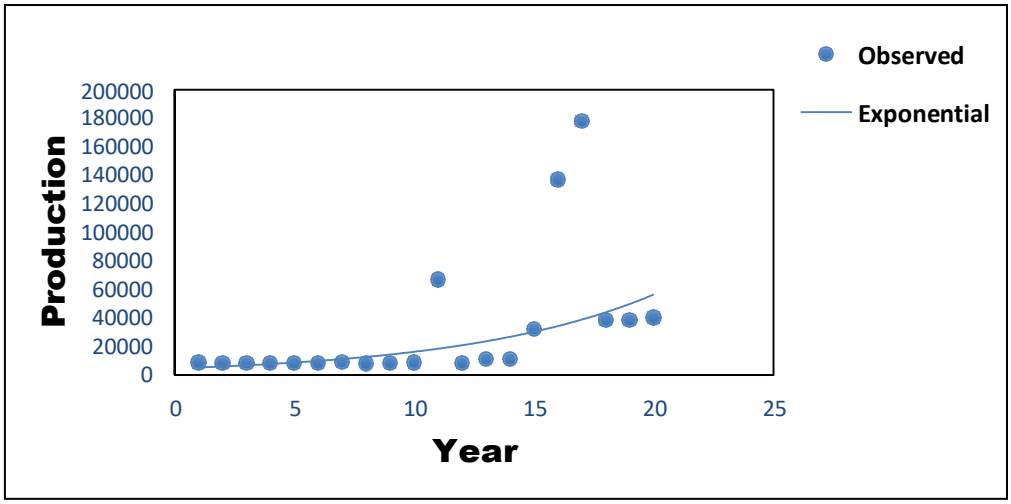

Fig 4.20 Trend in production of turmeric in Maharashtra

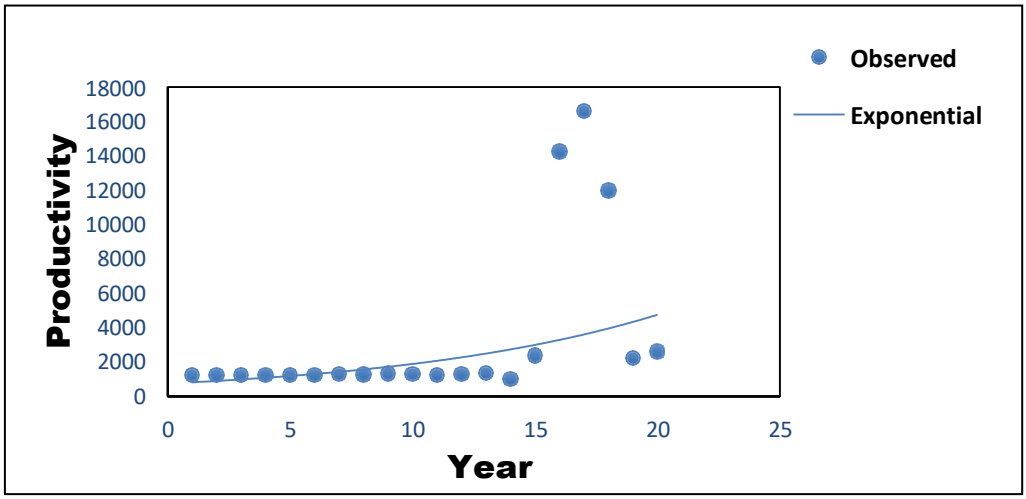

Fig 4.21 Trend in productivity of turmeric in Maharashtra

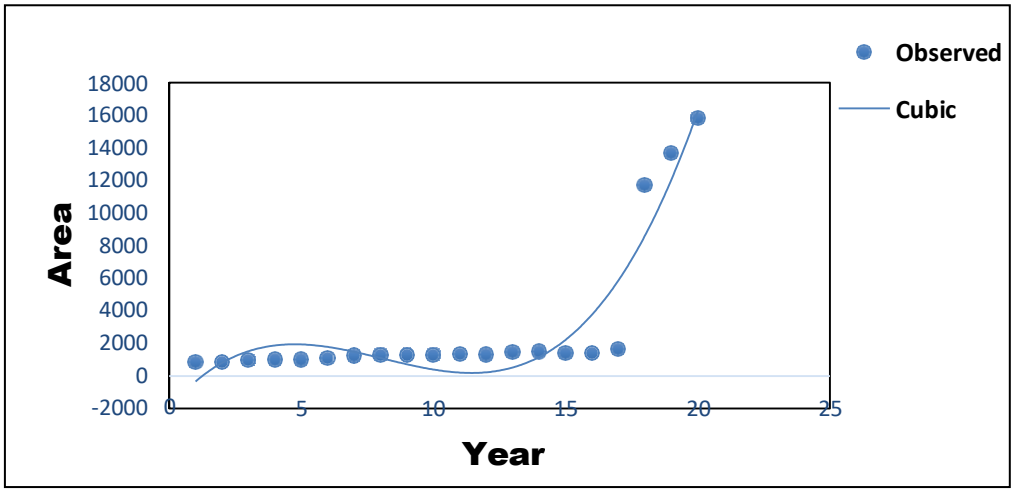

Fig 4.22 Trend in area of turmeric in Madhya Pradesh

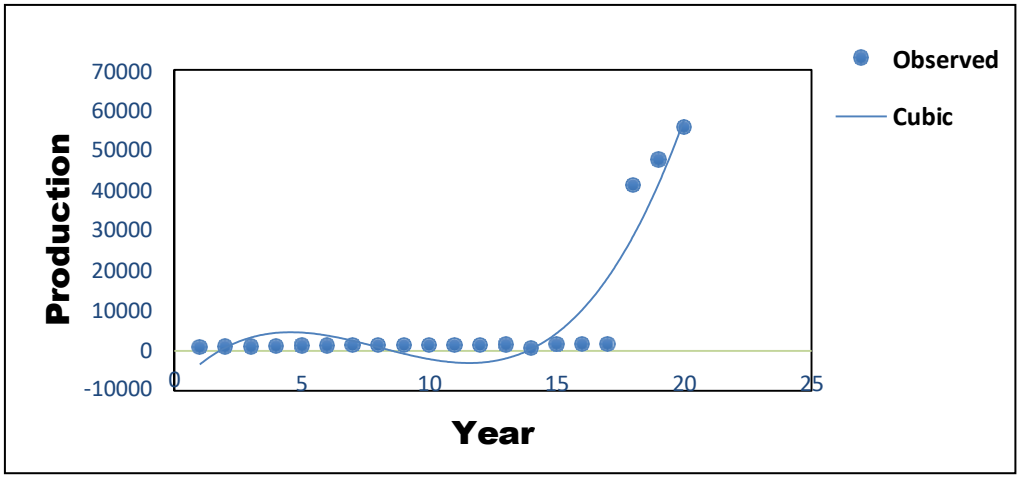

Fig 4.23 Trend in production of turmeric in Madhya Pradesh

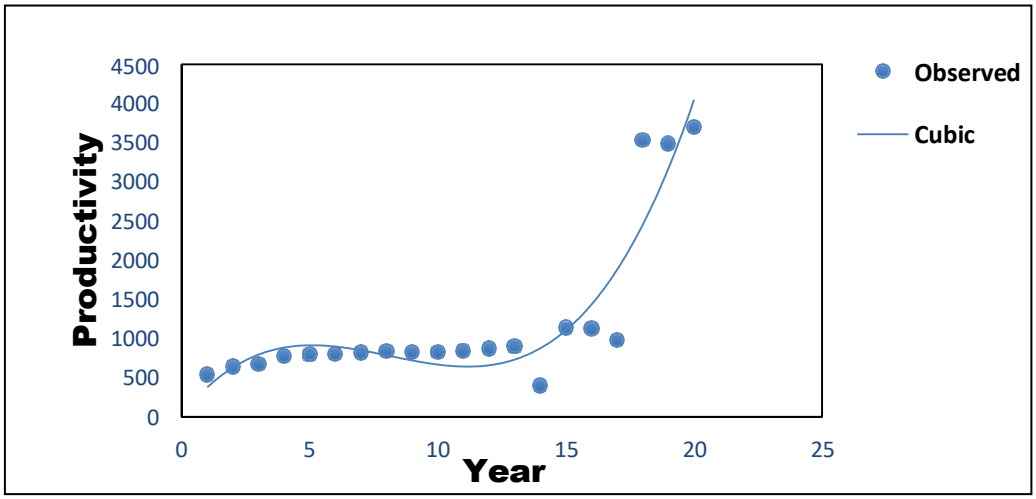

Fig 4.24 Trend in productivity of turmeric in Madhya Pradesh

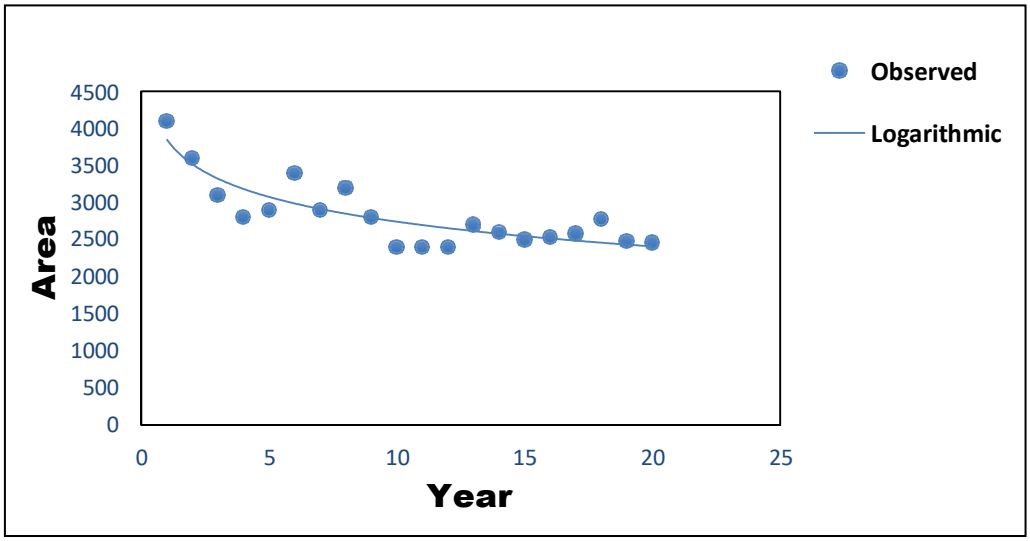

Fig 4.25 Trend in area of turmeric in Kerala

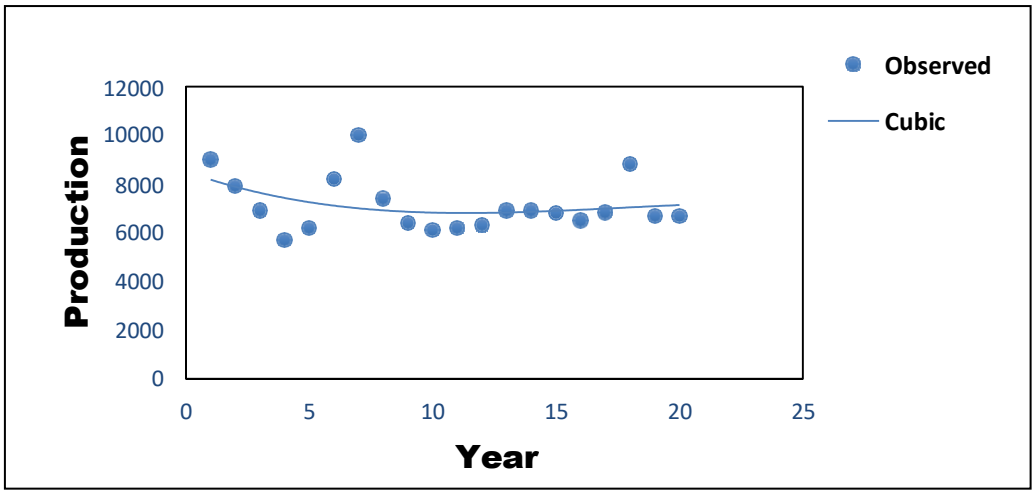

Fig 4.26 Trend in production of turmeric in Kerala

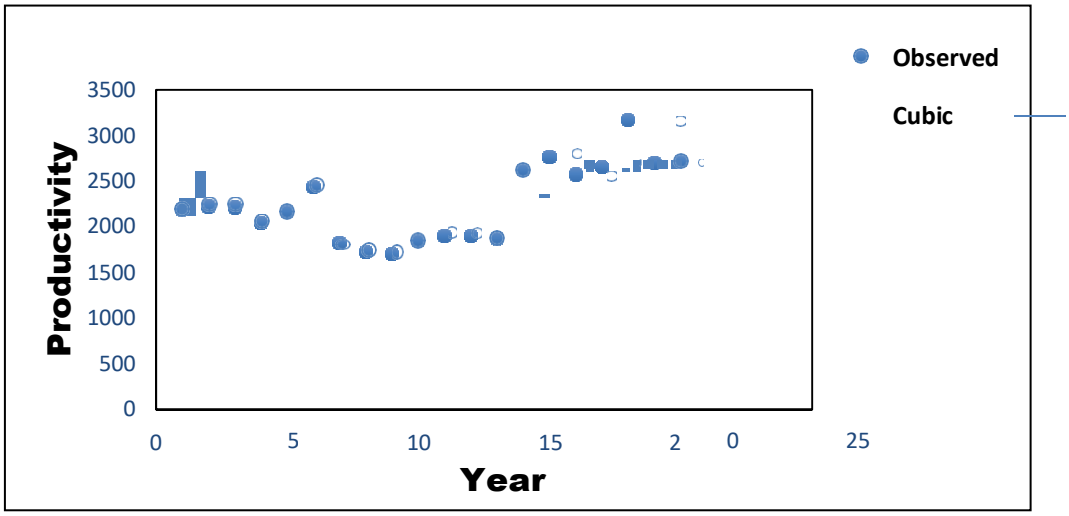

Fig 4.27 Trend in productivity of turmeric in Kerala

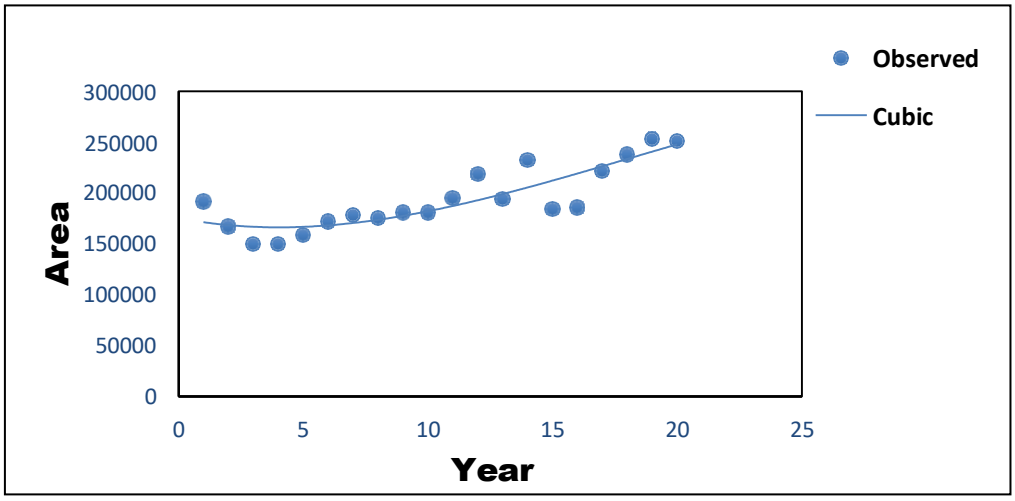

Fig 4.28 Trend in area of turmeric in India

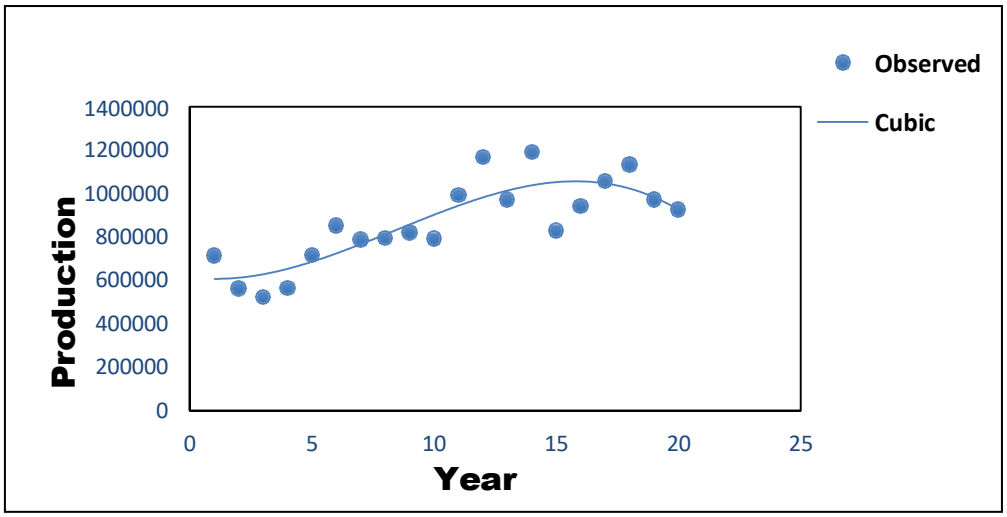

Fig 4.29 Trend in production of turmeric in India

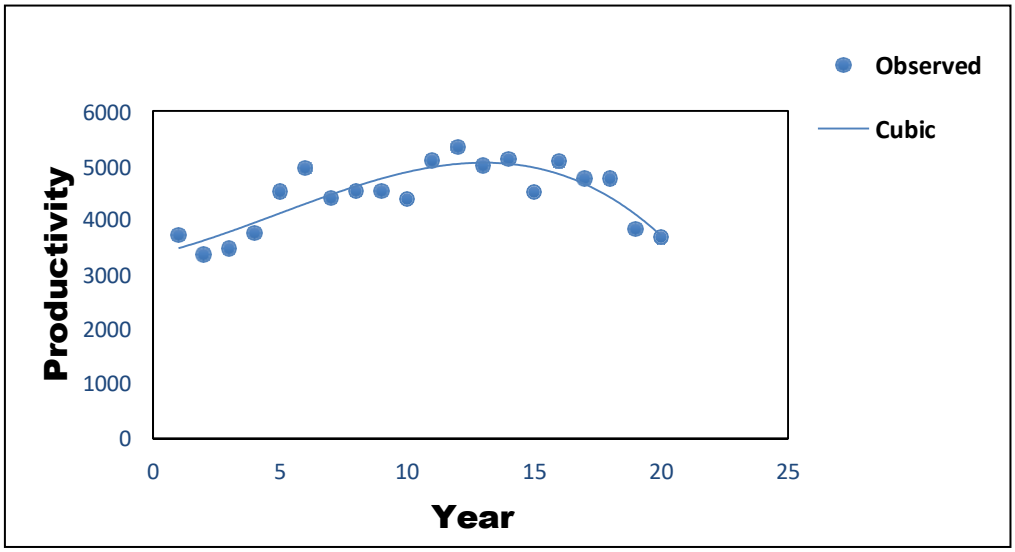

Fig 4.30 Trend in productivity of turmeric in India

4.4 Decomposition analysis in turmeric production

In this study attempt has been made to identify the contribution of area and productivity for increasing production of turmeric. This study period has been divided in two sub period and overall taking into consideration the important of each sub period as discussed in methodology.

The per cent contribution of area, yield and their interaction for changing production of turmeric in India for two periods and overall period was estimated and presented in Table 4.11.

It was evident from the Table 4.11 that, during period I, yield effect was the most responsible factor for changing production in Andhra Pradesh i.e. 237.50 per cent whereas area effect was found to be negative i.e. -91.20 percent. In this period yield effect was responsible to change in production for all the states except Karnataka (9.93 per cent), Assam (7.30 per cent) and Kerala (31.20 per cent), In this three states area effect was most responsible factor i.e. 80.88 per cent, 91.20 per cent and 81.80 per cent per annum. In India, yield effect was most responsible factor for changing turmeric production i.e. 160.00 per cent. whereas the area effect and interaction effect was negative at -51.00 per cent and -9.00 per cent respectively. Hence, yield effect indicates that the yield has been playing a driving force in differential form of turmeric production.

During period II, it was observed that yield effect of Odisha i.e. 107.60 per cent playing a major role in changing production of turmeric and area effect was negative i.e. -11.90 per cent per annum. In this period yield effect was the most responsible factor for change in production for almost all states except Karnataka, Tamil Nadu and West Bengal . In this states area effect was most responsible factor i.e. 87.40 per cent, 81.61 per cent, 67.18 per cent respectively. Whereas in Madhya Pradesh interaction effect was most responsible factor i.e. 72 per cent. In India yield effect was most responsible factor for changing turmeric

production i.e. 410.90 per cent. whereas, area effect was negative at -429.70 per cent and interaction effect was positive at 118.80 per cent.

Table 4.11 Per cent contribution of area, yield and their interaction for increasing production of turmeric in India

Sr.No.	States	Particular	Period I	Period II	Overall
1.	Andhra Pradesh	Area Effect	-91.20	10.50	-1.35
		Yield Effect	237.50	85.10	102.97
		Intr. Effect	-46.30	4.40	-1.62
2.	Odisha	Area Effect	-6.89	-11.90	-36.22
		Yield Effect	108.17	107.60	123.66
		Intr. Effect	-1.28	4.30	12.56
3.	Karnataka	Area Effect	80.88	87.40	71.84
		Yield Effect	9.93	8.40	9.73
		Intr. Effect	9.19	4.20	18.43
4.	Tamil Nadu	Area Effect	8.24	81.61	70.00
		Yield Effect	90.66	40.48	42.40
		Intr. Effect	1.10	-22.09	-12.40
5.	West Bengal	Area Effect	28.19	67.18	27.00
		Yield Effect	64.40	29.23	57.20
		Intr. Effect	7.41	3.59	15.80
6.	Assam	Area Effect	91.20	17.90	28.10
		Yield Effect	7.30	69.85	47.30
		Intr. Effect	1.50	12.25	24.60
7.	Maharashtra	Area Effect	-94.87	15.40	35.79
		Yield Effect	197.74	67.80	25.55
		Intr. Effect	-2.87	16.80	38.66
8.	Madhya Pradesh	Area Effect	39.46	21.30	13.90
		Yield Effect	39.35	6.70	4.60
		Intr. Effect	21.19	72.00	81.50
9.	Kerala	Area Effect	81.80	5.40	157.03
		Yield Effect	31.20	92.30	-95.05
		Intr. Effect	-13.00	2.30	38.02
	India	Area Effect	-51.00	-429.70	104.98
		Yield Effect	160.00	410.90	-3.80
		Intr. Effect	-9.00	118.80	-1.18

At overall period, the yield effect was most responsible factor for change in production for four states which included Odisha, Andhra Pradesh, West Bengal and Assam i.e. 123.66 per cent, 102.97 per cent, 57.20 per cent and 47.30 per cent respectively. The area effect was most responsible factor for change in production for three states which were Kerala, Karnataka and Tamil Nadu i.e. 157.03 per cent, 71.84 per cent and 70.00 per cent respectively. whereas, in remaining two states Madhya Pradesh and Maharashtra interaction effect is most responsible factor i.e. 81.50 per cent and 38.66 per cent respectively.

Regarding to country as a whole area effect was most responsible factor for change in turmeric production i.e. 104.98 per cent whereas yield effect and interaction effect were negative i.e. -3.80 per cent and -1.18 per cent respectively. Hence, in both period I and period II yield effect was responsible for increasing turmeric production but in overall period area effect was responsible for increasing turmeric production. The results obtained are in close agreement with the findings of Govindasamy (2015), concluded that, area effect is more than yield effect in the case of change in total production in turmeric.

Chapter V

SUMMARY AND CONCLUSIONS

Turmeric (*Curcuma longa*) is one of the most important spice which belongs to family Zingiberaceae. In India, 251.39 thousand hectare area is under cultivation and produces 926.11 metric tonnes of turmeric during 2019-20. Major growing states of turmeric in India area Andhra Pradesh, Odisha, Karnataka, Tamil Nadu, West Bengal, Assam, Maharashtra, Madhya Pradesh and Kerala. Andhra Prdesh is the highest producer of turmeric followed by Karnataka. 100 grams of turmeric contains protein (9.7 g), total Fat (3.3 g), calories (312), saturated fat (1.8 g), carbohydrate (67 g), dietary fiber (23 g), sugar, (3.2 g).

This study was conducted to estimate the growth, instability, trends and decomposition in area, production and productivity of turmeric across the potential turmeric growing states of India. Documentation of such estimates proves useful for policy makers in formulating policy instruments for the betterment of turmeric farming in India. However, the knowledge of the growth rates needs to be supplemented by the empirical evidence of production instability for policy makers to formulate development oriented policy and researchers to design investigative research activity for promoting sustainable turmeric production system at the state as well as national level, However the specific objective of the study were,

1. To estimate state wise growth rate of area, production and productivity of turmeric in India.
2. To workout state wise instability of turmeric.
3. To assess trends in area, production and productivity.
4. To estimate relative contribution of area and yield to change in the output of turmeric in India.

Turmeric crop is grown in most of the states of India. However, turmeric is grown in nine major states namely Andhra Pradesh, Odisha, Karnataka, Tamil Nadu, West Bengal, Assam, Maharashtra, Madhya Pradesh and Kerala together they account for about 88 per cent of the crop‟s total area. Andhra Pradesh Odisha and Karnataka together accounts more than half of the India‟s turmeric production.

Based on the objectives of the study, for the analysis of growth and instability the period was split into two sub-periods and overall as shown below.

Period I : 2000-01 to 2009-10

Period II : 2010-11 to 2019-20

Overall : 2000-01 to 2019-20

The present study was based on time series secondary data of area, production and productivity of turmeric in major states of India. The compound growth rate of area, production and productivity of turmeric of each turmeric growing states were estimated to study the growth.

One should not be so obvious of instability by taking the growth rates only because the growth rates will explain only the rates of growth over the period, where, instability will judge, whether the growth performance is stable or unstable for the period for the pertinent variable. To facilitate better understanding of the magnitude and pattern of changes in the level of production, cropped area and productivity of turmeric in the different turmeric growing states, instability of area, production and productivity of turmeric have been worked out for all the period.

The simple coefficient of variation (CV) often contains the trend component and thus overtimes the level of instability in the time series data characterized by long term trend. To overcome this problem, this

study used the instability index given by Cuddy Della Valle (1978) which corrects the coefficient of variation.

For the purpose of giving main area in India a state wise turmeric growing picture of the trend in area, production and productivity of turmeric have been fitted on the time series data. The slope of the curve is given by the value associated with year (x). Trend analysis provides the rate of change of particular variables during the period of reference and the direction of change but it fails to provide the rate of change per annum.

To measure the relative contribution of area and yield to the total output change for turmeric, Minhas (1964) three factor decomposition analysis model was used. The total change in production was decomposed into three effects viz; area effect, yield effect and the interaction effect. The main findings of the present study are given below.

The results of the study are summarized as follows,

At the overall level, the compound growth rate of area was positive in all the states except Odisha (-5.32 per cent) and Kerala (-1.86 per cent). Madhya Pradesh showed the highest positive growth rate (12.30 per cent) followed by Karnataka (6.27 per cent), Maharashtra (5.88 per cent), Assam (2.53 per cent) and West Bengal (2.17 per cent) and were positively significant at 1 per cent level. Tamil Nadu and Andhra Pradesh also showed positive growth rate of 1.99 per cent and 0.59 per cent per annum respectively. Andhra Pradesh, Odisha, Tamil Nadu and Kerala were non significant. In case of whole country, the growth rates were positive in both the periods as well as in over all. In period I, the growth rate was 0.86 per cent and in period II it was 2.57 per cent per annum. In the overall period the growth rate was 2.24 per cent per annum and was positively significant at 1 per cent level.

The compound growth rate of production at overall level was

highest in Madhya Pradesh (16.32 per cent) followed by Maharashtra (13.21 per cent), Karnataka (6.56 per cent), Assam (5.97 per cent) and West Bengal (4.58 per cent) which were positively significant at 1 per cent level. Tamil Nadu and Andhra Pradesh also showed positive growth rate of 0.86 per cent and 0.77 per cent respectively. Odisha and Kerala showed negative growth rate of -2.70 per cent and -0.49 per cent respectively. Andhra Pradesh, Odisha, Tamil Nadu and Kerala were non significant. In case of growth rate of turmeric production in whole country, the period I and overall period showed positive growth rate of 4.23 per cent and 3.20 per cent respectively and were positively significant at 5 per cent and 1 per cent respectively. Period II showed negative growth rate of -0.82 per cent and was non significant.

The compound growth rate of productivity at overall level was positive for all the states except Tamil Nadu (-1.13 per cent). The growth rate was highest in Maharashtra (9.62 per cent) followed by Madhya Pradesh (7.44 per cent), Andhra Pradesh (5.04 per cent), Assam (3.29 per cent), West Bengal (2.39 per cent), Karnataka (0.81 per cent) and they were positively significant at 1 per cent level. Odisha and Kerala also showed positive growth rates i.e. 1.80 per cent and 1.70 per cent per annum respectively. Where, Kerala is positively significant at 5 per cent level. Odisha and Tamil Nadu were non significant. In case of whole country the growth rates were positive at period I and over all period i.e 3.34 per cent and 0.93 per cent per annum respectively and period I was positively significant at 1 per cent level. Period II showed negative growth rate of -3.31 per cent per annum. Period II and overall period were non significant.

The coefficient of variation for area under turmeric cultivation was observed lowest in Andhra Pradesh (23.46 per cent) and highest in Madhya Pradesh (148.98 per cent). Considering whole country, India recorded low instability in area (26.99 per cent). The coefficient of variation of the area during the overall period was range in between 23.46 to 148.98 per cent. The average area under cultivation of

turmeric for last twenty years was highest in Andhra Pradesh followed by Tamil Nadu and Odisha viz; 65750, 33030, 19890 hectares, respectively.

The Cuddy Della Valle Instability index for area under turmeric cultivation was observed lowest in Assam (8.47 per cent) and highest in Madhya Pradesh (112.63 per cent). Considering whole country, India recorded low instability in area (15.32 per cent). The Cuddy Della Valle Instability index for area during overall period was range in between 8.47 to 112.63 per cent. The area was indicating stable growth in turmeric crop in almost all the states in India.

The coefficient of variation for production under turmeric was observed lowest in Kerala (26.62 per cent) and highest in Madhya Pradesh (208.01 per cent). Considering whole country, India recorded moderate instability in production (30.89 per cent). The coefficient of variation of the production during the overall period was range in between 26.62 to 208.01 per cent. The average production under cultivation of turmeric for last twenty years was highest in Andhra Pradesh followed by Tamil Nadu and Karnataka i.e. 387990, 162640, 73150 tonne respectively.

The Cuddy Della Valle Instability index for production under turmeric cultivation was observed lowest in West Bengal (8.75 per cent) and highest in Madhya Pradesh (162.10 per cent). Considering whole country, India recorded moderate instability in production (19.59 per cent). The Cuddy Della Valle Instability index for production during overall period was range in between 8.75 to 162.10 per cent. The production was indicating stable growth in turmeric crop in almost all the states in India.

The coefficient of variation for productivity under turmeric was observed lowest in Karnataka (23.26 per cent) and highest in Maharashtra (139.27 per cent). Considering whole country, India recorded moderate instability in productivity (25.50 per cent). The

coefficient of variation of the productivity during the overall period was range in between 23.26 to 139.27 per cent. The average productivity under cultivation of turmeric for last twenty years was highest in Andhra Pradesh followed by Karnataka and Tamil Nadu i.e. 8385.30, 5111.05 and 4750.95 respectively.

The Cuddy Della Valle Instability index for productivity under turmeric cultivation was observed lowest in West Bengal (11.72 per cent) and highest in Maharashtra (119.26 per cent). Considering whole country, India recorded moderate instability in productivity (23.54 per cent). The Cuddy Della Valle Instability index for productivity during overall period was range in between 11.72 to 119.26 per cent.

According to the goodness of fit, for all most all the states the Cubic functions were best fitted, except for Andhra Pradesh, Maharashtra and Kerala. In case of Andhra Pradesh productivity, Maharashtra production and productivity, the exponential functions were best fitted, whereas in case of Kerala area the logarithmic function was best fitted by considering the highest values of the $R^{2.}$

The $R^{2.}$ was estimated in the range of 0.22 to 0.95 for area, 0.120 to 0.972 for production and 0.35 to 0.96 for productivity. In case of country as a whole, the R^2 for area, production and productivity was 0.75, 0.72 and 0.74 respectively.

In India, Yield effect was most responsible factor for increasing turmeric production in Andhra Pradesh i.e. 237.50 per cent with interaction effect -46.30 per cent and area effect -91.20 per cent. Regarding to the country as a whole area effect was most responsible factor for change in turmeric production i.e. 104.98 per cent whereas yield effect and interaction effect were negative i.e. -3.80 per cent and -1.18 per cent respectively. In both period I and period II yield effect was responsible for increasing turmeric production but in overall period area effect was responsible for increasing turmeric production.

CONCLUSIONS

The result of the study leads to conclude that,

1) The compound growth rates for area was positive for all the turmeric growing states except Andhra Pradesh, Odisha and Kerala during Period I, Rajasthan during period II and Odisha and Kerala at overall period.

2) At overall level the compound growth rate of area of turmeric was highest in Madhya Pradesh i.e. 12.30 per cent.

3) The compound growth rates of production was positive for all the turmeric growing states except Maharashtra and Kerala in period I, Andhra Pradesh, Odisha, Tamil Nadu in period II and Odisha and Kerala at overall period.

4) The compound growth rate of production was highest in Madhya Pradesh i.e. 16.32 per cent.

5) The compound growth rate of productivity was positive for all the turmeric growing states except Kerala in period I, Odisha and Tamil Nadu in period II and Tamil Nadu at overall period.

6) The compound growth rate of productivity was highest in Maharashtra i.e. 9.62 per cent.

7) The compound growth rate of area under crop was positive. Hence, there is a need to concentrate on this crop for policy makers and researchers.

8) The highest coefficient of variation for area and production was observed in Madhya Pradesh i.e. 148.98 per cent and 208.01 per cent respectively. Whereas, the highest coefficient of variation for productivity was observed in Maharashtra (139.27 per cent).

9) The highest Cuddy Della Valle instability index for area and production was observed in Madhya Pradesh i.e. 112.63 per cent

and 162.10 per cent respectively. Whereas, the highest Cuddy Della Valle instability index for productivity was observed in Maharashtra (119.26 per cent).

10) The highest average area, production and productivity was observed in Andhra Pradesh i.e. 65750 hectares, 387990 tonne and 8385 kg/ha respectively.

11) The average area under cultivation of turmeric for last twenty year was 194,020 hectares, the production was 865,560 tonne and productivity was 4442.20 kg per hectare.

12) For all most all the states the Cubic functions were best fitted, except for Andhra Pradesh, Maharashtra and Kerala. In case of Andhra Pradesh productivity, Maharashtra production and productivity, the exponential functions were best fitted, whereas in case of Kerala area the logarithmic function was best fitted.

13) The $R^{2.}$ was estimated in the range of 0.22 to 0.95 for area, 0.120 to 0.972 for production and 0.35 to 0.96 for productivity. In case of country as a whole, the R^2 for area, production and productivity was 0.75, 0.72 and 0.74 respectively.

14) The relative contribution of area and yield to change in output was estimated by using Minhas decomposition model. The decomposition analysis for India was estimated the largest area effect on turmeric production. It was observed that, for both the periods yield effect was more pronounce than area effect and interaction effect, but in overall period area effect was responsible for increasing turmeric production.

IMPLICATIONS

1) As area effect is most responsible for change in the turmeric production, it is necessary for policy makers to take actions for providing remunerative prices to the farmer for turmeric crop.

2) In some states yield effect can also be seen responsible for the change in the production of turmeric, hence it is necessary to provide high yielding varieties to the farmers.

3) In order to maintain stability in production of turmeric, efforts like evaluation of high yielding and drought resistant variety of turmeric should be made available in the country.

Chapter VI

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VITA

1. Name of Student : Bandewar Aishwarya Srinivas

2. Date of Birth : 25th August 1997

3. Name of the College : College of Agriculture, Nagpur

4. Residential Address : At Post- Nanded
Tal- Loha, Dist. – Nanded Pin code- 431602
State - Maharashtra
Email: - aishu25aishu@gmail.com
Contact- 9423655538

5. Academic qualifications:

Sr. No.	Name of Degree awarded	Year in which obtained	vision / Class	Name of awarding University/ Board	Subjects
1.	B.Sc. Agriculture	2019	First	MPKV,Rahuri	Agriculture
2.	HSC	2015	First	Telangana	Science
3.	SSC	2013	First	Latur	General

6. **Field of interest** : Administration

Place : Nagpur
Date :02/06/ 2021

Signature of Student
(Bandewar Aishwarya Srinivas)

APPENDICES

Appendix I : Trend in area of turmeric in Andhra Pradesh

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	61717.4	384.293			0.152
Logarithmic	62332.7	1615.55			0.051
Inverse	65523.8	1271.43			0.002
Quadratic	65416.3	-624.50	48.0377		0.215
Cubic	66996.2	-1430.6	141.704	-2.9735	0.221
Compound	61558.8	1.0059			0.156
Power	62057.6	0.0256			0.055
Square root	11.0872	0.0152			0.001
Growth	11.0277	0.0059			0.156
Exponential	61558.8	0.0059			0.156

Appendix II : Trend in production of turmeric in Andhra Pradesh

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	363648	2319.10			0.044
Logarithmic	330775	27033.3			0.113
Inverse	404695	-92818			0.100
Quadratic	290373	22303.2	-951.62		0.239
Cubic	231118	52538.4	-4464.8	111.528	0.306
Compound	352867	1.0077			0.065
Power	321573	0.0819			0.141
Square root	12.9022	-0.2662			0.112
Growth	12.7738	0.0077			0.065
Exponential	352867	0.0077			0.065

Appendix III : Trend in productivity of turmeric in Andhra Pradesh

Equation	Parameter Estimates				
	A	b_1	b_2	b_3	R Square
Linear	4318.80	387.286			0.714
Logarithmic	2689.66	2690.71			0.651
Inverse	9717.11	-7403.6			0.373
Quadratic	3529.58	602.527	-10.250		0.728
Cubic	4884.67	-88.915	70.0914	-2.5505	0.748
Compound	4753.86	1.0505			0.776
Power	3759.23	0.3551			0.763
Square root	9.1662	-1.0148			0.471
Growth	8.4667	0.0492			0.776
Exponential	4753.86	0.0492			0.777

Appendix IV : Trend in area of turmeric in Odisha

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	24475.8	-436.27			0.061
Logarithmic	28110.8	-3881.3			0.092
Inverse	17786.0	11724.2			0.063
Quadratic	35530.6	-3451.2	143.568		0.237
Cubic	16214.2	6405.15	-1001.7	36.3569	0.520
Compound	25421.9	0.9468			0.097
Power	36804.8	-0.4462			0.122
Square root	9.3405	1.2695			0.075
Growth	10.1434	-0.0547			0.097
Exponential	25421.9	-0.0547			0.097

Appendix V : Trend in production of turmeric in Odisha

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	77201.3	-1272.9			0.026
Logarithmic	71750.2	-3738.8			0.004
Inverse	63934.1	-545.32			0.000
Quadratic	42537.5	8180.87	-450.18		0.111
Cubic	27435.2	15887.0	-1345.6	28.4253	0.120
Compound	72820.3	0.9729			0.099
Power	74443.6	-0.1465			0.053
Square root	10.8541	0.2976			0.017
Growth	11.1957	-0.0274			0.099
Exponential	72820.3	-0.0274			0.099

Appendix VI : Trend in productivity of turmeric in Odisha

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	2039.13	167.168			0.076
Logarithmic	1173.68	1238.07			0.078
Inverse	4381.10	-3261.5			0.041
Quadratic	-142.36	762.121	-28.331		0.133
Cubic	6156.95	-2452.2	345.146	-11.856	0.385
Compound	2443.29	1.0180			0.028
Power	2100.11	0.1601			0.043
Square root	8.0717	-0.4623			0.027
Growth	7.8011	0.0179			0.028
Exponential	2443.29	0.0179			0.028

Appendix VII : Trend in area of turmeric in Karnataka

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	5129.50	799.214			0.628
Logarithmic	2791.02	5069.13			0.477
Inverse	15736.2	-12313			0.213
Quadratic	7155.62	246.637	26.3132		0.646
Cubic	4076.93	1817.56	-156.22	5.7946	0.668
Compound	6515.93	1.0627			0.667
Power	5307.81	0.3987			0.540
Square root	9.5956	-0.9706			0.242
Growth	8.7820	0.0609			0.667
Exponential	6515.93	0.0609			0.667

Appendix VIII : Trend in Production of turmeric in Karnataka

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	25651.9	4524.37			0.597
Logarithmic	10942.4	29391.5			0.476
Inverse	86815.2	-75922			0.240
Quadratic	36119.4	1669.60	135.941		0.611
Cubic	10435.5	14775.0	-1386.8	48.3416	0.657
Compound	33876.8	1.0657			0.653
Power	26321.5	0.4347			0.576
Square root	11.3068	-1.1597			0.310
Growth	10.4305	0.0636			0.653
Exponential	33876.8	0.0636			0.653

Appendix IX : Trend in Productivity of turmeric in Karnataka

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	4674.29	41.5962			0.337
Logarithmic	4487.43	294.606			0.319
Inverse	5274.19	-906.88			0.229
Quadratic	4656.14	46.5448	-0.2356		0.338
Cubic	4459.54	146.866	-11.892	0.3701	0.355
Compound	46770.0	1.0082			0.338
Power	4500.40	0.0586			0.330
Square root	8.5689	-0.1834			0.245
Growth	8.4504	0.0081			0.338
Exponential	4677.00	0.0081			0.338

Appendix X : Trend in area of turmeric in Tamil Nadu

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	26444.1	627.180			0.064
Logarithmic	21383.6	5501.71			0.093
Inverse	35413.5	-13253			0.041
Quadratic	8548.97	5507.67	-232.40		0.297
Cubic	31912.1	-6413.6	1152.76	-43.974	0.507
Compound	24918.3	1.0199			0.094
Power	21638.4	0.1645			0.123
Square root	10.3944	-0.3557			0.044
Growth	10.1234	0.0197			0.094
Exponential	24918.3	0.0197			0.094

Appendix XI : Trend in production of turmeric in Tamil Nadu

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	143876	1787.62			0.012
Logarithmic	113199	23359.6			0.040
Inverse	174661	-66790			0.025
Quadratic	18772.5	35906.7	-1624.7		0.283
Cubic	134373	-23079	5229.05	-217.58	0.404
Compound	131881	1.0083			0.010
Power	111616	0.1196			0.040
Square root	11.9303	-0.3015			0.019
Growth	11.7897	0.0082			0.010
Exponential	131881	0.0082			0.010

Appendix XII : Trend in productivity of turmeric in Tamil Nadu

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	5280.63	-50.446			0.149
Logarithmic	5139.67	-183.64			0.037
Inverse	4720.88	167.176			0.002
Quadratic	4151.19	257.584	-14.668		0.481
Cubic	3936.26	367.252	-27.411	0.4045	0.487
Compound	5285.46	0.9887			0.162
Power	5147.31	-0.0440			0.046
Square root	8.4435	0.0527			0.005
Growth	8.5727	-0.0114			0.162
Exponential	5285.46	-0.0114			0.162

Appendix XIII : Trend in area of turmeric in West Bengal

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	11717.7	320.692			0.847
Logarithmic	10815.5	2016.99			0.632
Inverse	15908.1	-4575.4			0.246
Quadratic	12002.8	242.941	3.7024		0.850
Cubic	13279.3	-408.38	79.3821	-2.4025	0.882
Compound	11923.6	1.0218			0.823
Power	11203.9	0.1362			0.622
Square root	9.6675	-0.3068			0.239
Growth	9.3863	0.0215			0.823
Exponential	11923.6	0.0215			0.823

Appendix XIV : Trend in production of turmeric in West Bengal

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	19877.5	1474.19			0.930
Logarithmic	13603.3	10276.6			0.853
Inverse	40404.5	-28062			0.481
Quadratic	16164.9	2486.71	-48.215		0.957
Cubic	20116.2	470.535	186.051	-7.4370	0.972
Compound	21327.8	1.0458			0.901
Power	17326.0	0.3204			0.869
Square root	10.5996	-0.8967			0.515
Growth	9.9678	0.0448			0.901
Exponential	21327.8	0.0448			0.901

Appendix XV : Trend in productivity of turmeric in West Bengal

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	1697.06	51.2654			0.802
Logarithmic	1448.23	371.849			0.796
Inverse	2434.76	-1108.5			0.535
Quadratic	1533.64	95.8360	-2.1224		0.838
Cubic	1621.06	51.2295	3.0606	-0.1645	0.844
Compound	1723.34	1.0240			0.808
Power	1523.96	0.1756			0.837
Square root	7.7978	-0.5390			0.597
Growth	7.4520	0.0237			0.808
Exponential	1723.34	0.0237			0.808

Appendix XVI : Trend in area of turmeric in Assam

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	10696.2	355.922			0.898
Logarithmic	9451.22	2353.68			0.741
Inverse	15534.1	-6118.8			0.379
Quadratic	10537.9	399.096	-2.0557		0.898
Cubic	12290.1	-494.97	101.829	-3.2979	0.950
Compound	10974.5	1.0253			0.892
Power	10017.7	0.1671			0.753
Square root	9.6449	-0.4397			0.394
Growth	9.3033	0.0250			0.892
Exponential	10974.5	0.0250			0.892

Appendix XVII : Trend in production of turmeric in Assam

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	4846.46	750.823			0.899
Logarithmic	3052.64	4571.78			0.629
Inverse	14709.0	-11001			0.276
Quadratic	7956.54	-97.381	40.3906		0.968
Cubic	8835.71	-545.98	92.5149	-1.6547	0.971
Compound	6508.10	1.0598			0.932
Power	5534.27	0.3695			0.694
Square root	9.5532	-0.9059			0.324
Growth	8.7808	0.0580			0.932
Exponential	6508.10	0.0580			0.932

Appendix XVIII : Trend in productivity of turmeric in Assam

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	536.521	29.1789			0.769
Logarithmic	489.316	167.038			0.475
Inverse	910.837	-377.66			0.184
Quadratic	753.258	-29.931	2.8148		0.957
Cubic	709.604	-7.6565	0.2266	0.0822	0.962
Compound	585.982	1.0330			0.796
Power	552.901	0.1882			0.507
Square root	6.7913	-0.4318			0.202
Growth	6.3732	0.0324			0.796
Exponential	585.952	0.0324			0.796

Appendix XIX : Trend in area of turmeric in Maharashtra

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	4143.21	535.218			0.679
Logarithmic	3093.59	3150.73			0.444
Inverse	11065.7	-7242.0			0.177
Quadratic	7262.77	-315.57	40.5138		0.782
Cubic	6755.56	-56.765	10.4422	0.9547	0.784
Compound	5323.45	1.0528			0.711
Power	4761.82	0.3081			0.480
Square root	9.2494	-0.7156			0.196
Growth	8.5799	0.0515			0.711
Exponential	5323.45	0.0515			0.711

Appendix XX : Trend in production of turmeric in Maharashtra

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	-17026	5200.43			0.275
Logarithmic	-28511	31221.7			0.187
Inverse	50545.2	-72082			0.075
Quadratic	-782.71	770.441	210.952		0.287
Cubic	57417.2	-28927	3661.54	-109.54	0.368
Compound	4977.08	1.1254			0.391
Power	3703.76	0.7255			0.279
Square root	10.0601	-1.7076			0.117
Growth	8.5126	0.1181			0.391
Exponential	4977.08	0.1181			0.392

Appendix XXI : Trend in productivity of turmeric in Maharashtra

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	-993.05	416.681			0.267
Logarithmic	-1748.7	2423.85			0.170
Inverse	4356.46	-5416.5			0.064
Quadratic	949.035	-112.98	25.2219		0.293
Cubic	5489.69	-2429.9	294.431	-8.5463	0.367
Compound	757.698	1.0963			0.380
Power	649.933	0.5284			0.237
Square root	7.8064	-1.1734			0.089
Growth	6.6303	0.0919			0.380
Exponential	757.698	0.0919			0.381

Appendix XXII : Trend in area of turmeric in Madhya Pradesh

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	-2270.8	512.238			0.428
Logarithmic	-2622.4	2707.01			0.226
Inverse	4140.04	-5738.9			0.077
Quadratic	4273.31	-1272.5	84.9884		0.740
Cubic	-1977.6	1917.06	-285.62	11.7653	0.890
Compound	515.113	1.1231			0.574
Power	420.576	0.6715			0.363
Square root	7.7518	-1.6056			0.157
Growth	6.2444	0.1161			0.574
Exponential	515.113	0.1161			0.574

Appendix XXIII : Trend in production of turmeric in Madhya Pradesh

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	-10957	1837.86			0.393
Logarithmic	-11743	9488.08			0.198
Inverse	11841.0	-19457			0.063
Quadratic	14387.5	-5074.2	329.144		0.725
Cubic	-9515.0	7122.27	-1088.0	44.9887	0.881
Compound	447.238	1.1632			0.439
Power	376.559	0.8313			0.250
Square root	8.0301	-1.8869			0.097
Growth	6.1031	0.1512			0.439
Exponential	447.238	0.1512			0.439

Appendix XXIV : Trend in productivity of turmeric in Madhya Pradesh

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	-20.342	118.814			0.470
Logarithmic	-160.10	655.380			0.270
Inverse	1497.54	-1502.8			0.107
Quadratic	1312.46	-244.68	17.3091		0.733
Cubic	21.7862	413.898	-59.213	2.4293	0.863
Compound	466.501	1.0745			0.503
Power	401.075	0.4277			0.337
Square root	7.0994	-1.1114			0.172
Growth	6.1453	0.0718			0.503
Exponential	466.501	0.0718			0.503

Appendix XXV : Trend in area of turmeric in Kerala

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	3430.16	-57.015			0.554
Logarithmic	3851.72	-481.97			0.748
Inverse	2517.87	1743.47			0.740
Quadratic	3900.82	-185.38	6.1124		0.723
Cubic	4133.55	-304.13	19.9107	-0.4380	0.744
Compound	3414.04	0.9813			0.568
Power	3895.51	-0.1559			0.732
Square root	7.8393	0.5467			0.681
Growth	8.1357	-0.0189			0.568
Exponential	3414.04	-0.0189			0.568

Appendix XXVI : Trend in production of turmeric in Kerala

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	8330.63	-155.35			0.255
Logarithmic	8835.19	-1008.9			0.203
Inverse	6136.43	3130.14			0.148
Quadratic	7272.17	133.326	13.746		0.308
Cubic	9526.08	-1016.7	119.885	-4.2423	0.434
Compound	8917.23	0.9686			0.282
Power	9551.95	-0.1908			0.190
Square root	8.6653	0.5297			0.111
Growth	9.0957	-0.0319			0.282
Exponential	8917.23	-0.0319			0.282

Appendix XXVII : Trend in productivity of turmeric in Kerala

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	1827.42	41.1932			0.339
Logarithmic	1854.18	191.692			0.138
Inverse	2313.24	-296.63			0.025
Quadratic	2398.81	-114.64	7.4207		0.629
Cubic	2616.68	-225.81	20.3375	-0.4101	0.651
Compound	1861.61	1.0171			0.300
Power	1898.20	0.0748			0.110
Square root	7.7251	-0.1005			0.015
Growth	7.5292	0.0169			0.300
Exponential	1861.61	0.0169			0.300

Appendix XXVIII : Trend in area of turmeric in India

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	147774	4404.29			0.678
Logarithmic	140591	25240.1			0.420
Inverse	202669	-48085			0.115
Quadratic	169074	-1404.9	276.628		0.749
Cubic	175629	-4749.4	665.239	-12.337	0.752
Compound	151759	1.0225			0.681
Power	146054	0.1284			0.428
Square root	12.2068	-0.2407			0.114
Growth	11.9300	0.0222			0.681
Exponential	151759	0.0222			0.681

Appendix XXIX : Trend in production of turmeric in India

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	599001	25387.1			0.598
Logarithmic	481414	181479			0.577
Inverse	951101	-475491			0.299
Quadratic	465058	61917.1	-1739.5		0.672
Cubic	614781	-14480	7137.30	-281.80	0.721
Compound	605860	1.0320			0.618
Power	521704	0.2271			0.604
Square root	13.7519	-0.5916			0.310
Growth	13.3144	0.0315			0.618
Exponential	605860	0.0315			0.618

Appendix XXX : Trend in productivity of turmeric in India

Equation	Parameter Estimates				
	a	b_1	b_2	b_3	R Square
Linear	4032.49	39.0195			0.147
Logarithmic	3566.57	413.663			0.312
Inverse	4706.93	-1471.6			0.299
Quadratic	2900.42	347.766	-14.702		0.699
Cubic	3367.14	109.623	12.9684	-0.8784	0.749
Compound	3992.21	1.0093			0.153
Power	3571.95	0.0987			0.325
Square root	8.4529	-0.3509			0.311
Growth	8.2921	0.0093			0.153
Exponential	3992.21	0.0093			0.153

Appendix XXXI : State wise per cent contribution of area and production of turmeric in India

Sr.No.	States	Per cent contribution of Area	Per cent contribution of Production
1.	Andhra Pradesh	28.9	41.70
2.	Odisha	11.08	4.70
3.	Karnataka	10.70	16.19
4.	Tamil Nadu	9.28	9.97
5.	West Bengal	7.05	4.90
6.	Assam	7.01	2.46
7.	Maharashtra	6.89	4.33
8.	Madhya Pradesh	6.28	6.01
9.	Kerala	0.97	0.72
	Total	**88.16**	**90.98**