PRICE BEHAVIOUR OF TURMERIC IN INDIA

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

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Kerala Agricultural University, Thrissur

Department of Agricultural Economics

COLLEGE OF HORTICULTURE

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DECLARATION

I hereby declare that the thesis entitled **"Price behavior of turmeric in India"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

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(2009-11-156)

CERTIFICATE

Certified that the thesis entitled **"Price behavior of turmeric in India"** is a record of research work done independently by **Miss. T. Jyothi** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to her.

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Affectionately Dedicated

To my

Beloved Dad & Mum

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Jyothi
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Introduction

1. INTRODUCTION

India is a land of spices. Indian spices are popularly known for their flavour both in the domestic and international market. They are not only indispensable for the dietary pattern but are also known for their medicinal and curative effects since time immemorial. With the growing awareness of ill effects of synthetic chemicals, drugs and medicines, people are now switching towards traditional system of medicines where spices like ginger, turmeric, chillies etc. are widely used. India is the largest producer, consumer and exporter of spices. Nearly, 94 per cent of the total production of spices in the country is domestically consumed and the remaining six per cent is exported. India's share in the world trade of spices is 47 per cent in terms of volume and 25 per cent in terms of value (Spices Board, 2009). Thus, Indian sub-continent is the spice hub of the world and has the lion's share of the global market.

Among spices, turmeric is an important commercial spice crop widely grown in India and is referred to as 'Indian saffron'. Indian turmeric is considered to be the best in the world due to the presence of high curcumin content. The origin of turmeric is believed to be South-East Asia. It is a very important spice in India from ancient times. India is the forerunner of world's turmeric production and it consumes nearly 80 per cent of the total production. With its inherent qualities, Indian turmeric is considered the best in the world.

1.1. GLOBAL SCENARIO

Turmeric is an ancient spice. A native of South East Asia, it is widely cultivated in India, China, Taiwan, Sri Lanka, Java, Peru, Australia and the West Indies. India is the largest producer and exporter of turmeric in the world. Turmeric occupies about 6 per cent of the total cultivated area under spices and condiments in India. At global level (Fig.1.1), India constitutes 78 per cent of total production of turmeric followed by China (8%), Myanmar (4%), Nigeria (3%) and Bangladesh (3%) during triennium ending 2008-09 (Spices Board, 2009).

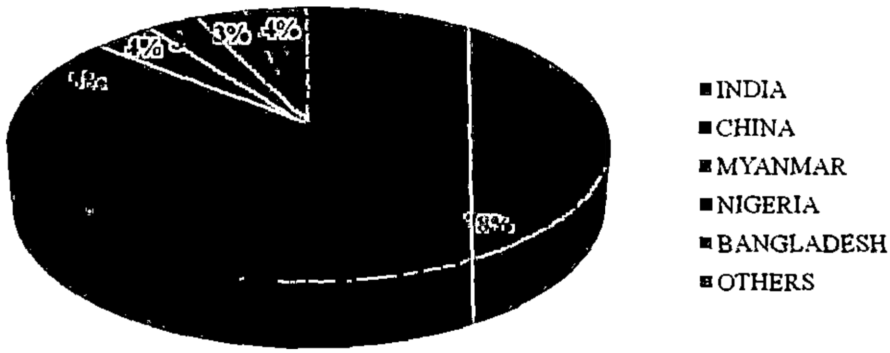


Figure 1.1. Share of different nations in global turmeric production

1.2. INDIAN SCENARIO

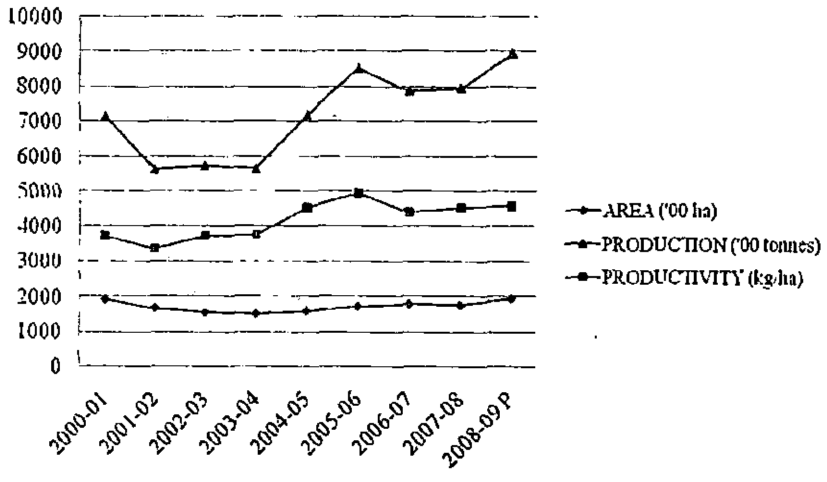
As quoted earlier, India is the largest producer, consumer and exporter of turmeric in the world and it accounts for about 78 per cent of world's turmeric production. The domestic consumption of turmeric accounts for nearly 94 per cent of total production, as it has diversified uses such as food adjunct in many vegetables, meat and fish preparations, colouring agent for cheese, pickles, liquor, fruit drinks, cakes, confectionery and food industry, as an ingredient in the preparation of medicinal oils and ointments. In view of its diversified uses, there is an increase in area under turmeric from 191.7 thousand ha in 2000-01 to 195.0 thousand ha in 2008-09. Similarly, the production has increased from 704.3 thousand tonnes in 2000-01 to 894.2 thousand tonnes in 2008-09 and this increase in production is due to significant contribution from turmeric productivity ie. increased from 3.73 tonnes/ha in 2000-01 to 4.59 tonnes/ha in 2008-09 (Table 1.1). As shown in Fig.1.2, the total area under turmeric has increased gradually during the reference period (2000-01 to 2008-09) and at the same time the production has also risen. The productivity of turmeric has shown significant increase compared to area increase and this contributed more towards increase in production of turmeric during the reference period.

Table 1.1. Area, production and productivity of turmeric in India

YEAR	Area (ha)	Production (tonnes)	Productivity (kg/ha)
2000-01	191700	714300	3726
2001-02	167100	562800	3368
2002-03	154200	573900	3722
2003-04	150100	564900	3763
2004-05	158700	718100	4525
2005-06	172000	851700	4952
2006-07	178500	786800	4408
2007-08	175300	794400	4532
2008-09P	195040	894250	4585

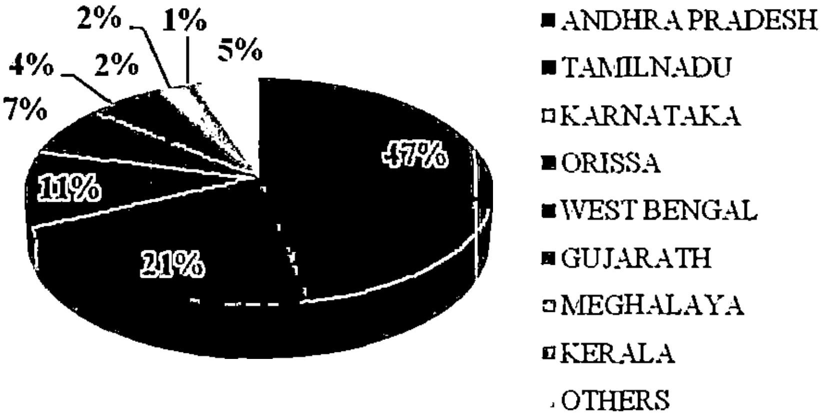
Source: www.indiastat.com

Fig. 1.2. Trends in area, production and productivity of turmeric (2000-01 to 2008-09)



Regarding state-wise scenario, in 2006-07, India had approximately 1.86 lakh hectares under turmeric cultivation, of which, Andhra Pradesh had the largest area (36%) with 47 per cent production. It is followed by Tamil Nadu with 16 per cent and 21 per cent in terms of area and production respectively. Other major states include Orissa, Karnataka, West Bengal and Kerala (Fig.1.3).

Fig. 1.3. State-wise shares of production of turmeric (2006-07)



With the advent of trade liberalization, in the recent past of one and a half decade, this crop has gained immense significance in the international market because of its medicinal properties, colouring pigment curcumin and spicy flavours. Kerala produces the best quality turmeric which is exported under the trade name Alleppy Finger Turmeric (AFT) (Nybe *et al.,* 2007). Most of the turmeric produced in the Erode belt is used for domestic consumption and on the other hand, the quality of Salem turmeric is comparatively better and has acceptance in the international market for grinding and blending purposes. Nizamabad market in Andhra Pradesh has gained the good reputation in offering better quality produce at remunerative prices to the farmers (NMCE, 2007).

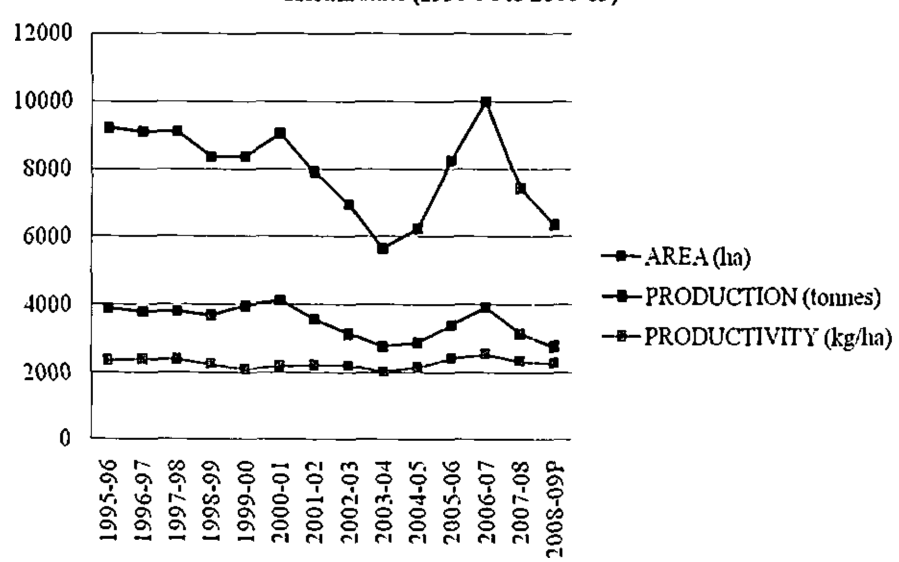
The growth analysis on area, production and productivity of turmeric in Kerala was presented through Table 1.2 and Fig.1.4. The findings reveal a disappointing picture in the sense that, both area and productivity exhibited declining trends during the reference period (1995-96 to 2008-09) and hence, production of turmeric showed dismal performance.

Table 1.2. Area, production and productivity of turmeric in Kerala

YEAR	Area (ha)	Production (tonnes)	Productivity (kg/ha)
1995-96	3900	9200	2359
1996-97	3800	9100	2395
1997-98	3800	9100	2395
1998-99	3700	8360	2259
1999-00	3970	8360	2106
2000-01	4130	9040	2189
2001-02	3560	7900	2219
2002-03	3140	6940	2210
2003-04	2770	5650	2040
2004-05	2880	6240	2167
2005-06	3380	8240	2438
2006-07	3920	9980	2546
2007-08	3160	7430	2351
2008-09P	2780	6360	2288

Source: www.indiastat.com

Fig. 1.4. Trends in area, production and productivity of turmeric in Kerala state (1995-96 to 2008-09)



1.3. EXPORT SCENARIO

India in the past had almost monopolized the world turmeric trade with over 80 per cent of the world output and 60 per cent of the world exports. However, India exports 5-6 per cent of its total turmeric production to other countries since 1995 and the rest is consumed locally. With the advent of trade liberalization, turmeric exports gained momentum from the country (Table 1.3). United Arab Emirates is the major importer of turmeric from India accounting for 18 per cent of the total exports followed by United States of America with 8 per cent. The other leading importers are Bangladesh, Japan, Sri Lanka, UK, Malaysia, South Africa, Netherlands and Saudi Arabia which together account for 75 per cent of the world trade. Asian countries supplies 75 per cent to the entire world and the remaining 25 per cent is met by Europe and North America, Central and Latin American countries. United States imports 97 per cent of its turmeric requirement from India and remaining portion from the Islands of the Pacific and Thailand.

Table 1.3: Exports of turmeric from India

Year	Quantity (M.T.)	Value (Rs Lakhs)
2005-06	46405	15286
2006-07	51500	16480
2007-08	49250	15700

Source: www.indiastat.com

Turmeric is the third-largest spice exported from India (NMCE, 2007). Its exports increased from 0.44 lakh tonnes to 0.52 lakh tonnes in terms of quantity and from Rs. 11567 lakhs to Rs. 16480 lakhs in terms of value during the period 2000-01 to 2006-07. However, the share of turmeric exports in total spice exports declined from 18.92 per cent to 13.78 per cent in terms of quantity and from 6.31 per cent to 4.48 per cent in terms of value during the same reference period.

A close examination of the Table 1.4 reveals that, the share of turmeric exports in total spices exports in terms of value was 6.31 per cent during the year 2000-01 and it was increased to 6.67 per cent during 2003-04. However, the share was declined to 4.48 per cent during 2006-07. The reason for the variation in terms of value was due to fluctuations in prices of turmeric in the world market. Though, India occupies a dominant position in turmeric exports, it is still essential on the part of the Government to formulate suitable policies to further enhance the turmeric exports, as India enjoys more comparative advantage in the international market.

Table 1.4. Export earnings of spices and turmeric from India

Years	Quantity			Value		
	Spices (tonnes)	Turmeric (tonnes)	Turmeric share	Spices (lakhs)	Turmeric (lakhs)	Turmeric share
2000-01	235,917	44,627	18.92	183,352	11,567	6.31
2001-02	243,203	37,778	15.53	194,054	9,073	4.68
2002-03	264,107	32,402	12.27	208,671	10,337	4.95
2003-04	254,382	34,500	13.56	191,160	12,751	6.67
2004-05	348,524	43,097	12.37	235,051	15,624	6.65
2005-06	350,363	46,405	13.24	262,762	15,286	5.82
2006-07	373,750	51,500	13.78	367,575	16,480	4.48

Source: www.indiastat.com

1.4. IMPORT SCENARIO

Occasional imports of turmeric take place in India with meager amount depending upon its domestic production level. The imports were not regular during pre-WTO regime, but regular during post-WTO regime (Table 1.5) mainly for maintaining trade relationships with the member countries.

Table 1.5. Imports of turmeric into India

Years	Quantity (Tonnes)	Value (Rs.Lakh)
2000-01	83.00	18.10
2001-02	120.00	11.74
2002-03	1313.00	250.37
2003-04	3005.00	841.29
2004-05	1615.00	702.25
2005-06	4022.00	1676.14
2006-07	7003.00	2519.82
2007-08	4650.00	1227.30
2008-09	2525.00	820.25

Source: www.indiastat.com

Having studied both export and import scenarios of turmeric from the country, it can be inferred that, India enjoys net exporter status in the international market. However, the net trade of turmeric from the country depends upon several factors viz., area under turmeric, weather influences, crop output and stock level - carry forward stocks and stock with farmers/traders/warehouses, domestic and export demand etc. In the recent period, the prices of turmeric are greatly volatile, thereby affecting the export competitiveness of turmeric from the country. Further, with the onset of trade liberalization, the international prices of turmeric are supposed to influence the domestic competitiveness of turmeric. Hence, it is imperative to analyze the price behaviour of turmeric in the major markets of the country, so as to formulate the policies for boosting its domestic and export competitiveness. It is witnessed from the past reviews that, the price volatility of turmeric is very severe in the major turmeric markets in the country and in this context, an attempt was made to conduct the study on 'Price behavior of turmeric in India' with the following specific objectives:

1) To investigate the secular trend, seasonality, cyclical and irregular movements in the price of turmeric in India

2) To evolve a reliable price forecasting model for turmeric

1.5. SCOPE OF THE STUDY

Spices export seems to be the engine of growth in exports, for agrarian economies of developing countries like India. The exports from a country are highly dependent on production and export prices. The export scenario of turmeric in the country is faced with competition from other producing countries of turmeric. Besides that, there have been some changes in area under turmeric as a result of price fluctuations when compared to past. The analysis of export competitiveness and price behaviour of turmeric would focus on the need to revitalize the situation. Efforts for broad basing the turmeric export basket by value addition and product diversification to meet global quality standards and exploring the scope for production and export of turmeric would bring about bright prospects for the Indian economy.

1.6. LIMITATIONS

The study was based on secondary data. In the case of secondary data, often data from different sources may not agree with each other and some efforts to choose the better among them are inevitable. In the case of prices, data were not obtained from a single source, and there will be minor differences in data according to change of sources. Care has been taken to avoid personal bias in such decisions. However efforts were made to make the available data as authentic as possible.

1.7 PRESENTATION OF THE STUDY

The report of the study has been spread out under five chapters as given below. The first chapter deals with introduction, in which, the statement of the problem, objectives, the scope and limitations of the study are discussed. The second chapter covers review of related studies in the light of the present investigation. The third chapter details the materials and methods used in the process of investigation. The results and discussion are presented in the fourth chapter and chapter five gives the summary and conclusion of the study followed by references, appendices and abstract.

Review of Literature

2. REVIEW OF LITERATURE

Review of literature is an appraising description of information found in the literature associated with the chosen prioritized area of research. The literature review illustrates, summarizes, appraises and clarifies the background for the proposed research investigation. It will give a hypothetical foundation for the research and helps the researcher to establish the nature and direction of proposed research activity. Literature reviews are important because they seek to summarize the literature that is available on the proposed research topic. They make sense of a body of research and present an analysis of the available literature so that the reader does not have to access each individual research report included in the review. Everyone who works within the scope of the proposed research topic has a professional duty to be up-to-date with recent developments and ideas, so that, they execute the proposed research topic on the systematic lines.

The thorough analysis of the research topic with reference to a particular subject area and sometimes in a particular subject area within a certain time period helps the researcher to analyze how each work is similar to and how it varies from the others, thereby, guides the researcher way forward for further research. Further, it helps to gain knowledge and understand about the proposed research topic. Considering these merits, the review of literature covering the various aspects of the present research investigation on 'Price behaviour of turmeric in India' are presented under the following sub-heads.

2.1 Trend in area, production and productivity

2.2 Trend in export and import status

2.3 Price behaviour

2.3.1 Secular trend

2.3.2 Seasonal variations

2.3.3 Cyclical variations

2.3.4 Irregular variations

2.4 Export competitiveness

2.5 Forecasting models

2.1 TREND IN AREA, PRODUCTION AND PRODUCTIVITY

Chatterji (1966) in his study on agricultural growth in India during 1950-1963 opined that linear trend fitting was the most appropriate tool to measure agricultural growth, which would avoid any affect due to seasonal and cyclical variation. He used linear model to estimate the growth rates of important cereals, pulses and non-food crops.

Mathew (1978) examined the possible reasons for the decline of productivity by studying the pattern of production and productivity of coconut in Kerala. Both linear ($y = a+bt$) and exponential ($y = ab^t$) regression equations were fitted to the data and corresponding growth rates were worked out. The compound rate of growth for area under coconut in Kerala (3.26 per cent) was slightly lower than that of the country as a whole (3.39 per cent). Among the different districts considered the rate of growth was lowest in Alappuzha. In Alappuzha, only 25 per cent of the new area had been brought under coconut because of the importance given there for food crops in general and rice in particular. The total production of nuts had not shown any increase in Alappuzha district and the researcher opined that prevalence of root wilt disease as one of the reasons for this stagnation.

Dandekar (1980) preferred log linear form over the linear form for working out the compound growth rates as it was found to be more suitable for the series of agricultural production as a whole.

Biradar and Annamalai (1982) conducted a study for estimating the trend in area, production and productivity of sweet potato in different states of India during the period 1966-67 to 1977-78. Exponential function of the form $Y = ab^t$ was fitted for time series data to estimate compound growth rates of area, production and productivity. Interpretation of the results revealed an increase in the area, production and productivity of the crop by 15.3, 22.5 and 6.4 per cent respectively between the years. Change in area ranged from 185.7 per cent (increase) in Rajasthan to 41.9 per cent (decrease) in Kerala. Likewise, change in production ranged from 300 per cent (increase) in Rajasthan to 47.3 per cent (decrease) in Kerala. Similarly, change in productivity ranged from 46.7 per cent (increase) in Tripura to 21.1 per cent (decrease) in Andhra Pradesh.

Bhat *et al.* (1986) carried out a study of growth rates of major crops in Jammu and Kashmir. The time series data on area, production and productivity of different crops for the period 1970-71 to 1983-84 were used for the study. The Compound growth rates of production, productivity and cropped area were worked out with the help of the exponential function of the form $Y = ab^t$. Students't' distribution was used to test the significance of growth rates. The results revealed that oilseeds showed the highest growth rate of 4.85 per cent followed by rice and wheat with 1.85 per cent and 1.19 per cent, respectively, which were found to be significant at one per cent level. The growth rates of area under maize and pulses indicated a non-significant trend. Oilseeds indicated high growth rate for all the factors viz. area, production and productivity.

The trends in area, production and productivity of pepper in India during 1961-85, which were estimated by Das (1988), revealed that area remained stagnant around 1.1 lakh ha and production around 0.25 lakh tonnes during this long period. But the world area under pepper showed 41.3 per cent increase in 25 years. As far as the competition to India is concerned, pepper area in Malaysia was doubled, while it was raised by two and half times in Indonesia and more than six folds in Brazil. In the world production, there was 52 per cent increase during 1976-80; but in the subsequent period it came down due to set backs in Indonesia, Malaysia and Brazil. The world pepper export showed a growth of 120 per cent in a period of 25 years, but India's relative share slipped from a virtual monopoly position in 1940s to 20 per cent in 1981-85.

Subramanian and Vasanti (1988) estimated period wise compound growth rates of area, yield and production of major crops in Tamil Nadu based on time series data from 1961 to 1978, using a linear function. It was found that, of all the crops studied sugarcane was the only crop which had shown positive rate of growth in area, yield and production in period I (1961-69). In period II (1970-78), the rates of growth of yield and production have been positive for all the crops indicating the impact of green revolution.

George *et al.* (1989) in their study of trends in area, yield, production and export of pepper during 1952-53 to 1983-84 reported that price was not a significant variable in explaining productivity change and lagged price had no influence on acreage allocation of pepper.

Arya and Rawat (1990) made an attempt to analyze a district wise agricultural growth of Haryana. Time series data for fifteen years from 1966-67 to 1980-81 were collected. Growth rates regarding area, production and productivity were worked out for the state and seven districts for various food and non-food crops. District wise data regarding area, production and productivity of various crops were examined and plotted. The growth rates were worked out by fitting exponential function of the form $Y = ab^t$. Results revealed that area under cereals and total food grains increased at the rate of 1.84 per cent and 0.93 per cent respectively. The production of pulses, coarse grains and sugarcane were found to be decreased at state level as well as at district level.

Ipe (1990) analyzed the instability in production of spices in Kerala. Arithmetic mean and standard deviation of the percentage change were used to explain the instability. Higher variability in production and productivity of pepper and cardamom was observed.

Thomas *et al.* (1991) examined the performance of tapioca in the state during the period 1960-61 to 1986-87. Trend in area, production and productivity and output response behaviour of tapioca in the state were analyzed. Semi logarithmic model of the form log Y = a + bt was used for estimating the trends in area, production and productivity. The analysis was carried out by fitting semi logarithmic function to the index numbers (with the triennium ending 1969-70 as the base) of the area, production and productivity for the entire period. The period of 27 years was divided into three phases viz. from 1960-61 to 1969-70, from 1970-71 to 1979-80 and from 1980-81 to 1986-87 and function was fitted to study the inter decadal growth. From the results obtained, it was interpreted that acreage under tapioca during 1960-61 to 1986-87 showed a declining trend. But, the positive growth rate of productivity had offset the negative impact of area. The results indicated that moderately high growth rate of area, production and yield took place during sixties. Trend analysis for the period of eighties revealed that the effect of technology had a very little impact on production.

The instabilities in area and production of pulses in Andhra Pradesh during 1970-71 to 1986-87 were examined by Bharathi *et al.* (1992). Coppock's instability index, coefficient of variation and standard deviation were used to work out instability. The results revealed that the contribution of area to production was more evident than yield. Moreover, the instability in yield levels was more than that of area and this caused further instability in production.

Das (1992) worked out the growth in area, production and yield of major crops of Kerala during 1973-74 to 1987-88 using exponential function of the type $Y = AB^t$. To measure instability, coefficient of variation was estimated. It was found that pepper registered positive growth rate only in the districts of Idukki, Thrissur, Palakkad and Kozhikode region. It varied from -3.43 per cent in Ernakulam district to as high as 34.8 per cent in Idukki district. Coefficient of variation was also high ranging from 21 per cent in Kollam region to 62 per cent in Palakkad district. Ginger production registered a positive growth rate in all districts except Kottayam (-4 per cent), Palakkad (-1.3 per cent) and Malappuram (-9.5 per cent).

In his study on growth and instability of oilseed production in India, Kaushik (1993) worked out growth rates in area, production and yield of principal food crops and oilseeds from 1968-69 to 1991-92, using exponential function of the form $\ln Y_t = a + b_t t$. The results revealed that total food grains showed a significant growth rate in production and productivity, whereas in the case of total oilseeds, growth rate was significant in area, production and productivity. It was also found that fluctuation in yield was the major cause for the fluctuation in the output and hence the fluctuations in yield have to be controlled to bring stability in the output.

In an analysis of growth trends of principal crops in Kerala over the period 1965-66 to 1989-90, decadal changes in growth rate of area, production and productivity of major crops of Kerala, contribution of area and productivity towards increasing the production and the magnitude and instability for each crop was examined by Bastine and Palanisami (1994). They fitted exponential functions $Y = AB^t$ to the data to compute the compound growth rates and coefficient of variation was used as the measure of instability. The results revealed that pepper showed positive growth rates in area, production and productivity during the first decade, while during the second decade there were negative growth rates in area, production and productivity and after that it showed substantial increase. Production instability was found to be very high. In the case of ginger growth rates were significant and positive for area, production and yield and at the same time high instability in production and yield during the period 1965-66 to 1984-85. The first decade showed spectacular performance in growth and after that growth rates were somewhat low. Area effect and productivity effect had greater role in production for pepper and ginger respectively.

The compound growth rate in area, production and productivity of pepper for the period from 1956-57 to 1989-90 was analysed by Babu *et al.* (1996) by fitting the functions of the type $Y = AB^t$ and magnitude of variability over time was worked out by coefficient of variation. The results revealed that over the years, pepper area increased by 0.97 per cent and production by 0.92 per cent per annum where as the productivity declined by 0.07 per cent per annum. Variability analysis revealed that growth in pepper production was accompanied by instability in production, caused by instability in both area and productivity.

Ajithkumar and Sankaran (1998) examined the factors responsible for the instability in turmeric production in India and the results showed that yield instability increased marginally in the eighties. However, the increase in yield instability was compensated by decrease in area instability resulting in reduction of production instability. Decomposition analysis showed that yield instability was the dominant factor affecting production instability.

Jain (2002) in his study examined the growth in area, production and export of spices in India during 1991-92 to 1998-99. The results revealed that the area of spices registered an increase of 24.69 per cent and production by 53 per cent. The export showed an increase of 21 per cent in quantity and 22 per cent in value.

Mishra (2002) undertook a study on spatial and temporal variations in the development of agricultural crops in Kerala. The time series data from 1970-71 to 1997-98 were used for the study. The trends of crop acreage as well as crop production were obtained by fitting four models viz. Lin-lin model, Lin-log model, Log-lin model and Log-log model or exponential model. Compound growth rates of acreage and production through exponential models were calculated by using the formula $(e^{B1} - 1) * 100$. It was found that rubber recorded the highest compound growth rate. The food crops viz. rice and tapioca showed negative compound growth rate whereas cash crops viz. coconut and pepper showed positive compound growth rate for both production and acreage.

Rajesh *et al.* (2002) studied the trends in area, production and productivity of major spices in India using exponential function of the form $Y = AB^t$. It was found that all major spices viz., black pepper, cardamom (small), cardamom (large), ginger, turmeric and chillies had registered significant positive growth rate in area, production and yield except the area of small cardamom. The area under small cardamom registered a negative growth rate of 1.01 per cent per annum, which was offset by increased productivity of 3.9 per cent through technological advancements.

Divya (2003) made an attempt to analyze the market behaviour of important spices of Kerala. The growth rates were worked out by using different growth models during 1971-2000. The results revealed that there was a significant and positive growth in area, production and productivity of pepper and ginger. But in the case of cardamom and turmeric growth in production and productivity was significant and positive while in area it was negative though insignificant. Variability measurement using Coppock's instability index and coefficient of variation exhibited higher variation in production compared to area and productivity in all the crops studied except cardamom where productivity variation was high.

Sebastian *et al.* (2004) in their study on trends in area, production and productivity of cashew in Kerala during the period 1952-53 to 1999-00 reported that growth rate in area was positive for the entire period, with stagnant production and productivity.

Varghese (2004) studied the trend in area, production and productivity of cardamom in Kerala using secondary data from 1970-71 to 2002-03. Both log linear and log quadratic functions were tested for acceleration and deceleration of area, production and productivity. The study indicated a negative trend in the growth rate of area under cardamom cultivation.

Babu (2005) attempted to study the price behaviour of coconut and coconut products in India. Trend in area, production and yield of coconut at world, national and state level over a period of 45 years from 1960-61 to 2004-05 was studied. Out of the different functions tried, cubic model gave the best fit for area, production and yield of coconut. Decade wise Compound growth rates of area, production and yield of coconut in the state, national and world level were also estimated. Results indicated that coconut plantations in India underwent significant improvement in area during sixties, eighties and nineties. Coconut acreage in Kerala was found to be expanded significantly during the fifties, sixties and during early seventies.

The trend in area, production and productivity of coconut during Pre-WTO period (1975-76 to 1994-95) and Post-WTO period (1995-96 to 2005-06) was examined by Swapna (2008). Growth rates were estimated by using exponential model for the whole period and kinked exponential model for the sub-periods. The results revealed that the growth rate of production (2.7 per cent) showed a positive and increasing trend and was equally contributed by area (1.37 per cent) and productivity (1.38 per cent) during the whole period in Kerala. In Pre-WTO period, growth in production (1.86 per cent) was attributed to expansion in area (1.18 per cent), even when the growth in productivity (0.82 per cent) was stagnant, whereas in Post-WTO period, the effect of productivity (2.17 per cent) was more pronounced, compared to growth in area (1.04 per cent) which resulted in a commendable growth in production (3.15 per cent). In case of Alappuzha district, growth in production (1.1 per cent) was more or less equally contributed by expansion of area (0.48 per cent) and growth in productivity (0.63 per cent) for the whole period.

2.2 TREND IN EXPORT AND IMPORT STATUS

The growth of export of turmeric from India during 1960-61 to 1979-80, was examined by Raveendran and Aiyaswamy (1982) and they found that the export prices had exhibited a much larger variation than the quantity exported. A linear function was fitted to study the relationship between export of turmeric and production of turmeric in the previous year. Ratio of export price and domestic price and time variable were used to capture the collective effect of various measures adopted to promote turmeric export. The results indicated that only time variable was found to be significant, suggesting the non-responsiveness of exports to the price variable. The highly significant trend variable 't' which was a proxy variable for export promotion measures implied that these measures were fairly successful in promoting turmeric export with an average annual increase of 247.62 t during the two decades.

The export performance of different pepper products between 1978-79 and 1982-83 was studied by Velappan (1984). It was found that, except for white pepper, there was an upward trend in export for all the pepper products.

Chandran (1987) in his study on the export performance of cardamom in South India observed that the export price had a positive relation with export quantum and the local price was negatively related to export quantum.

Chand (1989) in his study on growth and instability of exports and imports of agricultural commodities in India observed that for most of the agricultural commodities, exports showed less instability than the imports. The growth in exports as well as imports of the agricultural sector was much lower than the growth in total merchandise trade. The trade deficit of the agricultural sector was small and it was not rising in contrast to that of non-agricultural commodities.

Export performance and prospects of India's major spices like pepper, cardamom, ginger, turmeric and minor spices were examined by Ipe (1989). The results showed that all the commodities exhibited appreciable growth both in quantities exported and export earnings, even though there was much year to year fluctuation. Among the major spices, turmeric recorded the highest growth rate and instability in export earnings followed by ginger, cardamom and pepper.

Nirmala *et al.* (1989) in their study found a positive compound growth rate for production, domestic and export prices, export earnings and productivity of cardamom in India during the periods 1970-80 and 1980-86. Between 1970 and 1980, the growth rates of production and export were positive for India and negative for Guatemala. But during 1980-86 India's growth rates for the same variables were negative, while for Guatemala they were positive. For every one per cent increase in production in India, export showed an increase of 2.03 per cent.

The production and export performance of Indian cardamom during 1970-71 to 1984-85 were analysed by Thomas *et al.* (1989) using semilog and exponential functions. The study revealed that, India accounted for 67.3 per cent of world production in 1970-71 which declined to 40.83 percent in 1984-85, where as the share of export of cardamom decreased from 54.98 per cent to 29.6 per cent during the same period. The negative value of trend implied that the export promotion measures taken by the government were not successful. It was also reported that export performance of Indian cardamom was mainly dependent on production of cardamom, export price and export from other countries.

The trends in total value of agricultural exports as well as the value of individual agricultural commodity export, along with the change in export commodity complex, were examined by Tilekar (1989) during 1976-89. The results indicated that there had been a consistent increase in the total value of exports at current prices. Consistency was also observed in the trend in export of agricultural commodities during the period under study. But the share of total value of agricultural exports in total exports declined from 1976-77 to 1983-84. Export commodity basket of major agricultural commodities did not show any significant change during the period under study.

Pal (1992) analysed the magnitude of growth and instability in agricultural exports of India during the period 1970-89 using coefficient of variation. The study revealed that exports of agricultural products were constrained by the increasing domestic demand and the volatile world prices, and policy changes have induced a very high degree of instability in the export earnings from important agricultural products. However, the total earnings from both agricultural and non-agricultural exports was fairly stable primarily due to the stabilization effect of export diversification.

Singh (1992) examined trends in agricultural trade over time and analysed the performance of major commodities that are responsible for India's agricultural exports. He had identified the commodities which are favourable for exports in relation to the consumption and price ratios and concluded that the share of agricultural exports had been declining over the period from 1970-71 to 1990-91.

In their study on the trends in the export of cardamom from Kerala during 1979-80 to 1993-94, Mani and Jose (1996) observed that even though the share of Kerala state in the total exports of cardamom remained high (70.55 per cent) over the years, the percentage of exports to total production in the state alarmingly came down from 69.27 per cent in 1979-80 to 8.04 per cent in 1993-94. Export performance revealed greater variability both in quantity exported and its value. A high price for cardamom was found to keep our product less competitive in the international market.

In a study on the post globalization scenario of Indian fruits by Pawar and Patil (2001a), linear and semi-log functions were fitted to the data such as volume and value of export of fruits from India in post globalization period. The results revealed that export of fruits registered positive and significant growth of 19.42 per cent per annum and export earning of India through agricultural commodities increased significantly at a rate of 37.42 per cent per annum in post globalization period.

The performance and prospects for export of vegetables from India in post globalization era of agriculture was analysed by Pawar and Patil (2001b) based on secondary time series data compiled from monthly statistics of foreign trade of India during the period 1990-1996. Linear and exponential equations were fitted to the time series data for analysing the trend in export. The study revealed that export of green pepper both in volume and value terms exhibited upward trend significantly at a rate of 6.6 per cent and 15.05 per cent per annum. In general, most of the vegetables exported showed an increasing trend in volume.

In their study on Indian spices, Behera and Indira (2002) analysed the growth of spices export from India during the period 1994-95 to 1999-2000. The exports of Indian spices in terms of quantity has grown at the rate of 7.94 per cent while in terms of value it had grown significantly at the rate of 17.64 per cent during the period. The exports of value added spices like spice oils and oleoresins; mint oil and curry powder had sharply increased while the share of pepper and chillies was reduced by 1.96 per cent and 10.67 per cent respectively during the same period. The growth of spices import into India during the same period was found to be 6.69 per cent in terms of value, which was much below the growth rate of exports. It was found that India imported clove in comparatively larger quantities and nutmeg, pepper and other spices in small quantities mainly from European Union and USA.

Rajesh *et al.* (2002) studied the trend in export of major spices in India and found that black pepper registered a positive normal growth rate of 2.38 per cent in export quantity and 12.78 per cent in export value. While large cardamom registered 12.76 per cent growth in export quantity and 21.24 per cent in export value, ginger registered 4.05 per cent growth in export quantity and 10.15 per cent in export value. For turmeric, growth rate was at 4.14 per cent in export quantity and 13.08 per cent in export value. Export earnings was contributed by both increase in unit value and quantities in all the major spices except small cardamom which experienced negative growth rate of -8.12 per cent in export quantity and -1.71 per cent in export value.

The growth of export of pepper, cardamom, turmeric and ginger was examined by Divya (2003) and it was found that there was a significant positive growth in export quantity and value of pepper, ginger and turmeric during 1971-2001. In cardamom, growth was negative in both export quantity and value. Coefficient of variation exhibited a higher variation in export value compared to export quantity in all the spices. Comparison of growth in export performance during pre and post liberalization indicated a higher growth in export quantity and value during post liberalization period except for pepper.

The comparison of item wise export and import during pre WTO (1989-1995) and post WTO period (1996-2002) in value terms was examined by Divya (2003). The results indicated that pepper was the major foreign exchange earner in both the periods followed by turmeric, ginger and cardamom. In pepper products, black pepper garbled was the major exporting item with a share of 65 per cent. Export earnings from spices have increased three folds during post WTO period as that of pre WTO. The item wise import of all the spices increased in post WTO period and pepper contributed major value of import whereas it was cardamom during the pre WTO period. Since India contributed 80 per cent of world trade of turmeric its import to India is very less.

2.3 PRICE BEHAVIOUR

According to Kahlon and Tyagi (1953), agricultural prices have a tendency to display wider inter-year and intra-year fluctuations. The rise in agricultural commodity prices will be more than proportionate to the change in production.

Kulkarni (1963) analysed the relationship between market arrivals and price of groundnut in three regulated markets in Maharashtra during the period September 1949 to August 1959. The analysis of weekly figures revealed that the per cent rate of marketing in the "rapid marketing period" had a positive relationship with "price prospects" so that when the price prospects were favourable, the produce was marketed at a more than usual rapid rate.

Roger (1964) studied the changing role of prices. He indicated that prices would play a large part in the co-ordination of economic activity in United States than it formerly did. He argued that economists should be concerned with the restoring price to its role of inducing change.

Price behaviour was studied using the techniques of classical time series analysis (Croxton *et al.,* 1979; and Enders, 1995). This approach assumes that any time series can be decomposed into four essential components, viz., trend, seasonal, cyclic and irregular components.

Agarwal (1986) was of the opinion that during the last 23 years period, wholesale prices of food grains increased by 175 per cent to 450 per cent. There was no significant difference in the rate of increase in wholesale and farm-harvest prices. Prices of gram and pulses as a group increased at higher rates compared to cereals. Prices of gram and pulses have fluctuated more, resulting in higher price uncertainly compared to cereals.

Goosens and Boddez (1986) concluded that prices have remained fairly constant during the 1970's but during 1980's because of more intense competition prices had gone somewhat down. Vegetables grown under glass houses showed less price variations than those grown in the open. All the vegetables commanded a higher price outside their main season.

Nogueira and Alves (1991) concluded that although useful as an indicator, the price relationship alone should not be used as a basis for decisions, it was suggested to take into consideration – crop tradition, market prospects, and previous years yields, availability of credit and production factors.

Baharumshah and Habibullah (1994) employed the co-integration technique to analyse the long run relationship between weekly pepper prices in six different markets in Malaysia for the period 1986-91. The empirical findings of the study indicated that regional pepper markets in Malaysia were highly co-integrated and the price of pepper, tended to move uniformly across spatial markets indicating competitive pricing behaviour.

Bhatia (1994) stated that wholesale prices of agricultural commodities in India increased in the range of 7 to 10.5 per cent per annum during the period 1980 to 1992 except for sugar in which case the increase was relatively less. However the decline in the world prices of some of the agricultural commodities and continued increase in the domestic prices would adversely influence the future prospects of agricultural sector.

Department of Research, Indian Social Institute (1994) in its report to the tenth Lok Sabah Committee on Agriculture in 1993-94 in India offered an analysis of the price situation of agricultural commodities. The report concluded that the terms of trade have shifter against agriculture, continuing a trend witnessed between the mid 1970's and mid 1980's. The report considered the movement in the terms of trade as a measure of the increased agricultural prices.

Nayyar and Sen (1994) while discussing the various empirical estimates concluded that domestic relative prices of agricultural commodities in India were quite different from world price relatives and dismantling existing restrictions on international trade would in general worsen the terms of trade. Further they observed that domestic price moved closer to world surplus.

Saikat and Sanjith (1994) concluded that due to open trade status of pepper, prices moved synchronously indicating integration of world pepper market. The integration of markets also implied that the domestic supply variables were responsive to international market conditions.

Mohanty (1995) from his findings revealed that monthly wholesale prices of groundnut varied significantly in most districts as well as at the state level. Price tended to fall during the post harvest period when compared to the pre harvest period. A significant relationship between groundnut prices and its area and production was observed.

Ching *et al.* (1996) had addressed the robustness of overshooting hypothesis in agricultural prices. They had found that agricultural prices may undershoot their long-run level if the economy experienced an anticipatory monetary shock. They also found that the agricultural prices definitely displayed undershooting if the prices of manufacturers adjusted instantaneously rather than sluggishly.

An analysis of the price adjustment of pepper using monthly prices for 10 years in the futures and domestic prices by Nasurudeen and Pouchepparadjou (2000) using Ravallion model revealed that last month future price, current spot price and last month spot price were highly relevant in making price adjustments.

Selvaraj *et al.* (2000) opined that an increase in the degree of openness was bound to increase domestic price variability due to direct transmission of world prices. But the results of residual trend analysis showed that variability in domestic price was significant in pre-reform period where as variability in international prices were significant in the post reform period.

Ravindran *et al.* (2007) analyzed both prices and yield of turmeric in Tamil Nadu and concluded that they showed high degree of volatility, but with little correlation between these two variables. They stated that, the export prices of turmeric increased atthe rate of 11.75 per cent during 2001-01 to 2004-05. However the quantum of exports of turmeric declined by 0.93 per cent during the same period due to large scale domestic demand. They suggested that the favourable price trend in the international market is an important indicator for the country to plan for importers' need based exports.

2.3.1. Secular trend

Majumdar (1961) reviewed the trend in the prices of cereals and made an outlook on them. His opinion was that price movements could be fully explained by the movements of production but agreed that inputs played a significant role in governing prices.

Kulkarni (1965) examined the price behaviour of paddy in Ghoti regulated market in Maharashtra by collecting data during the period 1959-60 to 1961-62. He made a comparison of the behaviour of Ghoti prices and their relationship with the Nasik and Bombay prices. His analysis showed that from 1959-60 to 1961-62, there was a continuous declining trend in the prices at three centres. The regression analysis of monthly prices indicated that the trend in prices of Ghoti, as reflected by the maximum prices, did not show any association with the local supplies and was largely determined by the prices prevailing in Nasik. However, the local supply had significant influence on the price paid for the largest consignment marketed in bulk. If the total arrivals were large, the price paid for it was lower than the one paid when the total arrivals were small.

Thingalaya (1969) attempted to analyse price movements over a long period of time, for a century. He revealed a rising secular trend of price levels during the period and that the agricultural prices have tended to exert greater pressure on the general price level than non-agricultural prices.

Sahasvabudha (1970) studied the price trends of Paddy in Raipur regulated market and concluded that in the pre sowing period there was a rising trend whereas in the crop standing period it was roughly constant and during the post-harvest period it began to fall and then to rise.

In the long run a time series may show a tendency to increase, decrease or remain as such. The general direction in which the time series move over a long period of time is referred to as the secular trend (Croxton *et al.,* 1979; Spiegel, 1992).

Jhala (1984) examined the trend and seasonal fluctuations in groundnut oils and oilseeds. His analysis showed that the wide gap between demand and supply of edible oil seeds contributing to rapid increase in the price of edible oils. A time series analysis of monthly groundnut oil prices for a fairly long period clearly revealed that there was trend, cyclical, seasonal and random fluctuations in the price of edible oils.

Agarwal (1986) argued that even though four time period elements viz., trend, cyclical, seasonal and irregular movements were found associated with the changes in prices, secular and seasonal fluctuations played an important role in guiding the farmers and traders in decision making on production and marketing areas.

Das (1988) in his study on the trends in the prices of pepper observed that the prevailing price in the local markets was closely related to the unit value realization, which in turn was closely associated with the international prices. Pepper being an export oriented commodity, its international price obviously influenced the domestic market price of the producing countries.

A trend is usually established based on at least 10 to 15 years data. The long term trend of price of any commodity or group of commodities is the net result of forces affecting either demand or supply over a long span. The trends in price of individual commodities usually follow the general price level in the economy. In India the general price level had been raising since second five year plan (Acharya and Agarwal, 1991).

Patnaik and Anbumozhi (1991) analysed the trend and seasonal price behaviour of paddy, groundnut, cotton and their arrivals during 1983-84 to 1987-88 by using the tools like trend equations and seasonal indices based on weekly data collected from secondary sources. Further the determinant of market arrivals and prices of each commodity were analysed by using linear and log linear multiple regression based on weekly data. For the analysis of price behaviour across the selected commodities the principal component method was employed. The results indicated that there was a positive trend in the price of selected agricultural commodities. However the trend was in favour of groundnut. The seasonality had significant impact on the price behaviour of all the commodities. The market arrivals and the prices had shown statistically an inverse relationship. Despite the effect of prices on the market arrivals and vice versa, the other variables too influence much the behaviour of prices or market arrivals. The vertical integration was found to be relatively faster in paddy and lower in cotton.

Basavaraja (1993) analysed the fluctuations in prices and arrivals of major crops in Bijapur market in Karnataka state by collecting monthly time-series data on prices and market arrivals from the regulated market in Bijapur for the period from 1971 to 1992. Orthogonal polynomial regression analysis was used to study the trends in prices and market arrivals and prices and market arrivals showed an increasing trend during the whole period.

Jeromi and Ramanathan (1993a) examined the trends in pepper prices and its volatilities using an exponential model. Decade wise growth rates were estimated by fitting kinked exponential function and instability index was estimated from the residuals of exponential trend equation. The results showed that during the period 1960-61 to 1989-90, the annual compound growth rate of wholesale and export prices were around 10 per cent and in the decade wise analysis, seventies and eighties recorded highest growth at all levels of prices. However the latter half of eighties witnessed significant negative growth. The instabilities in prices were pronounced during seventies and eighties and it was highest in case of export prices. The wholesale price movements of major alternative crops of pepper in Kerala namely rubber, cardamom and coffee during 1960-61 to 1989-90 were analysed and compared with that of pepper. The analysis revealed that the rate of growth of pepper price was substantially higher than the corresponding growth rates of alternative crops. However, its impact was not reflected in the growth of area and production of pepper.

Sudhakar (1996) analysed the price trends of turmeric in Andhra Pradesh markets during 1981-82 to 1993-94 by using the method of second degree parabola of the form $Y=a+bx+cx^2$. The price line showed a cyclical trend in the price of turmeric in all the selected markets. Each cycle spreads about eight year span in which recession was observed for five years and the revival was for three years.

The monthly market prices of groundnut and cotton were subjected to trend analysis. The long-term trend component and the growth rate of prices over the years were estimated by fitting a linear regression equation to the de-randomized yearly data on groundnut and cotton prices. The trend analysis revealed that there was a significant annual increase in price of both the commodities (Hosmani, 2001).

Reddy *et al.* (2001) examined the price behaviour of tamarind in the Anantapur and Chittoor districts of Andhra Pradesh using time series data for the period from 1990 to 1999. They reported that the secular trend and the seasonal variations were the important factors, which determined the pattern of price movement of tamarind.

Divya (2003) analyzed price behaviour of spices by fitting linear trend for both domestic and international prices. Variability in prices were measured using coefficient of variation by splitting the time period as pre WTO (1988-1995) and post WTO (1996-2003) period. The results showed a higher growth in international prices compared to domestic prices in cardamom, ginger and turmeric. Comparison of coefficient of variation exhibited a lower variation in prices in post WTO period except for pepper.

2.3.2 Seasonal variations

Majumdar (1965) also analysed the seasonality in prices. He supported the finding that the producer's share of the consumer rupee was generally low in the marketing period and high in the lean supply period, which was borne out by a study conducted in respect of rice in Andhra Pradesh and Madras for the year 1962.

Sinha (1965) studied the seasonal variations in the food prices. The wholesale prices of rice and wheat at Calcutta and Bombay were taken for the study. Along with it, seasonal movement of wholesale prices of raw jute and raw cotton at Calcutta and Bombay respectively were also given for comparison of the seasonal variation of prices of cereals with that of non-cereals. The seasonal behaviour of the prices of rice and wheat in Calcutta and Bombay Markets indicated that the lowest prices were recorded in the harvest and post-harvest months and the highest prices in the month towards the end of the harvest months. In case of non-cereals, jute prices followed a seasonal pattern, while in case of cotton the seasonal variation was not marked. This was probably because the marketing conditions in respect of cotton were fairly well organised and the cotton growers were having a considerable holding and bargaining strength. In addition the prices of cotton were also influenced by the international stock.

Kahlon and Balwinder Singh (1967) analysed the trend and seasonal price movements of groundnut in Punjab during the period 1966-67. The results revealed that the trend in the price of groundnut showed a continuous upward movement through the years. To measure the magnitude of seasonal fluctuations, seasonal indices were computed. Twelve month moving averages were used to obtain the trend values. After removing the trend plus the seasonal and the cyclical fluctuations from the original data, whatever remains constitutes the irregular variations. These were irregular in character and hence it was measured by constructing an index of seasonal price variation (S*I/S). The index of irregular fluctuations was found to be uniform throughout the year.

Kahlon and Singh (1967) in their study on the price behaviour of wheat and gram analysed that the prices of wheat and gram followed the normal seasonal pattern of peak in pre-harvest months and low in post-harvest months.

Mellor (1968) studied the functions of agricultural prices in economic development and found that greater instability in the pattern of seasonal fluctuations necessarily would result in greater year to year fluctuations in harvest season prices.

Pavaskar (1971) studied the seasonality in cotton prices for the period 1967-68 to 1969-70. It was observed that though the two years of 1968-69 and 1969-70 showed a distinct rise in price from the peak marketing months to the season-end, no such seasonal rise was discernible during 1967-68. In fact, prices declined substantially during that year after completing the rush of arrivals. Evidently a seasonal upward movement in cotton prices after the sale of the crop in assembling markets was an exceptional regular phenomenon of the cotton market. The risk of subsequent fall in prices was also observed. Nevertheless, it may be conceded that the cotton prices of the past three years seem to have favoured the cotton merchants.

Pavaskar (1971) in his study on the price behaviour of cotton analysed that there was a seasonal upward movement in cotton prices after the sale of the crop in assembling markets. Prices of cotton declined substantially in a year after the rush of arrivals was over.

Ranjit Singh and George (1971) conducted a study on the seasonal fluctuations and secular trend for paddy in Punjab during the period 1957 to 1966-67. The trend was calculated by using twelve months moving average and the index of seasonal price variation. The results revealed that there was no visible trend indicating stable market conditions for paddy. However the pattern of market arrivals indicated a regular upward trend in these markets. But the trend in price was much subdued as compared with the trend of arrivals which was due to the Government's policy of fixing ceiling price on paddy and rice. The analysis showed that because of heavy arrivals of paddy, the price index was at the lowest level. On the other hand, when the paddy arrivals were the lowest, the price indices were at their highest in all the markets.

While examining seasonal movements of wheat prices, Venkataramanan and Muralidharan (1978) adopted a non linear seasonal regression model. The study was conducted for twelve primary and secondary wheat markets for the period of 1961-1970. For the study of inter-year seasonality two separate regression estimates were made, one by using monthly and the other by bi-weekly price observations within each year. The analysis showed an upward inter-year seasonal regression in all the twelve markets, showing that an owner of inventory would have received a positive gross return over the period 1961-70. The intra-year seasonal regression showed the year to year variability in the seasonal pattern but confirmed the upward seasonal character of price movements in all markets over most of the years.

Seasonal movements refer to the identical patterns of movement followed by a time series during corresponding months of successive years. Those movements, which recur, with some degree of variability, within a year are referred to as seasonal movements (Croxton *et al.,* 1979; Spiegel, 1992).

Blakley (1985) studied seasonal price indices for crops which indicated lowest wheat price at harvest in May, rising to a peak before January first. Hay prices exhibited a more pronounced seasonal pattern and larger price variability than other crops like grain, sorghum, cotton lint, cotton seed and groundnuts considered for analysis.

George *et al.* (1989) in their work on the pepper economy of India observed that during the period 1966-67 to 1972-73 the wholesale prices of Indian pepper were low during the harvest season, that is December to March. They also found that the prices of Indian pepper in the international market were generally higher than the price of pepper from other major competing countries.

Naik (1990) studied the long term as well as short term variations in prices and arrivals of groundnut and concluded that the seasonal variability in price was less than the variability in the arrivals of groundnut.

The seasonal phenomenon in the prices of small cardamom along with the seasonality in related variables like sales at auction centres and export price were analysed by Joseph and Naidu (1992). The analysis showed that the seasonal index of prices was the highest in January and the lowest in July, while the seasonal index of market sales was the highest in November and lowest in July. The extent of seasonality was higher in sales compared to prices, and compared to export prices, sales prices showed more market seasonality. An attempt was also made to quantify the extent of relationship between yearly sales price and the variables like production, quantity of sales at auction centres, export and export prices by employing multiple regression analysis. The analysis showed that market prices would be well explained (97 per cent) by the two variables namely export and export price.

Sabur and Haque (1993) concluded that the seasonal price variation of fine rice was found to be higher compared with coarse rice because of the continuous flow of the latter into the market. Peak price month had changed to April from September and seasonal price variation had reduced markedly due to higher production of boro paddy and there existed five year cycles in rice prices as revealed by their analysis and forecasting of price based on ARIMA model were poor.

Jain *et al.* (1994) identified the seasonal component in the price behaviour of milk and milk product based on the time series data on retail prices for milk, curd and ghee over the period from 1962 to 1989 in Andhra Pradesh. They reported that there were significant seasonal variations in the price of milk products. Milk prices tended to be higher in May to September with the peak price occurring in June, July or Aug. Curd prices showed similar trends but tended to be slowly lower than corresponding milk prices. Prices for ghee varied within a narrower range than those for milk or curd.

Adilakshmi *et al.* (1995) examined temporal and spatial variations in the prices of chillies for five selected markets in Andhra Pradesh and showed the fluctuations in the prices of chillies in all the selected markets were erratic which created problems to both growers as well as the policy-makers. It was observed that the seasonal indices were low during the period January to May which synchronised with harvesting period of chillies and high during the period of June to November. Off-seasonal rise in prices of chillies was relatively higher in Vijayawada and Guntur markets.

Radha and Prasad (1995) showed that the average wholesale prices of groundnut increased over the 10 year period (1984 to 1994) at one market but decreased at two other markets. The highest seasonal variation was recorded during the months of September, August and July.

Babu and Sebastian (1996) studied the seasonal price behaviour of coconut and coconut products. Monthly data from 1971 to 1990 were used for the study. The seasonal indices were estimated by the ratio-to-moving average method. It was found that seasonal peak in coconut production was coupled with seasonal trough in coconut prices, and vice versa, thereby indicating the prevalence of a distorted market in the state to the disadvantage of the coconut growers.

Gadhavi *et al.* (2001) were of the opinion that seasonality in supply and perishable nature of agricultural produce were the major cause of price fluctuation of agricultural commodities.

Based on an analysis of 25 years turmeric price data which was collected from Erode regulated market, Raveendran (2006) opined that, fresh turmeric arrival in Erode regulated market started from mid January to June and stored product was available throughout the year with a likely increase in price after the month of July, 2006.

2.3.3 Cyclical variations

Cyclical movements refer to the long-term oscillations or swing followed by a time series about a trend line. These cycles may or may not recur at regular intervals (Croxton *et al.,* 1979; Spiegel, 1992).

Short-term cyclical fluctuations in prices of small cardamom were analysed by Narayana *et al.* (1985). They observed that the turning points - upswings and downswings in prices recurred alternatively at regular intervals. In the long term the prices showed a significant upward trend with a ten-fold rise in 25 years.

Jain *et al.* (1980) analysed the potato arrivals and prices in Punjab and indicated instability of price. There was an upward trend in prices, but with large fluctuations. Their study showed that there was a three year cycle in potato prices.

Sudhakar (1996) argued that a bundle of evil effects were associated with long and wide spread price cycles, like instability in the income of the producer – the producers sometimes receive much less than the cost of production. It also led to uncertainty in market.

Sudhakar (1996) studied the price trend of turmeric in Andhra Pradesh from 1981-82 to 1993-94 with the help of a non-linear trend projection. The trend line showed the presence of wide cyclical movements in turmeric prices. Each cycle spread about eight year span, in which recession was observed for five years and revival for three years. The extent of fluctuation was also very sharp indicating the presence of huge gap between boom prices and depression price. They attributed the cycle trend to the demand-supply gap existing in the case of turmeric and also to the fact that supply of turmeric was positively correlated to its price i.e. as the supply increases, price also increased.

Hosmani (2001) analyzed the cyclical component of fluctuations in the prices of cotton and groundnut in Dharwad district of Karnataka using twelve month centred moving average method. They graphically analysed the de-randomized data on prices for both the crops and found out the presence of a four to five year cycle in groundnut prices and a two to three year cycle for cotton price. They attributed the presence of such short duration cycles to the demand and price of cotton and groundnut prevailing in important markets of the state as well neighbouring state.

The analysis of trends in auction, wholesale and fob prices of cardamom during 1971-72 to 1997-98 by Madan (2001) showed an overall upward trend with cyclical variations and short term fluctuations. Estimated growth equation indicated that while the auction price registered an average annual growth rate of 6.8 per cent, both the wholesale and export prices increased at the rate of 6.4 per cent. The closeness of growth rates of the three prices was indicative of the high degree of market integration at different levels of trade. The period-wise movement of cardamom prices was also examined and it showed cyclical fluctuations of prices and the period of this cycle was worked out to be around 11 years.

2.3.4 Irregular variations

Vyas and Parikh (1961) concluded that the oscillations of the price of food grains around the trend in the first plan years were sharper and were of longer durations compared to three earlier years. There was no significant change in the pattern or the magnitude of seasonal deviation during the years under review. There were significantly large random variations during the first seven plan years compared to three earlier years.

Irregular or random movements refer to the sporadic motions of time series and represent the residue of movements after trend, cyclic and seasonal movements have been accounted for (Croxton *et al.*, 1979; Spiegel, 1992). In practice the cycle would be so erratic and interwoven with irregular movements that it would be nearly impossible to separate them. Hence, in the analysis of time series into its components, trend and seasonal movements are directly measured while cyclic and irregular fluctuation are left together after other elements have been removed (Gupta, 1984). Hence, research attempts to isolate irregular price movements are also scanty.

Acharya and Agarwal (1991) argued that irregular price fluctuations are non-systematic price behaviour. No generalization can be made about irregular price fluctuations because of diversity in their nature and irregularity of the cause and effect relationship in their occurrence. They are caused by factors outside the general trend, cycle and annual or seasonal component and therefore may not recur in future.

Hosmani (2001) while studying the price behaviour of groundnut and cotton in Dharwad district found out that there was irregular component of price variation. But he ignored the irregular component in the price trend, as it was not the major component of price variation in the case of these crops.

2.4 EXPORT COMPETITIVENESS

A study conducted by Gill and Ghuman (1982) during 1970-71 to 1979-80 showed that the share of spices in the international market had been fluctuating throughout the 1970s. This has varied between 12.7 per cent and 20.5 per cent in that period mainly due to the fluctuations in production.

The committee on spices of Government of India (1988) reported that the prices of almost all spices produced in India were comparatively higher in world markets due to low productivity coupled with high production of consumption, so if India has to remain as a major supplier in the world market catering at the same time to the increasing domestic market it was imperative to increase production with a strong ascent on productivity of all the spices.

An analysis of the international market for pepper by George *et al.* (1989) for the period 1955-56 to 1980-81 showed that the Indian pepper had lost its premium to Lampung and Malaysian varieties. Its competitive position weakened during this period due to low productivity and high unit cost of production.

Based on the data on percent market share of top 20 countries exporting / importing agricultural products in the year 1980 and 1985, Pandey and Sharma (1989) reported that in the case of seven commodity groups, including spices, the market share in the export was observed to be relatively well spread among the top 20 countries. The number of new entrants and changes in the ranks of exporting countries were also fairly high in these commodity groups. The study also analysed the world market structure on agricultural products and found that the market concentration was quite high among the top five and top ten countries in both exports and imports respectively. However, there were a large number of new entrants and also changes in the ranks of the old countries between the two points of time indicating stiff competition among them. The study also revealed that in both exports and imports, the trade was dominated by the developed countries like U.S.A, U.K, Canada, France, West Germany, Belgium, Luxembourg, Netherlands, Italy, Japan and Australia. The developing countries showing dominance were Mexico and Brazil.

The export demand and income elasticities of pepper were compiled in general and in USSR market in particular by Sandhu (1989) during the eighties. The result indicated a favourable response for exports in the markets in terms of price competitiveness and income growth, basic as well as changing consumption patterns. USSR market acted as against the adverse price fluctuations. The study also showed that Indian pepper was priced high in the U.S.A market and the export market share was prominent relative to Brazilian and Indonesian pepper. Despite the competition, the market was favourable to Indian black pepper, because of its superior quality.

The prospects for agricultural exports from India was examined by Gill (1990) and it was revealed that exports of prices which amounted to 93,800 tonnes valued at Rs. 250.8 crores in 1987-88 showed a drop in value by about 19 per cent in spite of increase in volume of 12.9 per cent owing to fall in unit realization by 28.3 per cent. The exports of cardamom have suffered both because of higher prices in the domestic market and severe competition in West Asia from Guatemala. The exports of pepper have suffered due to the constraints of high standard of cleanliness expected in the major import markets.

In a neo-classical world, production was found to be determined on the basis of costs, and costs and prices were synonymous and trade would be determined by comparative advantage. However, it was generally agreed that costs of labour, land and capital especially in developing countries, did not reflect their opportunity costs with any accuracy because of market imperfections, although there was wide disagreement as to the extent of the typical discrepancies and how these might change over time. It was suggested that with the help of simplifying assumptions like two commodities, two countries, constant returns to scale and identical factors and identical production functions in both countries – a highly abstract but suggestive model of world trade could be constructed. It was also opined that trade liberations were associated with a substantial growth in the volume of trade. The developed market economies significantly increased their imports of meat and other food and in the case of rice, changed from being net exporters to net importers, which provided an indication of revealed comparative advantage (Goldin, 1990).

In a study on the agricultural exports of India, Pal (1992) opined that the comparative advantage in the production of agricultural products could not be exploited by least developed countries in the real world mainly because of poor bargaining power in the world market and tariff and non tariff protection strategy followed by developed countries. The export of least developed countries fluctuated more than that of developed countries. This was because of the fact that the export of least developed countries mainly comprised of agricultural products having erratic supply. The unstable export tended to destabilize the income of least developed countries as long as export earnings constituted a significant proportion of national income, which in turn had serious political and economic implications.

Reddy and Narayana (1992), argued that the exports of agricultural and agro based commodities linked with adverse effects on the domestic economy should be discouraged. Their analysis brought out that the share of agricultural exports had been declining over the years due to stagnant output, low yield rates, non competitiveness in the world markets and dependence on traditional export crops and they suggested a shift in the composition of exports in favour of non traditional; high value products like processed foods.

Jeromi and Ramanathan (1993b) noticed significant changes in the direction of pepper exports from India for the period 1975-90. It was observed that nearly 44 per cent of India's pepper exports were directed to the former USSR, which constituted above 82 per cent of total pepper imports of that country for the same period. Country-wise annual compound growth rate of pepper exports was positive and significant only in the case of USSR (3.38 per cent). On the other hand, India not only failed to increase its exports to USA in tandem with increased consumption in that country but also could not sustain the quantity exported in the past years.

Bhatia (1994) in his study on agricultural pricing, marketing and international trade under new economic environment opined that in order to take the maximum benefit from the new world trade environment, it would be essential to properly assess the available export surplus of various commodities in the country and to give greater emphasis to production strategy for the commodities for which the country had greater comparative advantage. The relative level of domestic and world prices would indicate the export competitiveness and possibility of export and import of agricultural commodities in the country. He opined that relatively low prices in the domestic market would indicate that the commodity had comparative advantage in the export of that commodity if the international prices were higher than the domestic price plus transport and other handling charges, in contrast to which, if international prices plus insurance and freight charges were lower than the domestic price, then the country was placed at a disadvantage in the production. He also observed that the ratio of domestic prices to world prices during 1992 was significantly lower than one in the case of wheat, rice, maize, cotton, jute, tea, coffee, rubber, tobacco, pepper and oil cakes and horticultural products like potato, mango and banana except oil seeds and sugarcane.

Paarlberg (1995) opined that export subsidies would raise the domestic price of the subsidized good for the exporting country because subsidies introduce price wedges and at the critical world price, there will be excess supply in the world market and excess demand in the domestic market.

Swaminathan (1995) emphasized the role of excellence in quality, reliability of supplies and price competitiveness in international trade and suggested ecologically sound methods of production, improved post harvest technology and maximum value addition for spices with particular attention to processing, packaging, transportation and marketing. The major challenges identified to Indian spice industry were the productivity challenge, the quality challenge and the value addition challenge.

Jeromi and Nagarajan (1996) attempted a relative price analysis of pepper in India in relation to Indonesia and Malaysia and were found that it was negatively associated with India's export. It implied that India was facing competition from these countries and any increase in our export price and/or any decline in the competitor's price tend to reduce our exports. Among the competing countries, Indonesia was found to be the dominant competitor of India followed by Malaysia.

Jhakhar (1996) was of the view that the economic liberalization policies would give Indian agriculture a new face of confidence and strength while opening up of farm sector for foreign investment and protecting the interest of the farmers at the same time posed challenges. Another disquieting trend was the declining of government funds in the farm sector and agricultural research. The author opined that phytosanitory conditions and market access measure should be studied in depth and a good market intelligence system should be developed as well as subsidies should be continued in the better interest of our farming community.

Ravi and Reddy (1998) analyzed the export competitiveness of jowar, maize, groundnut, sunflower, cotton and coffee using Nominal Protection Coefficient with particular reference to Karnataka. Results revealed that Karnataka lacked comparative advantage in most of the crops except in cotton. Even though Karnataka was the leading coffee exporting state, the domestic market seemed more favourable than the export market and export potential of jowar, maize, groundnut and sunflower were significantly low.

Reddy *et al.* (1998) in their study on global competitiveness of sunflower production in Karnataka during 1984-85 to 1993-94, analyzed the export competitiveness of sunflower through the nominal protection coefficient (NPC) both under importable and exportable hypotheses, which is a measure of comparative advantage. The results revealed that high competitiveness of sunflower seed under importable hypothesis with a NPC of 0.73 in the post-liberalized action period where as it was 1.19 during pre-liberalization period, indicating its role as an efficient import substitute. The coefficient was more than one under exportable hypothesis during pre and post-liberalization periods, which implied its inefficiency as an exportable commodity.

Selvaraj *et al.* (1998) examined the level of protection and comparative advantage of agriculture in Tamil Nadu during 1980-81 to 1991-92 using Nominal Protection Coefficient (NPC). NPC value was approximately 0.9 for rice and cotton and 2.5 and 2.2 for sugarcane and groundnut respectively. It was observed from the analysis that within agriculture, levels of protection were found to be very uneven among the crops. Rice and cotton was disprotected and in contrast sugarcane and groundnut was highly protected, which had influenced allocation of resources away from commodities in which India has a comparative advantage, leading to efficiency losses and misallocations of resources, including net losses in output and foreign exchange.

In his study on problems and prospects of India's rice trade in a WTO regime, Datta (1999) indicated that India was competitive both in Basmati and non-Basmati varieties of rice. However, while Nominal Protection Coefficient (NPC) values suggested that in three out of four varieties the competition was declining, the Domestic Resource Cost Ratio (DRCR) values suggested that in two out of four cases the comparative advantage had improved and in two other cases it had deteriorated. The study however indicated that with the growing domestic demand, India's ability to export non-Basmati might be limited.

Naik (1999a) in his study on the comparative advantage of wheat reported that comparative advantage in producing wheat varied across states, along with decline in the comparative advantage over the years, if this trend continued, India could be non-competitive in exporting wheat.

Comparative advantage of Indian cotton was assessed by Naik (1999b) through Domestic Resource Cost (DRC) and suggested that in the recent years the comparative advantage was eroding due to lower productivity and declining international prices. In most of the cases DRC was greater than one.

Srinivasan (1999) mentioned that the agricultural trade liberalization measures adopted in the QR agreements were comprised of many loopholes, which provided developed countries in maintaining dirty models against the interests of non-food exporting countries. So the event of trade liberalization actually achieved was very small and even negative in some regions like Western Africa.

Damodaran (2000) opined that more than 50 per cent of our cost on exported spices (small cardamom) and flowers were accounted by freight and marketing cost.. In the case of cardamom this has resulted in withdrawal of producers from the export market and concentration on the domestic market. Any drastic reduction in export subsidies for this sensitive commodity will considerably affect our exports of this traditional, high-quality spice.

Selvaraj *et al.* (2000) opined that developing countries with free trade specialized in labour intensive agricultural goods while developed countries specialized in capital intensive goods, which resulted in biased economic growth. Due to the lack of stability of demand for agricultural goods, developing countries had the problem of export instability. The terms of trade deteriorated in developing countries due to increase in price of imports and imperfection in international financial markets. They also estimated elasticity coefficient for testing the outward oriented trade policy during the period 1971-72 to 1984-85 and for the period 1985-86 to 1996-97. It was 0.84 in the first period and 0.87 in the second period which confirmed more importance to outward oriented agricultural trade policies in the second period to boost agricultural sector. The real agricultural exports grew exponentially at the rate of 11.14 per cent in the second period, while the per capita income grew exponentially at the rate of 1.91 per cent per annum.

An attempt was made by Jha (2001) to compare Nominal Protection Co-efficient of agricultural commodities over the years (1992-93 and 1996-97), which would indicate the impact of trade liberalization on the price competitiveness of the products.

The result revealed that over the years there was marginal increase in NPCs for cereals excluding wheat and maize. The increase in NPCs was significant for commercial crops like cotton, jute and tobacco. The increase in NPCs over the years indicated erosion in price competitiveness followed by trade liberalization. The author also opined that in India the comparative advantage is high for commercial crops like cotton, tobacco, jute, spices, tea and coffee which are produced efficiently in the country on a commercial scale. The country had also advantage in producing labour intensive crops like rice.

Export potentials and price competitiveness of agricultural commodities of Tamil Nadu was worked out by Kannaiyan and Ramasamy (2001). The study indicated that international prices of agricultural commodities would rise once developed countries reduce domestic support and export subsidies. In most of the commodities domestic prices were lower than the international prices showing great opportunity for promoting exports. Export competitiveness depended on inter year international price fluctuations. Commodities like cotton, groundnut, gingelly, tomato, banana, onion and potato showed high competitiveness.

Export performance of Indian tea industry under the new economic environment using Nominal Protection Coefficient and domestic resource cost was analysed by Mahesh *et al.* (2001). It was found that under importable hypothesis NPC and DRC were 0.71 and 0.66 respectively and under exportable hypothesis, the NPC and DRC were 0.98 and 0.93 respectively, implying moderately competitive position of Indian tea exports and also as a good import substitute.

Naik (2001) in his work on market assessment and exports of agricultural products observed that the competitiveness of countries in individual products/commodities is expected to play a major role in the international trade. India would have to increase productivity and improve quality to compete effectively in the international market. It was found that India had high share in the low potential market and low shares in high potential market.

Nambiar (2001) in his paper on the impact of globalization and WTO agreements on the agricultural economy of Kerala observed that countries that have a competitive advantage in terms of production costs and productivity would be placed in a more advantageous position. The overall productivity of agricultural crops in India is only about one-third as compared with that of advanced countries like USA and Australia and this makes India's agriculture globally uncompetitive for exports and attractive for imports.

Export competitiveness of selected fruits was examined by Pawar and Patil (2001a) using Nominal Protection Co-efficient (NPC). Results showed that India had comparative advantage in export of banana, grapes, mangoes, orange and lemon to Kuwait. It was also concluded that our fruits were mainly exported to Arabian countries.

The export competitiveness of selected variables was examined by Pawar and Patil (2001b) using NPC as a measure of competitiveness. It was seen from the result that NPC of onion was 0.75, which implied high comparative advantage. Indian export of potato also enjoyed slight comparative advantage. It was concluded that the export should be diverted to those countries where we have comparative advantage in terms of price.

Singh and Ashokan (2001) in their study on competitiveness of oilseeds, coconut and rubber observed that India is not competitive in many oilseeds indicating inefficiency in the processing sector. NPC of copra indicated that India was not an important competitor in copra; as domestic prices were very high compared to the international prices. However the DRDC was only 0.35 suggesting that proper by-product utilization can help in making this crop competitive.

Chand (2002) examined the correlation between quantity of export of black pepper and its fob price and found that it was negative or close to zero, which showed that fluctuation in export of black pepper might have resulted from fluctuations in domestic production. He also calculated Nominal Protection Coefficient of black pepper for the period 1991-92 to 1999-2000 and the result revealed that during 1997-98 NPC was greater than one and in other years it varied between 0.84 and 0.98. It indicated that the exporters of black pepper were operating at a very low margin and domestic prices were only slightly lower than the export prices.

The study on import liberalization and Indian spice economy by Madan and Kannan (2002) revealed that during post globalization period (1995-96 to 1999-2000) export had shown an annual compound growth rate of 3.8 per cent in quantity and 25 per cent in value. However during 2000-2001 the export had shown a decline of 3 per cent in terms of quantity and 20 per cent in rupee value. Spices export during the post QR free trade period i.e. April – August, 2001 was estimated at 91335 tonnes valued at Rs. 626.12 crores as against 67668 tonnes valued at Rs. 751.71 crores in the corresponding period of previous year.

Sai (2002) opined that in India agriculture was not a profitable proposition and farmers were losing comparative edge due to factors like non availability of credit on easy terms, constraints on critical inputs, stagnation of yield, lack of quality consciousness, imperfect domestic markets and uncertain international markets.

The measurement of trade competitiveness was examined by Divya (2003) by using Nominal Protection Coefficient during pre WTO (1988-1995) and post WTO (1996-2003) periods which exhibited a value of less than one during the two periods and NPC was lesser in post WTO period indicating high competitiveness in cardamom, ginger and turmeric. In the case of pepper NPC remained the same in both the periods.

2.5 FORECASTING MODELS

Narain (1965) used the procedure which was entirely one of simple graphical presentations against time with a sophisticated verbal comment in the study of price movements and areas under different crops.

Kaul and Johl (1967) estimated the trend values of productivity of different crops by fitting a linear function of the type Y = a + bt to the three year moving average of yield date.

Shingarey (1970) measured annual price fluctuations with the help of index numbers of variability (trend removed). They were constructed by expressing each years price as a percentage of the corresponding moving average.

Satish (1983) used trigonometric functions to discover the periodicities present in the price and arrival series in jowar in Gadag and Hubli markets. The markets were found to require 17 and 11 days respectively for adjusting to price variations. The time lag reflected the imperfection in the market condition.

Todd (1984) generalised the algorithms for maximising inter temporal quadratic objective functions to solve linear coefficients. It was suggested that the dynamic equilibrium models like the one developed by him were potentially superior to the other existing ones.

Tomek (1985) looked at the progress that was made and the limitations that existed in attaining the general goals in analysing prices. He concluded that the price analysis may need to concentrate on farm and wholesale level demand and progress was likely to come from a more multifaceted approach for analysis.

Bogahawatte (1988) applied Box-Jenkins Auto Regressive Integrated Moving Average approach (ARIMA) and it was revealed that the forecast values were over estimated when compared with the actual. Ignoring seasonality, the retail prices showed that price history provided no improvements in forecasting future price changes.

Chen and David (1990) studied about the predictive performance of structural and vector autoregressive (VAR) models for forecasting monthly cotton prices. Two distinct time periods were selected for testing – one, a period of major policy shock, and second, a period of more normal market conditions. The study also investigated a composite approach, using vector auto regressions to determine the future values of exogenous variables of the structural model. Multi-dimensional testing procedures were adopted to evaluate the accuracy of the forecasts. Simulation results demonstrated the superior performance of the structural model in handling major policy changes, while the time series approach showed greater accuracy in forecasting normal price movements. Although the composite approach failed to show improvement in forecasting accuracy, a joint specification of the structural model and the time series properties of exogenous variables may merit further investigation according to the authors.

Jeffrey and Christopher (1990) suggested that structural economics might not be superior to time series techniques even when the structural modellers were given the elusive true model. Ultimately, the choice of the "best" forecasting model would remain problem specific and tailored to the particular loss function of the decision maker employing the forecasts.

Goswami (1992) used harmonic analysis to examine the existence of cycles in the arrivals and prices of rice in Rongram and Tura markets in West Garo hills of Meghalaya.

John and Vincent (1992) measured relative price variability among forty seven agricultural commodities developed for the period 1962 to 1987. Econometric models were used to explore the effects of macroeconomic instability on relative price variability within the agricultural sector.

Gerlow *et al.* (1993) opined that price forecasts were typically evaluated on the basis of statistical criteria, such as mean error, mean absolute error, or root mean squared error. An alternative approach for evaluating price forecasts was to analyze those using economic criteria. Four types of economic criteria were applied to five quarterly hog price forecasting models over the period 1976 to 1985. In general, model evaluations under the different economic criteria were consistent with one another. However, the economic evaluations were not consistent with those found using traditional statistical evaluation.

Allen *et al.* (1994) concluded that price forecasts were largely made by commercial econometric methods with time series approaches occupying minor roles. There had been an over emphasis on explanation and little interest on the predictive power of models.

Tse (1995) examined the lead-lag relationship between the spot index and futures price of the Nikkei Stock Average by using daily data in the post-crash period and investigated the interaction between the spot and futures series through the error correction model. Two versions of error correction models were considered, depending on the postulated long-run equilibrium relationship. It was found that lagged changes in the futures price affected the short-term adjustment in the spot index, but not vice versa. Forecasting models for the spot index were also constructed using the univariate time series approach and the vector autoregressive method. He concluded that for the post-sample forecast comparison the error correction models produced the best results. The vector autoregressive method performed better than the martingale model, while the univariate time series method had given the poorest forecasts.

Christopher and Paul (1996) used non parametric density estimation and kernel smoothing techniques to examine the instantaneous distributional implications of Rice price changes in Madagascar.

Gerald (1996) reviewed a model of wholesale price determination in maize prices in Ghana. To test the model an Autoregressive conditionally heteroscedastic (ARCH) regression was applied to monthly maize data for two markets over the period 1978 to 1993. It was inferred that past prices, domestic and regional productions, commodity storage and trade were important to determine future prices.

Silva and Silva (1996) studied the time series analysis of charcoal prices using both classical and Box and Jenkins methodologies, with monthly observations during the period 1980 to 1992, from Minas Gerais, Brazil. In the classical analysis, the additive and multiplicative models gave similar results. The seasonal indices of the multiplicative model did not differ statistically at the 5 per cent level of probability by F test. The small variation of the indices and hence of prices occurred because companies store large amounts of charcoal during the rainy season. Of the five auto correlative (Box & Jenkins) models studied, the ARIMA model provided good estimates and forecasting of charcoal prices, and gave a better performance than the classical model.

Barrett (1997) was of the opinion that extended Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models were found to be the superior out-of-sample forecast accuracy using monthly food price data from Madagascar. These techniques also permitted cost reduction in food security operations by more precise estimation of the risk of hitting a critical price level.

Hamm and Brorsen (1997) compared neural network models to traditional forecasting methods in forecasting the quarterly and monthly US farm price of pigs. A quarterly neural network model forecasted poorly in comparison to a quarterly econometric model. A monthly neural network model outperformed a monthly ARIMA model with respect to the mean square error criterion and performed similarly to the ARIMA model with respect to turning point accuracy. The more positive results of the monthly neural network model in comparison to the quarterly neural network model might be due to nonlinearities in the monthly data which were not in the quarterly data. The regression model was used to forecast prices of the first nine months of 1995. Forecasted prices were very accurate since percentage deviation from real values did not exceed three per cent.

Bianchi *et al.* (1998) in their study analysed the existing and improved methods for forecasting incoming calls to telemarketing centres for the purposes of planning and budgeting. They studied the use of additive and multiplicative versions of Holt–Winters (HW) exponentially weighted moving average models and compared it to Box–Jenkins

(ARIMA) modelling with intervention analysis. The study determined the forecasting accuracy of HW and ARIMA models for samples of telemarketing data. Although there was much evidence in literature that "simple models" such as Holt–Winters performed as well as or better than more complex models, finally they found that ARIMA models with intervention analysis performed better for the time series studied.

Khim *et al.* (2000) in their study on time series modelling and forecasting of the Sarawak black pepper price found that Autoregressive Moving Average (ARMA) time series models fitted the price series well and they correctly predicted the future trend of the price series within the sample period of study. Amongst a group of 25 fitted models, ARMA (1, 0) model was selected based on post-sample forecast criteria.

Leskinen and Kangas (2001) in their study on future timber price development presented an approach utilising both time series data and expert judgments in modelling future timber prices. A time series model was used as the basis for the approach. Parameters describing future timber price trends, variation in future timber prices and the probabilities of price peaks taking place in the future were estimated with expert judgments as the basis. A case study involving 12 experts was carried out in Finland, and models were estimated for all the six major timber assortments in the country. The model produced could be utilised in the optimisation calculations of forest planning.

Mastny (2001) studied the ARIMA models, also called Box and Jenkins' models after their developers, which was a group of models for the analysis of time series with various features. He demonstrated the possible usage of the Box-Jenkins methodology for the analysis of time series for agricultural commodities and a basic mathematical explanation of ARIMA models together with a practical illustration of a price development forecast for a selected agricultural commodity.

Jun Yu (2002) evaluated the performance of nine alternative models for predicting stock price volatility using daily New Zealand data. The competing models that were selected for the study included both simple models such as the random walk and smoothing models and complex models such as ARCH-type models and a stochastic volatility model. Four different measures were used to evaluate the forecasting accuracy. The main results were the stochastic volatility model provided the best performance among all the candidates, ARCH-type models could perform well or badly depending on the form chosen, the performance of the GARCH (3, 2) model, the best model within the ARCH family was sensitive to the choice of assessment measures and the regression and exponentially weighted moving average models did not perform well according to any assessment measure, in contrast to the results found in various markets.

The application of time series forecasting models to Silicy's wholesale vegetable market prices, specifically univariate ARIMA (Autoregressive Integrated Moving Average) modelling techniques were employed by Cucuzza *et al.* (2003) to produce price forecasts for six different vegetable products and the precision of the forecasts was evaluated using standard criteria and possible developments to improve the performance of the models were also discussed following a critical examination of the results obtained.

Zhang (2003) pointed out that ARIMA was one of the popular linear models in time series forecasting during the past three decades. Recent research activities in forecasting with Artificial Neural Networks (ANN) suggested that ANN could be a promising alternative to the traditional linear methods. ARIMA models and ANN were often compared with mixed conclusions in terms of the superiority in forecasting performance. A hybrid methodology was proposed that combines both ARIMA and ANN models to take advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modeling. Experimental results with real data sets indicated that the combined model could be an effective way to improve forecasting accuracy achieved by either of the models used separately.

McMillan and Speight (2004) in their study on GARCH models found that in a dataset of 17 daily exchange rate series, the GARCH model was found to be the best over smoothing and moving average techniques which were previously identified as providing superior volatility forecasts. They also opined that GARCH models were able to capture the observed clustering effect in asset price volatility in-sample and they appeared to provide relatively poor out-of-sample forecasts. But the research made by them suggested that this relative failure of GARCH models raised not from a failure of the model but a failure to specify correctly the true volatility measure against which forecasting performance was measured.

The price forecasting of egg in Montgomery during 1993 to 2000 was analysed by Ahmad and Mariano (2006) using Artificial Neural Networks (ANN). They collected the data about number of hens, egg storage capacity and number of eggs placed for hatching from the USDA databases for the mentioned period to forecast egg price. Regression analysis explained only 37 per cent of the variation in egg price whereas in the case of ANN, the R^2 value was as high as 60 per cent. Finally they concluded that ANN was found to be the more reliable method for price forecasting of egg than simple regression analysis if reliable data were collected.

In the class of Nonlinear time-series models, Gaussian mixture transition distribution (GMTD) and Mixture Autoregressive (MAR) models were employed to describe those data sets that depict sudden bursts, outliers and flat stretches at irregular time-epochs. In order to capture volatility explicitly, recently a new family, viz. MAR-Autoregressive Conditional Heteroscedastic (MAR-ARCH) was introduced by Ghosh *et al.* (2006). These three families were studied by considering weekly wholesale onion price data during April, 1998 to March, 2002. Presence of ARCH in detrended and deseasonalised series was tested by Naive-Lagrange multiplier (Naive-LM) test. Estimation of parameters was done using Expectation-Maximization (EM) algorithm and best model from each family was selected on basis of Bayesian information criterion (BIC). The salient feature of work done was that, for selected models, formulae for carrying out out-of-sample forecasting up to three-steps ahead were obtained theoretically, perhaps for the first time, by recursive use of conditional expectation and conditional variance. In respect of out-of-sample data, results derived enable us to compute best predictor, prediction error variance, and predictive density. It was concluded that a two-component MAR-ARCH provided best description of the data for modelling as well as forecasting purposes.

GulseBal and RustuYayar (2006) analysed forecasting of sunflower oil price in Turkey by collecting monthly prices of sunflower oil during January 1994 to December 2005 based on ARIMA (Autoregressive Integrated Moving Average Processes) methodology and forecasted the price of sunflower oil for the year 2006-2007 by using ARIMA. These models were based on time series analysis and the results showed that the forecasts obtained were reliable and accurate. This approach was suitable for short term price forecasting, i.e. a week, a month, a quarter, a year.

Mandal *et al.* (2006) analysed the Neural Networks Approach to forecast several hour ahead electricity prices and loads in the deregulated market in the year 2006. They suggested two different ANN models, one for one to six hour ahead load forecasting and another for one to six hour ahead price forecasting. MAPE (Mean Absolute Percentage Error) results showed a clear increasing trend with the increase in hour ahead load and price forecasting. The sample average of MAPEs for one hour ahead price forecasts was 9.75 per cent. This figure increased to only 20.03 per cent for six hour ahead predictions. Similarly, the one to six hour ahead load forecast errors (MAPE) ranged from 0.56% to 1.30% only. MAPE results showed that several hour ahead electricity prices and loads in the deregulated Victorian market could be forecasted with reasonable accuracy. .

Fildes *et al.* (2007) in their study on optimal forecasting model selection and data characteristics suggested that various selection protocols such as Box-Jenkins, variance analysis, method switching and rules-based forecasting were available to measure data characteristics and the models were incorporated to generate best forecasts. These protocol selection methods were judgemental in application and often selected a single (aggregate) model to forecast a collection of series. An alternative was to apply individually selected models for the series. A multinomial logit (MNL) approach was developed and tested on Information and communication technology share price data. The results suggested that the MNL model had the potential to predict the best forecast method based on measurable data characteristics.

Galdeano-Gomez (2007) analysed the price expectations in the horticultural sector in south-eastern Spain. He proposed the combination of rational expectation models and lagged price expectation models and the proposed model with other traditional expectation models was compared. The results suggested that current market information (rational expectation viewpoint) was used complementary to lagged prices and it showed the suitability of a rational composite expectation model.

Gupta and Bawa (2007) found that commodities have emerged as an investment class. Before checking the volatility clustering, some data on commodity and financial markets were examined for stationarity by applying Autocorrelation Augmented Dickey Fuller and Phillip Peron Unit Root tests. The forecast was based on Adaptive Exponential Smoothing, ARIMA and neural network models. Policy measures were recommended for enhancing the involvement of investors in commodity markets.

Visvikis *et al.* (2007) tested the performance of popular time series models in predicting spot and forward rates on major seaborne freight routes. They found that vector equilibrium correction (VECM) models were the best in-sample fit, but implausibly suggested that forward rates converge strongly on spot rates. In out-of-sample forecasting all models easily outperformed a random walk benchmark. Forward rates were useful to forecast spot rates, suggesting some degree of speculative efficiency. However, in predicting forward rates, the VECM was unhelpful, and ARIMA or VAR models forecast was better. This further illustrated that the dangers of forecasting with equilibrium correction models when the underlying market structure was evolving, and coefficient estimates were conflicted with sensible priors.

Murugananthi *et al.* (2008) analysed and forecasted the scenario of turmeric prices based on the price data of Erode regulated market using Auto Regressive Integrated Moving Average (ARIMA) and Artificial Neural Networks (ANN). They concluded that there was an upward trend in turmeric prices in the forthcoming season.

Ajjan *et al.* (2009) observed that majority of the rural producers were unable to understand and interpret the market and price behaviour into their advantages. Hence they attempted on this accurate time series forecasting for economic variables using univariate ARIMA model.

Coelho Junior *et al.* (2009) analyzed the behaviour of natural rubber prices in the international market during the period from January 1982 to December 2006 in function of its aggregated demand and supply, pointing out the main producing and consuming countries. Specifically, the research studied the evolution of prices and of the marketed quantum of natural rubber in the international market. It was characterized, identified, estimated and analyzed the models for the real monthly prices series of raw rubber RSS 1 (US$/t), and the accuracy of the estimated models for forecasting prices of this commodity was tested from January 2006 to December 2006. The studied models were of ARIMA-ARCH class. The main results were the real natural rubber prices presented decreasing tendency in the period being studied; the ARIMA family estimated model indicating the existence of heteroscedasticity in the series, making it necessary to identify, to estimate and to analyze the models of ARCH family; the model which best adjusted the returns of the price series of the raw rubber RSS1 was AR(1) - GARCH (1,1); the models of the ARIMA family didn't satisfy the prognosis conditions of the series being studied; the AIR (1)-GARCH (1,1) model was accurate for forecasting rubber prices.

Octavio (2009) opined that the behaviour of agricultural commodity markets could arguably resulted in markedly asymmetric price cycles ie downward cycles of substantially different length and breadth than upward cycles. This study assessed whether asymmetric-cycle models could enhance the understanding of the dynamics and provided for a better forecasting of U.S. soybeans and Brazilian coffee prices. The forecasts from asymmetric cycle models were found to be substantially precise than those obtained from standard autoregressive models. The asymmetric cycle models also provided useful insights on the markedly different dynamics of the upward versus the downward cycles exhibited by the prices of these two commodities.

Marzo and Zagaglia (2010) studied the forecasting properties of linear GARCH models for closing-day futures prices on crude oil traded in the New York Mercantile Exchange for the period January 1995 to November 2005. They compared models based on the normal, student's t and generalized exponential distribution to account for fat tails in the empirical distribution of the series and focussed on out-of-sample predictability by ranking the models according to a large array of statistical loss functions. The results from the tests for predictive ability showed that the GARCH-G model was the best for short horizons from 1 to 3 days ahead. For horizons from 1 week ahead, no superior model was identified. Exponential GARCH models displayed the best performance in this case.

The literature reviewed above pertaining to different aspects is immensely useful to pursue the present research investigation. A thorough review of the earlier studies enable the researcher to employ different tools of analysis viz., Compound Growth Rates (CGR), trend analysis (Exponential model), Nominal Protection Coefficients (NPCs), forecasting models to analyze the price behaviour of turmeric crop. As very few studies were conducted on the price behaviour of turmeric at All-India level in general and with reference to major markets in different states in particular, the present investigation is certainly a contributing one and this further justifies the selection of 'turmeric' for the study.

Materials and Methods

3. MATERIALS AND METHODS

Appropriate research design is a prerequisite to draw meaningful inferences about any study. The present investigation entitled 'Price behaviour of turmeric in India' is an attempt to study the secular trend, seasonality, cyclical variations and irregular movements in the price of turmeric in India and to evolve a reliable price forecasting model. The present study outlines the relevant methodology under appropriate heads.

3.1. TYPE OF DATA

The present study viz., "Price behaviour of turmeric in India" is based on secondary data published by various institutions and organizations. Data pertaining to the area, production and productivity of turmeric in the major producing states in India and at All-India level were collected to get a background picture of production and supply situation of turmeric over a period of time from 1980-81 to 2008-09. The main items of observation were the monthly modal prices of turmeric in the main market centres viz., Kochi (Kerala), Nizamabad (Andhra Pradesh) and Erode (Tamil Nadu). The international prices of turmeric were also collected for the period from 1980-81 to 2009-10. Export details of turmeric from India in terms of both quantity and value were collected from 1960-61 to 2009-10. Similarly, details of turmeric imports during the period 1998-99 to 2009-10 were also collected.

3.2. SOURCE OF DATA

Secondary data pertaining to the area, production and productivity of turmeric in India were collected from the official website of Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi. Area, production and productivity data of turmeric in the major turmeric growing states in India were collected from the head quarters of Spices Board, Kochi. Data on monthly modal prices of turmeric in the major market centres were collected from the Agmarknet and from various issues of Spices Board Journals. The export and import details of turmeric and the international prices of turmeric at New York were also collected from Spices Board, Kochi.

3.3. PERIOD OF STUDY

The data on area, production and productivity were collected from 1980-81 to 2008-09. In order to study the influence of liberalized trade regime in the context of WTO on the production and trade scenarios of turmeric from the country, the total period of study was divided into two sub periods viz., pre-WTO regime and post-WTO regime. Period before the signing of WTO agreement i.e. January 1995 was taken as the pre WTO regime and period after January 1995 was considered as the post WTO regime. The data on prices of turmeric were collected for the period from 1995 to 2010. However, in case of Kochi market, the data on turmeric prices were available from 1999 to 2010 only. The international prices of turmeric were collected from 1980-81 to 2009-10.

3.4. MAIN MARKET CENTRES STUDIED

Kochi, Nizamabad and Erode markets were identified as the major market centres for the study, as these are the leading domestic markets, where bulk of the transactions in turmeric and its products are taking place. The Free on Board (fob) prices from New York were considered as the international prices, as it is the major international market for turmeric in the world.

3.5. CONCEPTS STUDIED AND TOOLS OF ANALYSES EMPLOYED

3.5.1. AREA, PRODUCTION AND PRODUCTIVITY SCENARIOS

The area, production and productivity data of turmeric at All-India level and at the selected states level were subjected to the following analyses:

3.5.1.1. Trend analysis

To understand the trends in the area, production and productivity of turmeric in selected states and at All-India level, a detailed trend analysis was carried out using the respective time series data for the period 1980-81 to 2008-09. Linear, quadratic, compound, growth, logarithmic, cubic, sigmoid, exponential, inverse, power and logistic models were tried for fitting trends in area, production and productivity of turmeric in Kerala, Andhra Pradesh, Tamil Nadu and in India. The final model was selected based on the adjusted R^2, standard error and outlier values.

3.5.1.2. Compound Growth Rates (CGR)

CGR of area, production and productivity for turmeric was calculated from the exponential function fitted as:

$$Y = AB^t \text{ ------------------- } (3.1)$$

where, Y = Area/Production/Productivity,

A = intercept,

B = (1+r)

where, r is the CGR

The CGR was worked out as (Biradar and Annamalai, 1982),

$$r = (B-1) \times 100 \text{ ------------------- } (3.2)$$

3.5.1.3. Coefficient of Variation (CV)

CV is the most commonly used relative measure of variation, developed by Karl Pearson. It is a very useful tool to measure the variability (instability) of time series in terms of percentage. That series or group for which the CV is greater is said to be more variable or unstable. On the other hand the series for which coefficient of variation is less is said to be more stable or more consistent and more homogenous (Gupta, 1984).

$$CV\,\% = \frac{\sigma}{\overline{X}} * 100 \text{ ------------ } (3.3)$$

where, σ - standard deviation of each individual series and

$\overline{X}$ - arithmetic mean of the each individual series

3.5.2. EXPORT AND IMPORT SCENARIOS

To analyze the export potential of turmeric from India, average share of turmeric exports (quantity) in total turmeric production (1960-61 to 2008-09) and in total spices exports (2005-06 to 2009-10) before and after WTO regimes were computed by means of percentage composition. The true prospects of turmeric trade in terms of exports (1960-61 to 2009-10) and imports (1998-99 to 2009-10) were analysed using CGR (as per Equation 3.2) for both quantity and value. For the same reference periods, instability in turmeric exports and imports were studied by employing CV measure. The item wise exports and imports of turmeric have been examined for the period 1988-89 to 2008-09. The major items of exports and imports of turmeric were identified based on their per cent share in the total value of all the items exported from and imported into the country. Further, the item wise exports and imports were analysed for the selected two sub-periods viz., pre WTO regime (1988-89 to 1994-95) and post-WTO regime (1995-96 to 2008-09). Above all, to analyze the future prospects of turmeric trade from the country, trends and projections of turmeric area and productivity vis-a-vis net trade of turmeric in the international market during post-WTO regime were studied by fitting an exponential function and the trends are forecasted up to 2020-21.

3.5.3. PRICE BEHAVIOUR OF TURMERIC

Price volatility influences the decisions of farmers, traders and consumers regarding the transactions and consumption of the commodities in the market. Turmeric is not an exception for this and the information pertaining to its price behaviour in terms of trend and variations influences the competitiveness of the commodity both in the domestic and international markets. In this context, an attempt is made to analyze the price behaviour of turmeric prices, so that, a meaningful price policy can be formulated. The price behaviour of turmeric was studied using the techniques of classical time series (Croxton *et al.*, 1979; Spiegel, 1992).

The time series data on prices of turmeric was assumed to behave in a multiplicative scheme in respect to trend (T), seasonal (S), cyclical (C) and irregular (I) components. Therefore, it was assumed that,

$$Y(P) = T x C x S x I \text{ ---------------- } (3.4)$$

where, Y (P) = Monthly modal price of turmeric,

T = Secular trend,

C = Cyclical movement,

S = Seasonal index and

I = Irregular movement

3.5.4. ESTIMATION OF TREND VALUES

Trend analysis is worked out to analyze the long run behaviour of the prices of turmeric. For selected markets, viz., Kochi, Nizamabad and Erode markets, trend equations were fitted separately, but no satisfactory fit was observed based on adjusted R^2 values and standard errors. Hence, trend lines are fitted with single exponential smoothing, double exponential smoothing and winters' method (multiplicative method) by using Minitab package, version 16. The method, which is having the lowest Mean Absolute Percentage Error (MAPE) was taken as the best fit. Among all the smoothing methods, single exponential method was found to be the best and this method smoothens the data by computing exponentially weighted averages and provides short-term forecasts.

Minitab displays the smoothing constant (weight) used and computes three measures of accuracy of the fitted model viz., MAPE, Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) for each of the simple forecasting and smoothing methods which are given in the equations 3.10 to 3.12. For all three measures, the smaller the value, the better the fit of the model.

3.5.5. ESTIMATION OF SEASONAL VARIATIONS

Seasonal fluctuations are variations that are occurring within the span of a year with regular periodicity. In order to estimate the seasonal variations, Ratio to moving average method was studied, which gives the periodicity of changes without seasonality. These reflect the values of trend and cyclical variations and show the typical intra year movement of prices and measure how much lower or higher is the price of particular month compared to price of an average month. In order to compute the seasonal indices, first the data were made free from the effect of other components viz., trend, cyclical and irregular components. For this, a 12-point centred moving average method was used, as the prices were in monthly terms.

3.5.6. ESTIMATION OF CYCLICAL COMPONENTS

Cyclical variations are the oscillatory movements of the time series with a variable period and amplitude. They differ from seasonal variations in the sense that, they are of longer duration, usually extending a few years and are of different periodicity. Residue method (Croxton *et al.,* 1979; Spiegel, 1992) was employed for the estimation of cyclical components through employing the following three steps:

3.5.6.1. Removal of trend component

3.5.6.2. Removal of seasonal effect (deseasonalization)

3.5.6.3. Removal of irregular component (smoothening)

3.5.6.1. Removal of trend component

This is removed by computing the percentage of the ratio between the original values of the time series by their corresponding trend values. This is given by,

$$TxCxSxI/T = CxSxI \quad \text{-----------------} \quad (3.5)$$

So, after the removal of trend component, the de-trended data consists of cyclical, seasonal and irregular variations.

3.5.6.2 Removal of seasonal effect

The de-trended data for each month is divided by the corresponding seasonal index and expressed in terms of percentage. This is given by,

CxSxI/S = CxI -------------- (3.6)

Thus, the de-seasonalized data involves only cyclical and irregular components.

3.5.6.3 Removal of Irregular Components

Since, the irregular movements are highly entangled with cyclical movements, 12-month moving averages were taken to smoothen the irregular variations to nullify their influence and to get the clear data explaining cyclical variations. .

3.5.7. ESTIMATION OF IRREGULAR VARIATIONS

By the nature of movements, no formula, however approximate, can be suggested to obtain an estimate of the irregular component in a time series. In practice, the three components of a time series viz., trend (T), seasonal (S) and cyclical (C) are obtained and the irregular component is obtained as a residual, which is unaccounted for by these components after eliminating them for the given series. Using the multiplicative model of time series, the random or irregular component is given by,

CxI/C = I -------------- (3.7)

3.5.8. MARKET INTEGRATION

Johansen's Multiple Co-integration procedure using Eviews software was employed to understand the degree of market integration among the selected markets Kochi, Nizamabad and Erode markets. The integration was studied for each of the market pairs for turmeric involving Kochi, Nizamabad and Erode market centres. In order to know the direction of causation between the markets ie., to know the mutual influence exerted by the markets on each other, Granger causality test was done by using Eviews software.

3.5.9. EXPORT COMPETITIVENESS

Prices influence both domestic and export competitiveness of agricultural commodities in the market economy. In the modern era of agri-business, export competitiveness of commodities is gaining more significance, as it fetches more foreign exchange to the exporting country that enjoys more comparative advantage in the international market. A country is said to be export competitive with respect to a commodity, if its domestic market price is less than international price of the same commodity in the importing country. If a country enjoys export competitiveness for a commodity, it will fetch several advantages to the country like earning significant amount of foreign exchange, slowly capturing the monopoly gains in the international market, quality enhancement of the commodities, planning towards importers' need-based exports, simplification and regulation of procedural formalities at ports for making the exports at rapid pace, strengthening the exports infrastructure at ports, analyzing the tariff levels on the commodities of importing countries and accordingly fixing the export prices, strengthening the trade relationships across the countries etc. These advantages in the liberalized trade regime direct the Government to formulate healthy trade policies favouring significant exports from the country. In fact, the trade environment at the global level guides the country to formulate cost-effective production strategies.

In this context, Nominal Protection Coefficients (NPCs) were worked out to estimate the export competitiveness of turmeric by computing the ratio between domestic market price (Kochi market) and its international or border price at New York port, as it is the leading market centre in the world during both pre and post-WTO regimes. This will facilitate to identify the potentiality of turmeric in the export trade of the country and thereby, guides to plan the strategies for improving the export competitiveness, keeping in view the price trends of selected commodities both in domestic and international markets in the future. In working out the export competitiveness of turmeric from Kochi market, the exportable hypothesis, which is relevant, was taken into consideration. Under this hypothesis, the selected commodity was considered deemed to be export competitive in the international market.

The NPC of a commodity is the ratio of domestic market price to its border price. Symbolically,

$$NPC = p_d/p_b \text{ ---------------------- } (3.8)$$

where, NPC = Nominal Protection Coefficient,

p_d = Domestic market price,

p_b = Border price

If the NPC value lies below unity, it implies, the commodity enjoys more competitiveness and if the NPC value rises above unity, it indicates, the commodity is not export competitive in the international market.

The volatility of turmeric prices in both the domestic as well as international markets were studied using the coefficient of variation (as per Equation 3.3).

3.5.10 PRICE FORECAST AND ITS VALIDATION

3.5.10.1 Price forecast of turmeric

Price forecast of turmeric was carried out for the months of March, April and May 2011 for Kochi, Nizamabad and Erode markets separately by using various price forecasting methods such as single exponential smoothing, double exponential smoothing, Winters' multiplicative method, Winters' additive method, moving average method and Auto Regressive Integrated Moving Average (ARIMA). This analysis was carried out by using Minitab package, version 15 and SPSS package, version 16. Among these various price forecasting methods, double exponential smoothing was found to be the best model based on MAPE values for Nizamabad and Erode markets, whereas Winters' multiplicative method and Winters' additive method were found to be the best based on the MAPE values for Kochi market.

I) Exponential smoothing

The construction of forecast function based on discounted past observations is most commonly carried out by exponential procedures. These procedures are attractive, that they allow forecast function to be updated very easily every time a new observation becomes available. Forecasting procedures based on exponential smoothing have become popular, since they are easy to implement by putting more weight on the most recent observations and can be quite effective.

1) Single Exponential Smoothing

This model assumes that the data fluctuates around a reasonably stable mean, i.e. there is no trend or consistent pattern of growth and smoothens the data by computing exponentially weighted averages and provides short-term forecasts.

The specific equation for single exponential smoothing is

$$S_t = \alpha X_t + (1-\alpha) S_{t-1} \text{ -------------- } (3.9)$$

In more general terms, next forecast period = weight (present period observation) + (1-weight) (present period forecast)

where,

S_t = Smoothed observation at time period t

X_t = Original observation at time period t

α = Smoothing constant

The accuracy of the fitted model was tested by using three measures viz., MAPE, Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) for each of the simple forecasting and smoothing methods. For all three measures, the smaller the value, the better the fit of the model.

MAPE: It measures the accuracy of fitted time series values in terms of percentage.

$$MAPE = \frac{\Sigma|(Y_t - \hat{Y_t})/Y_t|}{n} * 100 \quad \text{-----------------} (3.10)$$

where Y_t is the actual value, $Y_t^{\wedge}$ is the fitted value and n is the number of observations

MAD: It measures the accuracy of fitted time series values in terms of the same units as the data, which helps to conceptualize the amount of error.

$$MAD = \frac{\Sigma_{t=1}^{n}|Y_t - \hat{Y}_t|}{n} \quad \text{--------------------} (3.11)$$

where Y_t is the actual value, $Y_t^{\wedge}$ is the fitted value and n is the number of observations

MSD: It is always computed using the same denominator 'n', regardless of the model, thereby, facilitate to compare MSD values across models.

$$MSD = \frac{\Sigma_{t=1}^{n}|Y_t - \hat{Y}_t|^2}{n} \quad \text{-------------------} (3.12)$$

where Y_t is the actual value, $Y_t^{\wedge}$ is the fitted value and n is the number of observations

2) Double Exponential Smoothing

Double exponential smoothing smoothens the data by Holt double exponential smoothing and provides short-term forecasts. This facilitates to allow forecasting of data with trends. Dynamic estimates were calculated for two components viz., level and trend. In double exponential smoothing, the smoothing constants (weights α and β) for the level and trend components were displayed. The weights α and β can be chosen from a grid of values (say, each combination of $\alpha = 0.1, 0.2, \ldots\ldots, 0.9$ and $\beta = 0.1, 0.2, \ldots\ldots, 0.9$) and then select the combination of α and β which correspond to the lowest MAPE. Here also three measures of accuracy (MAPE, MAD and MSD) of the fitted model were computed like that of single exponential smoothing. For all three measures, the smaller the value, the better the fit of the model.

The double exponential smoothing equation can be written as

$$S_t = A_t + B_t \text{ ------------------ } (3.13)$$

where,

$$A_t = \alpha X_t + (1-\alpha) S_{t-1}, \; 0 \le \alpha \le 1$$

$$B_t = \beta (A_t - A_{t-1}) + (1 - \beta) B_{t-1}, \; 0 < \beta < 1$$

Here, the parameter α is a smoothed estimate of the value of the data at the end of each period and β is for trend, which is a smoothed estimate of average growth at the end of each period.

3) Winters' Method (Triple Exponential Smoothing)

Winters' Method smoothens the data by Holt-Winters exponential smoothing and provides short to medium-range forecasting. This method can be used when both trend and seasonality are present, as these two components being either additive or multiplicative depending on whether seasonality is modelled in an additive or multiplicative way. This method calculates dynamic estimates for three components viz., level, trend and seasonal. The better fit for the model can be selected based on the three measures of accuracy as given by the equations 3.10 to 3.12.

(i) Multiplicative Model: This model will be employed when the seasonal pattern in the data depends on the size of the data. In other words, the magnitude of the seasonal pattern increases as the series goes up and decreases as the series goes down. Most time series plots exhibit such a pattern. In this model, the trend and seasonal components are multiplied and then added to the error component.

After the level, slope and seasonal estimates have been smoothed, a one-step-ahead forecast is obtained with the following equation:

$$S_t = [(A_{t-1} + B_{t-1})]\ S_{t+1}\ (t+1-L) \text{ -------------- } (3.14)$$

where

S_t = the forecast for the next time period t+1

A_t = the smoothed estimate for the level at time period t

B_t = the smoothed estimate for the slope at time period t

$S_{t+1}(t+1-L)$ = the smoothed estimate for the (t+1)th season made at time period t+1-L (ie. a year earlier)

(ii) Additive Model: This model will be employed when the seasonal pattern in the data does not depend on the size of the data. In other words, the magnitude of the seasonal pattern does not change as the series goes up or down.

After the level, slope and seasonal estimates have been smoothed, a one-step-ahead forecast is obtained with the following equation:

$$S_t = [A_t + B_t] + S_{t+1}(t+1-L) \text{ -------------- } (3.15)$$

where

S_t = the forecast for the next time period t+1

A_t = the smoothed estimate for the level at time period t

B_t = the smoothed estimate for the slope at time period t

$S_{t+1}(t+1-L)$ = the smoothed estimate for the t+1 season made at time t+1-L (ie. a year earlier)

4) Moving average method

The underlying assumption of moving average method is that, regardless of what has influenced the time series in the past, and regardless of which components the time series consists of, the method simply attempts to eliminate the irregular influences and extrapolate the whole pattern as it is, in the future.

The forecast for the future period by moving average method is expressed as:

$$F_{t+1} = x_t + x_{t+1} + x_{t+2} + \ldots + x_{t-N+1}/N \text{ -------------- } (3.16)$$

where F_{t+1} is the forecast in the t+1 period, x_t is a data point in the time series and N is the number of data in the period for which moving average is calculated.

5) ARIMA Model

In general, an ARIMA model is characterized by the notation ARIMA (p,d,q) where p, d and q denote orders of auto-regression, integration (differencing) and moving average respectively. In ARIMA parlance, TS is a linear function of past actual values and random shocks. For instance, given a time series process $\{y_t\}$, a first order auto-regressive process is denoted by ARIMA (1,0,0) or simply AR (1) and is given by

$$y_t = \mu + \phi_1 y_{t-1} + \varepsilon_t \text{ -------------- } (3.17)$$

and a first order moving average process is denoted by ARIMA (0,0,1) or simply MA (1) and is given by

$$y_t = \mu - \theta_1 \varepsilon_{t-1} + \varepsilon_t \text{ -------------- } (3.18)$$

Alternatively, the model ultimately derived, may be a mixture of these processes and of higher orders as well. Thus a stationary ARMA (p,q) process is defined by the equation

$$y_t = \mu + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \phi_p y_{t-p} - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} + \ldots - \theta_q \varepsilon_{t-q} + \varepsilon_t \text{ ------------ } (3.19)$$

where ε_t's are independently and normally distributed with zero mean and constant variance σ^2 for t = 1,2,.......n. Note here that the values of p and q, in practice lies between 0 and 3.

Seasonal ARIMA modeling

Identification of relevant models and inclusion of suitable seasonal variables are necessary for seasonal. The seasonal ARIMA i.e. ARIMA (p,d,q) $(P,D,Q)_s$ model is defined by

$$\phi_p(B)\,\varnothing_P(B^s)\,\nabla^d\nabla_s^D y_t = \Theta_Q(B^s)\,\theta_q(B)\,\epsilon_t \text{ -------------- } (3.20)$$

where, $\phi_p(B) = 1 - \phi_1 B - \ldots - \phi_p B^p$, $\theta_q(B) = 1 - \theta_1 B - \ldots - \theta_q B^q$

$\varnothing_P(B^s) = 1 - \varnothing_1 B^s - \ldots - \varnothing_P B^{sP}$, $\Theta_Q(B^s) = 1 - \Theta_1 B^s - \ldots - \Theta_Q B^{sQ}$

B is the backshift operator (i.e. $B\,y_t = y_{t-1}$, $B^2 y_t = y_{t-2}$ and so on), 's' the seasonal lag and 'ϵ_t' a sequence of independent normal error variables with mean 0 and variance σ^2, $\varnothing$'s and ϕ's are respectively the seasonal and non-seasonal autoregressive parameters, Θ's and θ's are respectively seasonal and non-seasonal moving average parameters. p and q are orders of non-seasonal auto regression and moving average parameters respectively whereas P and Q are that of the seasonal auto regression and moving average parameters respectively. Also d and D denotes non-seasonal and seasonal differences respectively.

Construction of ARIMA model

Box and Jenkins popularized a three stage method aimed at selecting an appropriate model for the purpose of estimating a univariate time series. This model is based on the assumption that the time series is stationary because the estimation procedures are available only for stationary series. The three main stages in developing a Box-Jenkins time series model are;

(i) Model Identification
(ii) Model Estimation
(iii) Model validation

(i) Model Identification

The foremost step in the process of modeling is to check for the stationarity of the series, as the estimation procedures are available only for stationary series. There are two kinds of stationarity, viz., stationarity in 'mean' and stationarity in 'variance'. A cursory look at the graph of the data and structure of autocorrelation and partial correlation coefficients may provide clues for the presence of stationarity. Another way of checking for the stationarity is to fit a first order autoregressive model for the raw data and test whether the coefficient 'ϕ_1' is less than one. If the model is found to be non-stationary, stationarity could be achieved mostly by differencing the series or go for a Dickey-Fuller test. Stationarity in variance could be achieved by some modes of transformation, say, log transformation. This is applicable for both seasonal and non-seasonal stationarity.

Thus, if 'X_t' denotes the original series, the non-seasonal difference of first order is

$$Y_t = X_t - X_{t-1} \text{ ------------- } (3.21)$$

followed by the seasonal differencing (if needed)

$$Z_t = Y_t - Y_{t-s} = (X_t - X_{t-1}) - (X_{t-s} - X_{t-s-1}) \text{ ------------- } (3.22)$$

The next step in the identification process is to find the initial values for the orders of seasonal and non-seasonal parameters p,q, and P,Q. They could be obtained by looking for significant autocorrelation and partial autocorrelation coefficients.

(ii) Model Estimation

At the identification stage, one or more models are tentatively chosen that seem to provide statistically adequate representations of the available data. Then the parameters of the models are estimated by least squares as advocated by Box and Jenkins. Standard computer packages such as SPSS, Minitab and Eviews are available for finding the estimates of relevant parameters using iterative procedures.

(iii) Model validation

Different models can be obtained for various combinations of AR and MA individually and collectively. The best model is obtained with following diagnostics.

a) Low Akaike Information Criteria (AIC)/Bayesian Information Criteria (BIC)/Schwarz-Bayesian Information (SBC)

AIC is given by AIC = (-2 log L + 2 m) where m = p + q +P + Q where L is the likelihood function. Since -2 log L is approximately equal to {n (1 + log 2π) + n log σ^2} where σ^2 is the model MSE, AIC can be written as AIC = {n (1 + log 2π) + n log σ^2 + 2 m} and because first term in this equation is a constant, it is usually omitted while comparing between models. As an alternative to AIC, sometimes SBC is also used which is given by SBC = log σ^2 + (m log n)/n.

(b) Plot of residual ACF

Once the appropriate ARIMA model has been fitted, one can examine the goodness of fit by means of plotting the ACF of residuals of the fitted model. If most of the sample autocorrelation coefficients of the residuals are within the limits ± 1.96 / $\sqrt{N}$, (where N is the number of observations upon which the model is based) then the residuals are white noise indicating that the model is a good fit.

(c) Non-significance of auto correlations of residuals via Portmanteau tests (Q-tests based on Chi-square statistics)-Box-Pierce or Ljung-Box tests

After tentative model has been fitted to the data, it is important to perform diagnostic checks to test the adequacy of the model and, if need be, to suggest potential improvements. One way to accomplish this is through the analysis of residuals. It has been found that it is effective to measure the overall adequacy of the chosen model by examining a quantity Q known as Box-Pierce statistic (a function of auto correlations of residuals) whose approximate distribution is chi-square and is computed as follows:

$$Q = n \Sigma r^2 (j) \text{ -------------- } (3.23)$$

where summation extends from 1 to k with k as the maximum lag considered, n is the number of observations in the series, r (j) is the estimated auto correlation at lag j; k can be any positive integer and is usually around 20. Q follows Chi-square with $(k-m_1)$ degrees of freedom where m_1 is the number of parameters estimated in the model. A modified Q statistic is the Ljung-box statistic which is given by

$$Q = n(n+2) \Sigma r^2 (j) / (n-j) \text{ -------------- } (3.24)$$

The Q statistic is compared to critical values from chi-square distribution. If model is correctly specified, residuals should be uncorrelated and Q should be small (the probability value should be large). A significant value indicates that the chosen model does not fit well.

3.5.10.2 Validation of turmeric price forecast: The forecasted prices of turmeric across the selected markets are validated for the same period by comparing the actual modal price of the month with that of the predicted price, such that, the actual modal price for the particular month fall within the range of the predicted price or not.

3.5.10.3 Accuracy of turmeric price forecast: This methodology involves the following two steps:

(i) First, the ratio will be computed by taking the absolute deviation of actual modal price and predicted price to the predicted price. This ratio will be expressed in terms of percentage.

(ii) The accuracy of price forecast can be estimated by deducting the above calculated percentage ratio from 100. If the percentage is above 90, it implies, the forecast is reliable.

Accuracy of price forecast (%) = 100 – [{|AMP – PP|/ PP} x 100] ---------------- (3.25)

Whereas, AMP is the actual modal price of a month

PP is the predicted price for a month

3.5.11 CONCEPTS USED IN THE STUDY

Nominal Protection Coefficient (NPC): Pursell and Gupta (1998) defined NPC of a commodity as the ratio of that commodity's domestic price to its international reference price. It determines the degree of export/import competitiveness of commodities by measuring the divergence of domestic price from the international or border price.

Border price: Pursell and Gupta (1998) defined border price as what the prices of the domestic varieties would have been during the same period under conditions of free trade at the same exchange rate.

Domestic price: Domestic prices used in the estimation of NPC are estimated to approximate as closely as possible the prices that the farmers receive during the harvest.

Export competitiveness: Used to reflect the ability of a nation to grow successfully and to maintain its share of world trade.

Instability: It is defined as the deviation from the general trend (Bharathi *et al,* 1992). It is also defined as the fluctuation from trend (Mohan and George, 1993).

Free on board (f.o.b) price: This pricing term indicates that, the cost of the goods, including all transportation and insurance costs from the manufacturer to the port of departure, as when as the costs of loading the vessel are read filed in the ported price. Fob price does not include shipping price and insurance charges.

Trend: It is defined as the general tendency of the data to increase or decrease during a long period of time (Gupta, 1984).

Seasonal variation: Gupta (1984) defined seasonal variation as a rhythmic force which operates in a regular and periodic manner over a period of less than a year and have the same pattern year after year.

Cyclical variation: The oscillatory movements in a time series with a period of oscillation more than one year are termed as cyclical variations (Gupta, 1984).

Irregular variation: The variations which are not accounted by trend, seasonal and cyclical variations are termed as irregular variations. These fluctuations are purely random, unforeseen and unpredictable which are beyond the control of human hand (Gupta, 1984).

CGR: It is a measure of how much something grew on average, per year, over a multiple year period, after considering the effects of compounding.

Net trade: It refers to the difference between total exports and imports of a country with reference to a commodity.

Market integration: Kohls and Uhl (1980) defined market integration as a process which refers to the expansion of firms by consolidating additional marketing functions under a single management.

Comparative advantage: It refers to a situation in which a country or individual or company or region can produce a commodity at a lower opportunity cost than its competitor.

Results & Discussion

4. RESULTS AND DISCUSSION

The present study analyses the trends in area, production and productivity of turmeric in Kerala, Andhra Pradesh, Tamil Nadu and at National level along with price behaviour, export status, import status and export competitiveness in the context of liberalized trade regime. Keeping the objectives in view, the data collected were subjected to statistical analysis and the results are presented and discussed in this chapter. The chapter is arranged in ten sections as given below.

4.1 Area, production and productivity status

4.2 Export status

4.3 Import status

4.4 Price behaviour

4.5 Secular trend

4.6 Seasonal variations

4.7 Cyclical variations

4.8 Irregular variations

4.9 Export competitiveness

4.10 Price forecast and its validation

4.1. AREA, PRODUCTION AND PRODUCTIVITY STATUS

The supply situation of any crop depends on its area, production and productivity and the changes there of. Against this backdrop, the analysis of trends in area, production and productivity of the crop at state level and national level is attempted.

4.1.1. Trends in the Area, Production and Productivity of Turmeric

In order to explore the underlying patterns in the growth of turmeric at the state and national level, the time series data pertaining to the area, production and productivity of turmeric were subjected to trend analysis. Different functional forms, both linear and non linear were tried to explain the trends in area, production and productivity and the model with the highest R^2 value was selected as the model of best fit in each case. The exponential model was found to be the best fit for studying the trends in area, production and productivity (Appendix I to VI).

The analytical findings pertaining to area, production and productivity of turmeric across the selected states and at All-India level are presented through Fig. 4.1 to 4.12.

4.1.1.1. Trends in area of turmeric across the selected states and at All-India level

The actual area under turmeric at All-India level (Fig.4.1) showed slight fluctuations when compared to the trend projections. For most of the period (1981-85, 1988-89, 1990-93, 1997-00, 2002-08), the actual area under turmeric is lower than the trend area under turmeric and the major reason for this is due to price-volatility of turmeric in the domestic market. However, during mid-nineties and 2000-01, the actual area under turmeric was greatly increased and this is due to favourable trading scenario both in domestic and international markets.

The comparative study of the area under turmeric across the states reveals an interesting picture. In Kerala, for most part of the selected period ie., during eighties and early nineties and during first decade of the 21st century (except in 2006-07), the actual area under turmeric lies below the trend projections (Fig.4.2). Only during late nineties and earlier part of first decade of 21st century, the actual area under turmeric is above the trend projections. This infers that, with the advent of WTO regime and due to trade liberalization, the farmers have increased the area under turmeric to produce and export more. But, during the first decade of 21st century, due to stiff competition from other major exporting countries of turmeric, the export prospects of turmeric were declined and thereby, the area under turmeric was adversely affected. Regarding Andhra Pradesh, during nineties, there is significant increase in area under turmeric above the trend projections, but for the remaining period, the actual area lies below the trend projections, especially during the first decade of the 21st century (Fig.4.3). This infers that, decline in export prospects of turmeric has led to decline in area under turmeric cultivation. However, in Tamil Nadu, the actual area under turmeric cultivation showed frequent fluctuations compared to trend projections and this also proves the fluctuations in area in tune with the price volatility of turmeric in the state (Fig.4.4).

Fig. 4.1. Trend in area under turmeric in India during 1980-81 to 2008-09

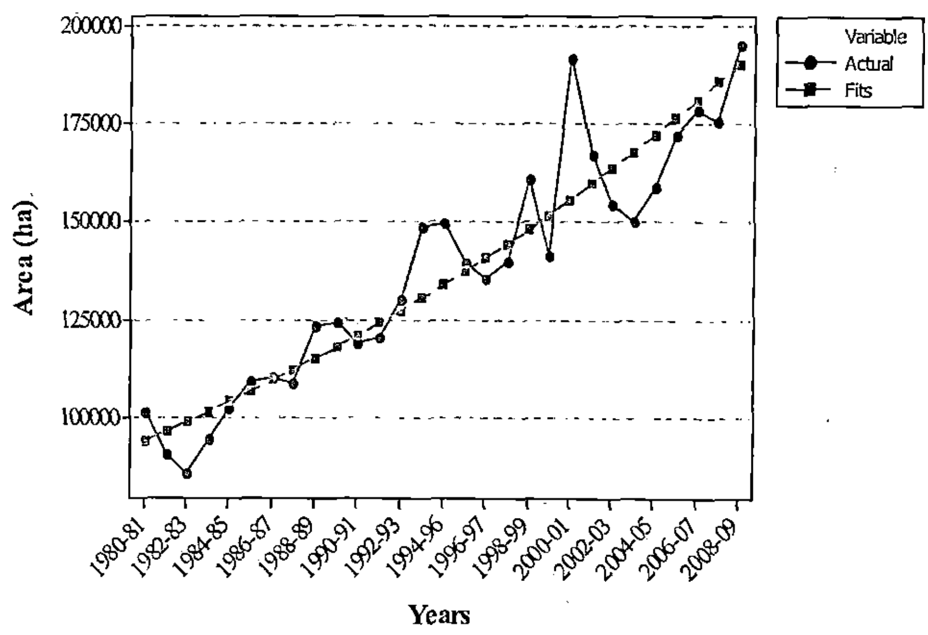


Fig. 4.2. Trend in area under turmeric in Kerala during 1980-81 to 2008-09

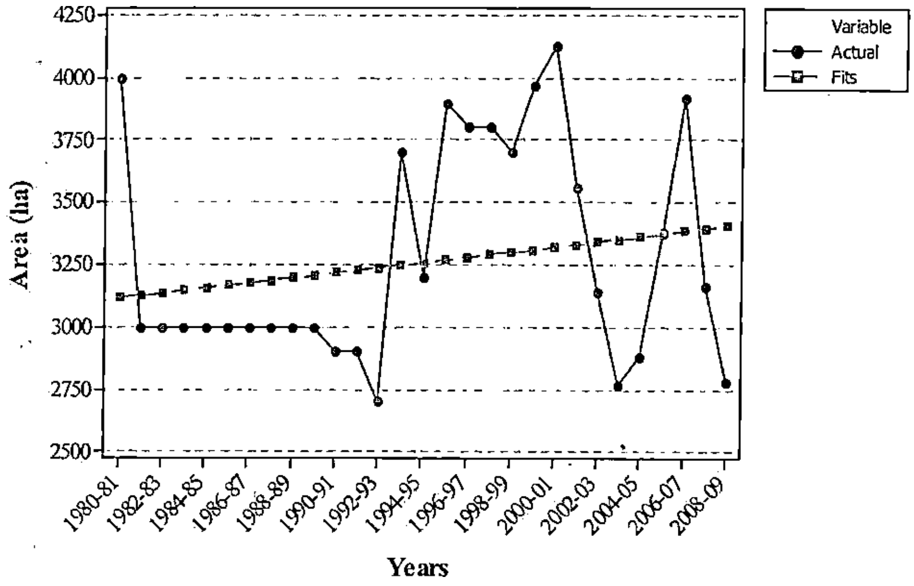


Fig. 4.3. Trend in area under turmeric in Andhra Pradesh during 1980-81 to 2008-09

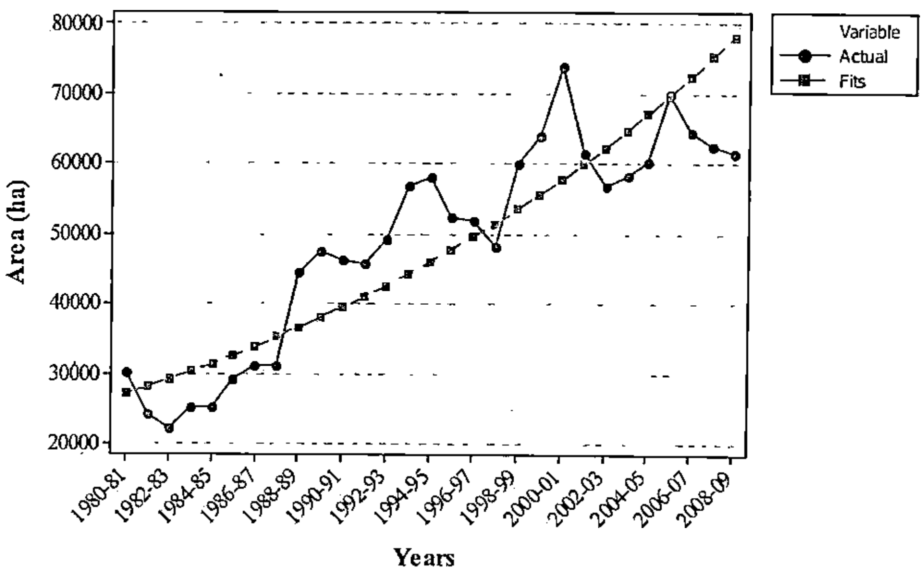
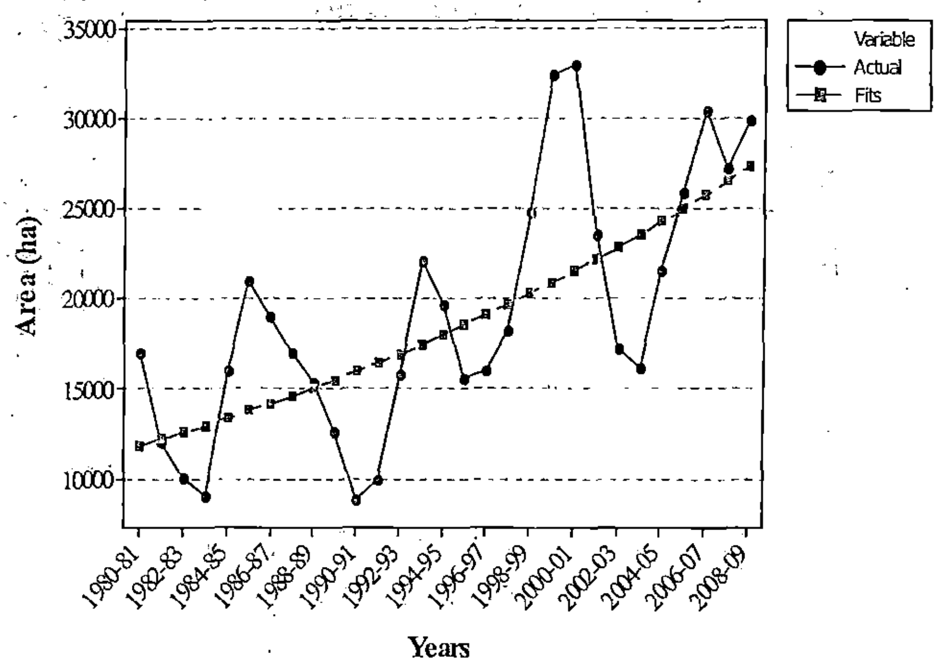


Fig. 4.4. Trend in area under turmeric in Tamil Nadu during 1980-81 to 2008-09



4.1.1.2. Trends in production of turmeric across the selected states and at All-India level

Regarding the trends in production of turmeric at All-India level, the disheartening aspect is that, the actual production of turmeric is below the trend projections for a significant period, especially during the first decade of the 21st century, except in 2005-06 (Fig.4.5). This dismal performance is due to decline in both area and productivity of turmeric. This infers that, price volatility, decline in export competitiveness, escalation in the cost structure, unfavourable climatic factors etc., are all responsible for this dismal performance of turmeric production in India even during post-WTO regime.

Similar picture was noticed with respect to trends in production of turmeric across the two selected states viz., Kerala and Andhra Pradesh (Fig.4.6 and 4.7). During eighties (entire period for Kerala and significant period for Andhra Pradesh) and for significant period during first decade of 21st century in Kerala and Andhra Pradesh, the actual production is lower than the trend projections and the same reasons mentioned earlier are equally applicable here. However, in case of Tamil Nadu, the production trends showed periodic fluctuations and this again is attributed to both area and productivity fluctuations (Fig.4.8).

Fig. 4.5. Trend in production of turmeric in India during 1980-81 to 2008-09

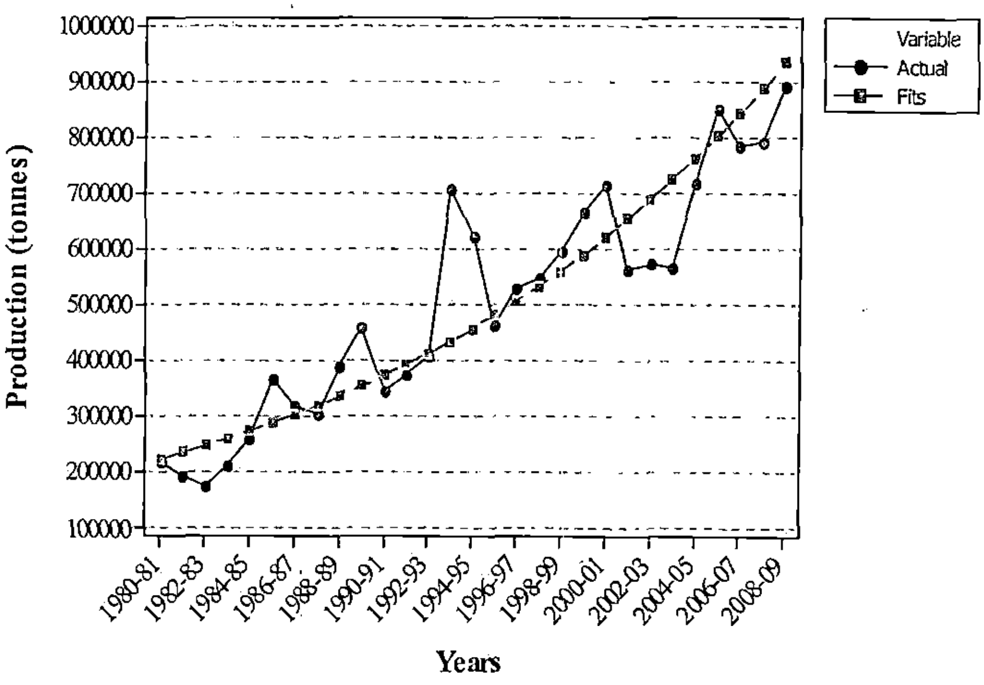


Fig. 4.6. Trend in production of turmeric in Kerala during 1980-81 to 2008-09

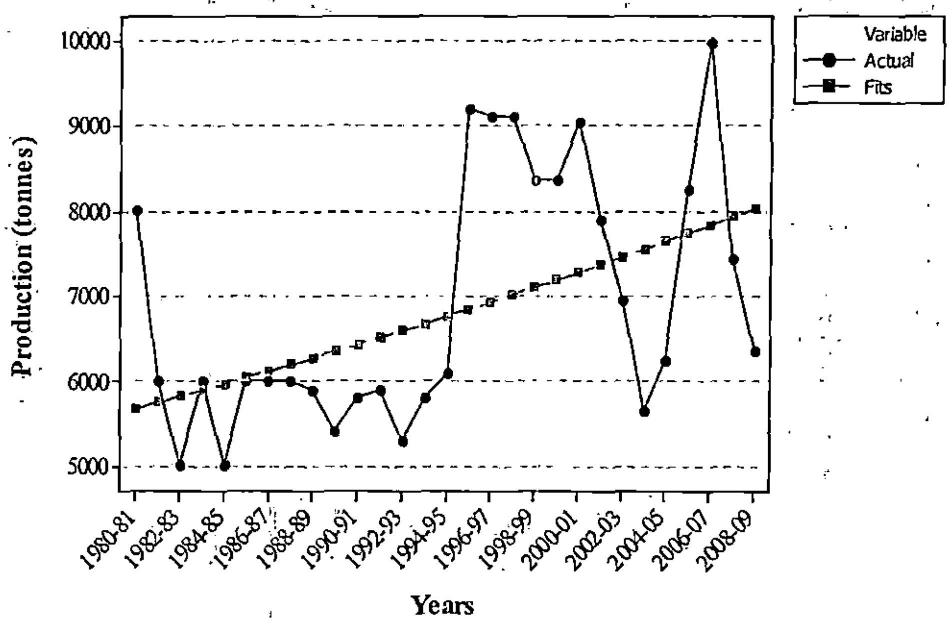


Fig. 4.7. Trend in production of turmeric in Andhra Pradesh during 1980-81 to 2008-09

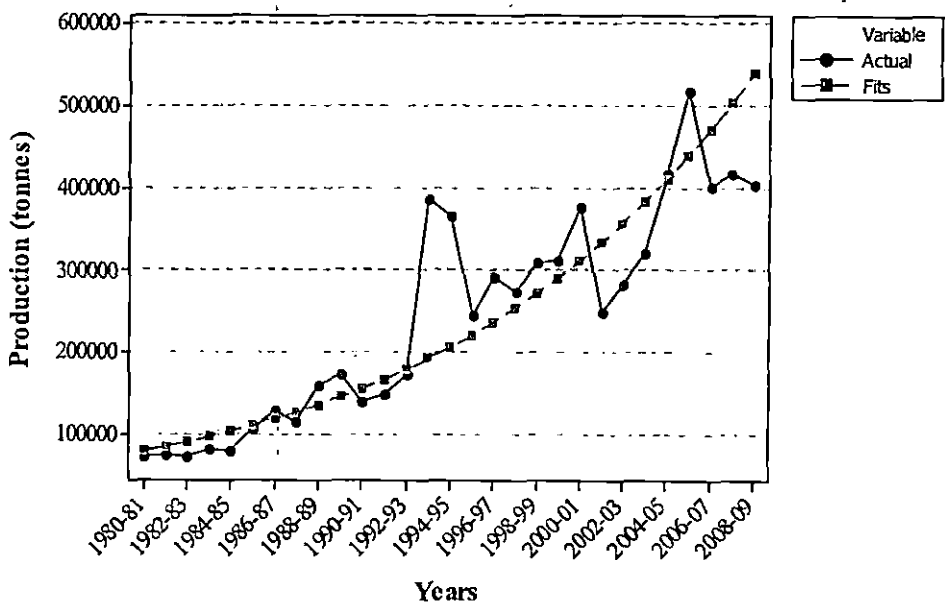
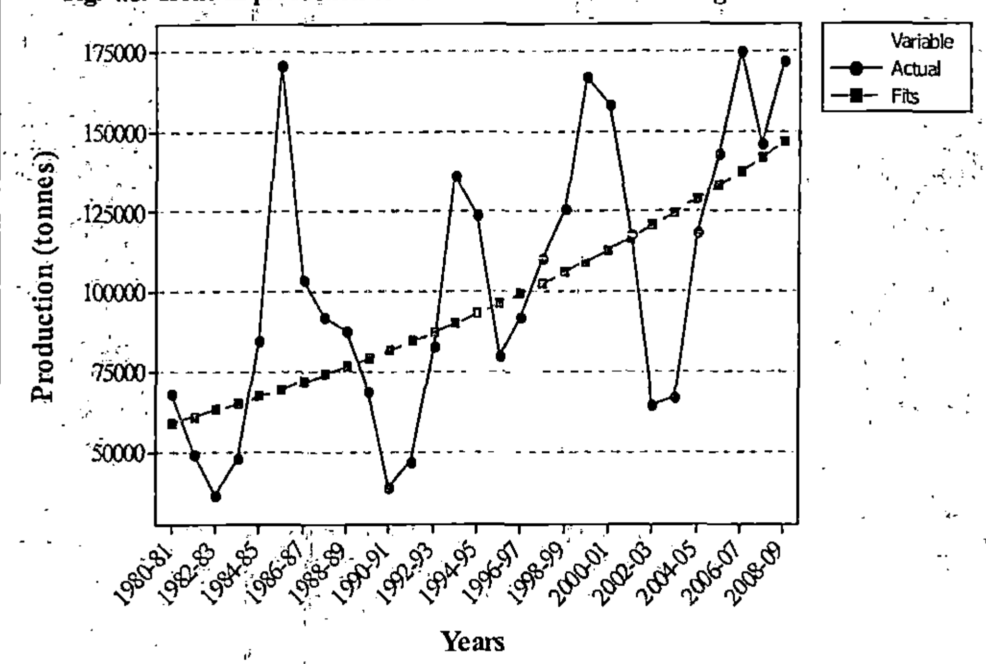


Fig. 4.8. Trend in production of turmeric in Tamil Nadu during 1980-81 to 2008-09



4.1.1.3. Trends in productivity of turmeric across the selected states and at All-India level

Regarding the trends in productivity of turmeric at All-India level, the disheartening aspect is that, the actual productivity of turmeric is below the trend projections for a significant period especially during the first decade of 21st century, except in 2004-06 (Fig.4.9). This calls for strengthening R&D support to produce and release promising HYV suiting to different farming situations.

It is interesting that, same picture was noticed with respect to trends in productivity of turmeric across the two selected states viz., Kerala and Andhra Pradesh (Fig.4.10 and 4.11). In Andhra Pradesh, during mid to late nineties and during significant period in the first decade of the 21st century (except during 2004-06), the actual productivity level of turmeric lies below the trend projections. In case of Kerala, a significant period during first decade of 21st century (except in 2005-07), the actual productivity level of turmeric lies below the trend projections. However, during eighties and nineties, periodic fluctuations are noticed and this implies the unfavourable climatic conditions played major havoc with the farmers cultivating turmeric. However, in Tamil Nadu (Fig.4.12), the actual productivity levels of turmeric are more than trend projections for most of the reference period and this infers that, weather uncertainities are less and further the varieties under cultivation are suiting to different agro-ecological farming situations.

Fig. 4.9. Trend in productivity of turmeric in India during 1980-81 to 2008-09

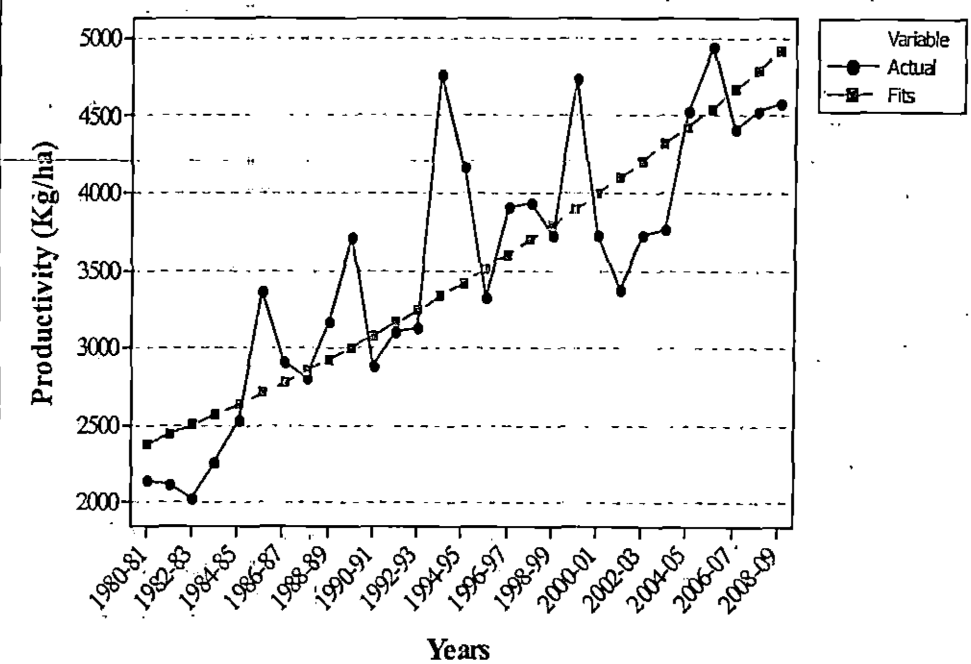


Fig. 4.10. Trend in productivity of turmeric in Kerala during 1980-81 to 2008-09

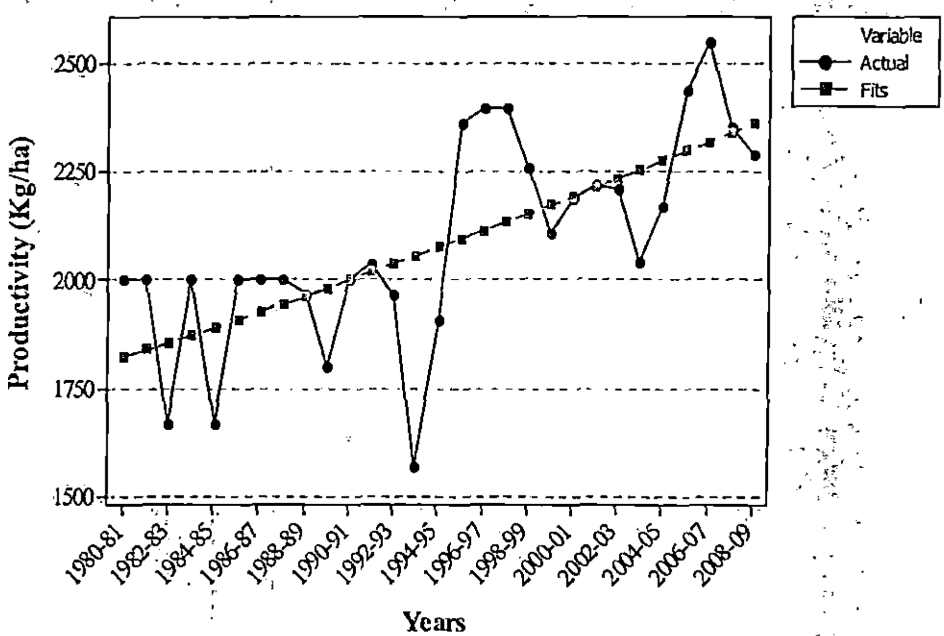


Fig. 4.11. Trend in productivity of turmeric in Andhra Pradesh during 1980-81 to 2008-09

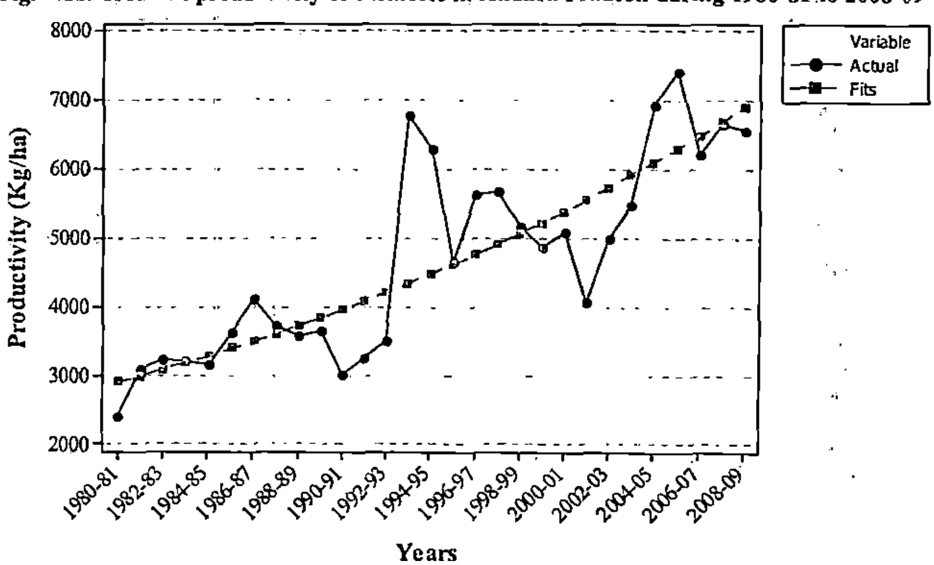
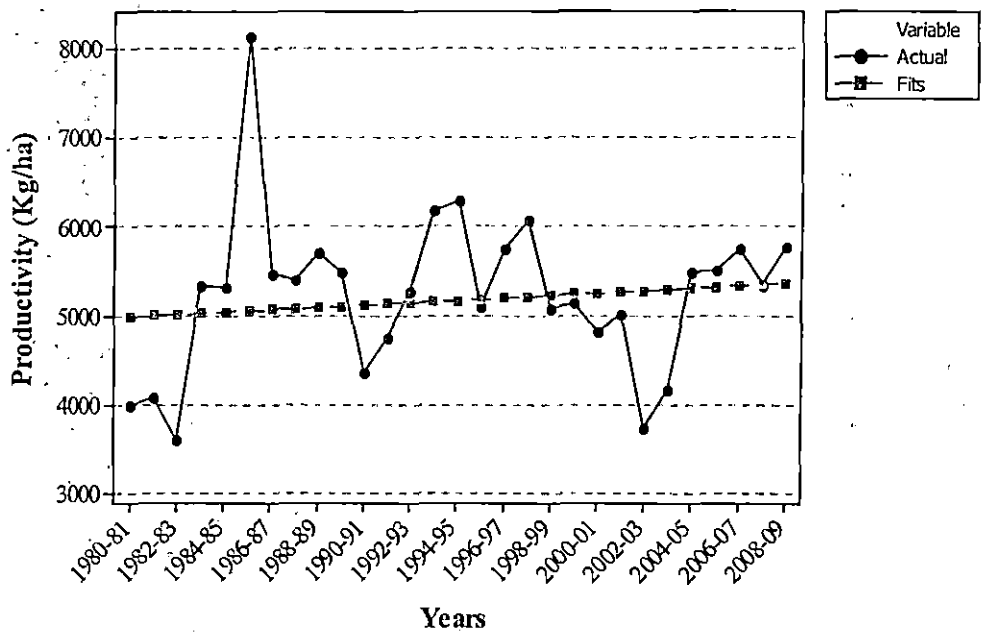


Fig. 4.12. Trend in productivity of turmeric in Tamil Nadu during 1980-81 to 2008-09



4.1.2. Growth Rates in Area, Production and Productivity of Turmeric

Growth rate of a variable may be defined as the rate of change per unit of time, usually a year. An attempt was made to examine the magnitude and extent of changes that have taken place in area, production and productivity of turmeric over the years. Though there are different tools available to quantify growth, in a biological production process like agriculture, the Compound Growth Rate (CGR) is more appropriate (Rath, 1971). Therefore, CGR was used as the tool in quantifying the growth of area, production and productivity of turmeric. For analyzing the growth pattern of turmeric in terms of area, production and productivity, the entire period (1980-81 to 2008-09) has been divided into two sub periods namely Period I: Pre-WTO regime (1980-81 to 1994-95) and Period II: Post-WTO regime (1995-96 to 2008-09). For the two sub periods as well as for the entire period, growth rates in area, production and productivity of turmeric were estimated and the analytical findings are presented through Tables 4.1 to 4.4.

4.1.2.1. CGR for Area, Production and Productivity of Turmeric in India

The estimated CGR of area, production and productivity of turmeric in India are outlined in Table 4.1. At All-India level, both area and productivity of turmeric showed significant growth rates during both pre-WTO (1980-81 to 1994-95) and post-WTO (1995-96 to 2008-09) regimes and even during the overall reference period (1980-81 to 2008-09). As a result, the production of turmeric also exhibited significant growth trend during the selected reference periods. However, compared to pre-WTO regime, the growth rate in area and productivity of turmeric showed declining trend and hence, growth in production during post-WTO regime, which infers that, during post WTO regime, this crop has not received adequate attention, as the farmers might have shifted to other lucrative crops, which enjoy export competitiveness in the international market. However, due to its diversified uses and domestic competitiveness within the country, this crop continued to show significant growth trends with reference to area (5.93%) and productivity (6.17%) and hence, in production (12.46%) during the selected overall reference period (1980-81 to 2008-09).

Table 4.1. CGR for area, production and productivity of turmeric in India

Period	Area	Production	Productivity
Pre-WTO regime (1980-81 to 1994-95)	8.14 **	21.06 **	11.94**
Post-WTO regime (1995-96 to 2008-09)	4.95 **	9.65 **	4.47*
Entire period (1980-81 to 2008-09)	5.93 **	12.46 **	6.17 **

** - Significant at 1 per cent level, * - Significant at 5 per cent level

4.1.2.2. CGR for Area, Production and Productivity of Turmeric in Kerala

Similarly, the growth rates were also worked out for the area, production and productivity of turmeric across the selected states and the details for Kerala are shown in Table 4.2. The growth performance of turmeric is dismal in terms of area, production and productivity with reference to both pre-WTO and post-WTO regimes in Kerala. It is disheartening to note that, the significant decline in area of turmeric (-4.72%) outweighed the positive growth in productivity (0.23%, non-significant) and thereby, the production of turmeric showed declining trend (-4.50%), though non-significant. Even during the pre-WTO regime, the growth rate in area, production and productivity of turmeric showed declining trend and it can be inferred that, the crop has not received due attention in spite of the trading prospects within and across the countries. Further, the decline in area and production are more prominent during post-WTO regime compared to pre-WTO regime. This reveals that, in the liberalized trade regime the farmers shifted towards other lucrative crops that enjoy export competitiveness in the international market. However, during the overall reference period (1980-81 to 2008-09), the significant productivity growth (2.09%) only contributed much to the significant production growth rate (2.80 %) and the area growth under turmeric is not significant in Kerala.

Table 4.2. CGR for area, production and productivity of turmeric in Kerala

Period	Area	Production	Productivity
Pre-WTO regime (1980-81 to 1994-95)	-0.92 NS	-1.37 NS	-0.46 NS
Post-WTO regime (1995-96 to 2008-09)	-4.72 *	-4.50 NS	0.23 NS
Entire period (1980-81 to 2008-09)	0.69 NS	2.80 **	2.09 **

** - Significant at 1 per cent level, * - Significant at 5 per cent level,
NS-Non-significant

4.1.2.3. CGR for Area, Production and Productivity of Turmeric in Andhra Pradesh

The estimated CGR of area, production and productivity of turmeric in Andhra Pradesh are given in the Table 4.3. The crop showed prominent and significant growth trends in terms of area, production and productivity in Andhra Pradesh during the selected reference periods. During the overall reference period (1980-81 to 2008-09), both the area and productivity showed significant positive growth rates (9.14% and 7.40% respectively) and this contributes to significant growth in the production of turmeric (17.22%). However, the comparative picture during the pre-WTO and post-WTO regimes reflect that, the growth in area, production and productivity of turmeric showed declining trend during post-WTO regime compared to pre-WTO regime. But, still during the post-WTO regime, all the parameters showed positive and significant growth rates. This infers that, the crop has not received adequate attention in Andhra Pradesh, though it contributed significant growth rates during both pre-WTO and post-WTO regimes, as factors like price volatility, decreased export competitiveness etc., might have contributed for the decline in the growth of selected parameters during post-WTO regime.

Table 4.3. CGR for area, production and productivity of turmeric in Andhra Pradesh

Period	Area	Production	Productivity
Pre-WTO regime (1980-81 to 1994-95)	17.22 **	29.12 **	10.15 **
Post-WTO regime (1995-96 to 2008-09)	3.51 *	9.90 **	6.17 *
Entire period (1980-81 to 2008-09)	9.14 **	17.22 **	7.40 **

** - Significant at 1 per cent level, * - Significant at 5 per cent level

4.1.2.4. CGR for Area, Production and Productivity of Turmeric in Tamil Nadu

The estimated CGR of area, production and productivity of turmeric in Tamil Nadu are given in Table 4.4. During the overall reference period (1980-81 to 2008-09), though the productivity of turmeric showed positive and non-significant growth rate (0.69%), it was compensated by positive and significant growth rate in area (7.15%) and thereby, the production of turmeric showed positive and significant growth rate (7.89%). However, during the selected sub-periods viz., pre-WTO (1980-81 to 1994-95) and post-WTO (1995-96 to 2008-09) regimes, the area, production and productivity of turmeric showed insignificant growth rates and that too, during post-WTO regime, the growth in productivity showed declining trend (0.23% non-significant) and it was slightly compensated by the growth in area (7.89% non-significant) compared to pre-WTO regime. This infers that necessary Research and Development support should be given towards the production of high yielding varieties of turmeric so as to boost its production and with due emphasis on cost effectiveness and quality control.

Table 4.4. CGR for area, production and productivity of turmeric in Tamil Nadu

Period	Area	Production	Productivity
Pre-WTO regime (1980-81 to 1994-95)	3.51 NS	8.64 NS	4.95 NS
Post-WTO regime (1995-96 to 2008-09)	7.89 NS	8.14 NS	0.23 NS
Entire period (1980-81 to 2008-09)	7.15 **	7.89 **	0.69 NS

** - Significant at 1 per cent level, NS-Non-significant

4.1.2.5. Comparative analysis of CGR of area, production and productivity of turmeric across the selected states and at All-India level

The estimated CGR of area, production and productivity of turmeric across the selected states and at All-India level are portrayed through Tables 4.1 to 4.4. At All-India level, during the overall reference period (1980-81 to 2008-09), productivity is the major contributing factor (6.17%) compared to area (5.93%) in increasing the production (12.46%) at significant level. However, area growth (4.95%) contributed more compared to productivity (4.47%) in influencing the significant growth in production (9.65%) during the post-WTO regime, unlike pre-WTO regime.

Among the selected states, the crop showed prominent and significant growth trends in terms of area, production and productivity in Andhra Pradesh compared to Tamil Nadu and Kerala. It is interesting that, in Andhra Pradesh and Tamil Nadu, area growth (9.14% and 7.15% respectively) contributed more compared to productivity (7.40% and 0.69% respectively) in influencing the significant growth in production (17.22% and 7.89% respectively) during the overall reference period (1980-81 to 2008-09). But, in Kerala, productivity growth (2.09%) contributed more compared to area (0.67%) in influencing the significant growth in production (2.80%) during the same period.

During post-WTO regime, only Andhra Pradesh witnessed positive and significant growth rate with reference to turmeric production (9.90%), unlike Tamil Nadu and Kerala. Both productivity (6.17%) and area (3.51%) contributed significantly for this significant growth in turmeric production in Andhra Pradesh. However, for the same period, the crop has not witnessed significant growth rate in production (8.14%) in Tamil Nadu and further, it is disheartening to note that, turmeric production (-4.50%, non-significant) showed declining trend in Kerala due to significant decline in area (-4.72%). Further, the performance of area, production and productivity of turmeric across all the states during post-WTO regime is disappointing compared to pre-WTO regime, especially with reference to area and production of turmeric in Kerala.

4.1.3. Instability in Area, Production and Productivity of Turmeric

The instability in area, production and productivity of any crop enterprise provides useful information regarding its supply into the market, thereby, influences its price behaviour. So, an attempt was also made to measure the magnitude of instability in the area, production and productivity of turmeric in terms of the Coefficient of Variation (CV).

4.1.3.1. CV in area of turmeric

The estimated CV in area under turmeric across the selected states and at All-India level is outlined in Table 4.5. It is evident that, the instability in area under turmeric is more in Tamil Nadu (even higher than at All-India level) followed by Andhra Pradesh and Kerala during the overall reference period (1980-81 to 2008-09). This higher instability in turmeric area in Tamil Nadu is due to low productivity of turmeric. Similar is the case for Tamil Nadu during post-WTO regime and this call for strengthening the R&D support towards the release of HYV of turmeric suiting to different agro-ecological situations. However, the comparative picture between Pre-WTO and Post-WTO regimes reveals that, instability in area under turmeric is declined during post-WTO regime compared to pre-WTO regime across all the states and at All-India level.

Table 4.5. CV in area of turmeric

Period	Kerala	Andhra Pradesh	Tamil Nadu	India
Pre-WTO regime (1980-81 to 1994-95)	10.25	31.97	28.48	15.99
Post-WTO regime (1995-96 to 2008-09)	12.97	10.96	25.79	11.62
Entire period (1980-81 to 2008-09)	13.29	30.88	35.49	21.77

4.1.3.2. CV in production of turmeric

The estimated CV in production of turmeric across the selected states and at all-India level is outlined in Table 4.6. It is clear that, the instability under turmeric production is highest in Andhra Pradesh (even higher than at All-India level) followed by Tamil Nadu and Kerala during the overall reference period (1980-81 to 2008-09). This highest instability in production of turmeric in Andhra Pradesh is due to higher instabilities with reference to both area and productivity of turmeric. However, reverse is the case for Kerala, as low instability both in terms of productivity and area of turmeric contributed towards low instability of production of turmeric. The instability in turmeric production declined during post-WTO regime compared to pre-WTO regime among all the selected states (except Kerala) and even at All-India level. For Kerala, the rise in instability under production during post-WTO regime compared to pre-WTO regime is due to rise in area instability during post-WTO regime.

Table 4.6. CV in production of turmeric

Period	Kerala	Andhra Pradesh	Tamil Nadu	India
Pre-WTO regime (1980-81 to 1994-95)	11.40	62.70	45.44	41.19
Post-WTO regime (1995-96 to 2008-09)	15.66	22.23	29.57	19.37
Entire period (1980-81 to 2008-09)	21.02	53.04	41.47	23.90

4.1.3.3. CV in productivity of turmeric

The estimated CV in productivity of turmeric across the selected states and at All-India level is outlined in Table 4.7. It is clear that, the instability under turmeric productivity is highest in Andhra Pradesh (even higher than at All-India level) followed by Tamil Nadu and Kerala during the overall reference period (1980-81 to 2008-09). It is heartening to note that, the instability with reference to productivity declined during post-WTO regime compared to pre-WTO regime across all the selected states and at All-India level. This infers that the adoption of modern techniques of production of turmeric contributed towards declined instability during post-WTO regime.

Table 4.7. CV in productivity of turmeric

Period	Kerala	Andhra Pradesh	Tamil Nadu	India
Pre-WTO regime (1980-81 to 1994-95)	7.73	30.51	20.31	25.09
Post-WTO regime (1995-96 to 2008-09)	5.87	16.37	11.92	12.35
Entire period (1980-81 to 2008-09)	11.30	30.17	16.89	23.90

4.1.3.4. Comparative analysis of CV in area, production and productivity of turmeric across the selected states and at All-India level

The estimated CV in area, production and productivity of turmeric across the selected states and at All-India level are outlined in Tables 4.5 to 4.7. The comparative analysis of instability (CV) with reference to area, production and productivity of turmeric was studied across the selected states and at All-India level. It is evident from

Table 4.6 that, the CV with reference to production of turmeric is higher in Andhra Pradesh (53.04%) followed by Tamil Nadu (41.47%) and Kerala (21.02%) during the overall reference period, 1980-81 to 2008-09. Greater instability both in terms of area (30.88%) and productivity (30.17%) of turmeric are responsible for the highest CV of production of turmeric in Andhra Pradesh. However, for Tamil Nadu, the higher instability in area (35.49%) compared to productivity (16.89%) is responsible for significantly higher instability of production (41.47%) of turmeric. However, for Kerala, the instability in terms of area and productivity are low and this contributes towards low instability of turmeric production (21.02%). Even the variability in the production of turmeric in Kerala is less compared to All-India level.

To ascertain the influence of open trade with the advent of WTO on the production instability of turmeric, the same analysis was done with respect to two regimes viz., pre-WTO regime (1980-81 to 1994-95) and post-WTO regime (1995-96 to 2008-09). A close look at the Tables 4.5 to 4.7 reveals that, during post-WTO regime, the instability with respect to production of turmeric is declined during post-WTO regime compared to pre-WTO regime for Andhra Pradesh and Tamil Nadu and at All-India level, due to decline in instability of both area and productivity. However, for Kerala, though instability under productivity was declined during post-WTO regime (5.87%), but the increased instability under area (12.97%) during post-WTO regime compared to pre-WTO regime was responsible for the rise of instability for the production of turmeric during post-WTO regime (15.66%). On the whole, the decline in instability of turmeric production at All-India level and in majority of the states viz., Andhra Pradesh and Tamil Nadu, during post-WTO regime infers that, the farmers might have realized competitive prices in the domestic market. With reference to Kerala, there is slight or insignificant increase in the instability in production during post-WTO regime (15.66%) compared to pre-WTO regime (11.40%) and this increase in instability of turmeric production is due to increase in instability under turmeric area (even at insignificant level) and the actual causes may be attributed to weather calamities and not due to price risk.

4.2. EXPORT STATUS

4.2.1. Average Share (%) of Turmeric Exports

Turmeric exports occupy a meagre share in terms of turmeric production and total spices exports as indicated in Table 4.8. In terms of share in turmeric production, the share values are low at an average of five per cent during the pre-WTO regime (1960-61 to 1994-95). Further, the exports share showed mixed trends during the selected sub-periods of pre-WTO regime. It is disheartening to note that, the share of turmeric exports in total spices exports showed declining trend during the post-WTO regime. The low shares of turmeric both in terms of turmeric production and total spices exports infers that, the country has to pay serious attention on cost-effective production, as several countries like Myanmar, Europe, UAE, USA, Syria, Turkey and Iran are posing severe competition to Indian turmeric both in terms of cost-effectiveness and quality.

Table 4.8. Average share (%) of turmeric exports (Quantity)

S.No.	Item	Period	Average Share (%)
1.	In total turmeric production	1960-61 to 1969-70	5.36
		1970-71 to 1979-80	8.03
		1980-81 to 1994-95	4.63
		1960-61 to 1994-95	5.25
		1995-96 to 2008-09	5.90
2.	In total spices exports	2005-06	13.24
		2006-07	13.78
		2007-08	11.09
		2008-09	11.16
		2009-10	10.09

4.2.2. Growth in Turmeric Exports

The trends in export quantity and value of turmeric are presented in this section. An attempt was made to examine the magnitude and extent of changes that have taken place in export quantity and value of turmeric over the years. The entire period (1960-61 to 2009-10) has been divided into two sub periods namely, Pre-WTO regime (1960-61 to 1994-95) and Post-WTO regime (1995-96 to 2009-10). For these two regimes, growth rates in export quantity and value were estimated by exponential model, so as to draw the comparative picture about the trade prospects of turmeric with the advent of liberalized trade regime. The variability was estimated based on coefficient of variation. It may be mentioned that export data was that of the country as a whole, as state wise information on the above was not available and hence the analysis of this section is based on all India data.

Turmeric exports were regular into the international market, indicating the demand for Indian turmeric across the countries. Regarding growth trends, during both pre and post-WTO regimes, the exports of turmeric in terms of quantity, value and unit price showed significant positive growth rates (Table 4.9) indicating that, this crop had bright prospects in the international market. However, the worry some factor is that, the rate of growth in exports of turmeric in terms of quantity, value and unit price showed declining trend during post-WTO regime compared to pre-WTO regime, indicating that, India could not exploit the trade advantage with the opening up of market opportunities in the era of liberalized regime. This might be due to slow growth in the production of turmeric during post-WTO regime (9.65%) and drastic increase in the cost of production of turmeric and post harvest costs and consequent fall in demand for turmeric in the international market. This is indicated by the decline in the growth rate of unit price of turmeric during post-WTO regime (13.50%) compared to pre-WTO regime (21.06%).

Table 4.9. CGR of turmeric exports at All-India level

Period	Quantity (Tonnes)	Value (Rs. Lakh)	Unit price (Rs/kg)
Pre-WTO regime			
1960-61 to 1969-70	34.28 *	82.81 **	36.14 **
1970-71 to 1979-80	16.14 NS	58.85 **	36.77 **
1980-81 to 1994-95	15.88 **	43.22 **	23.59 **
1960-61 to 1994-95	11.43 **	34.59 **	21.06 **
Post-WTO regime			
1995-96 to 2009-10	11.94 **	27.06 **	13.50 **

** - Significant at 1 per cent level, * - Significant at 5 per cent level, NS-Non-significant

4.2.3. Instability in Turmeric Exports

The fluctuations in exports of turmeric in terms of quantity, value and unit price of turmeric in the international market due to irregularities in its supplies (tradable surplus) will adversely influence the reputation of the country in the international trade. Besides tradable surplus, the prices were largely influenced by quality, production of commodities in the importing country, tariffs imposed etc. To ensure good reputation in the international trade, the country should be a regular supplier of turmeric, that too, at competitive price and without much price fluctuations. As shown in Table 4.10, the turmeric exports in terms of quantity, value and unit price showed more stability during post-WTO regime compared to pre-WTO regime, as indicated by the fall in CV. This is mainly due to regularity in the supply of turmeric into the international market keeping in view the importer's requirements like quality standards and price. This also indicates that, the open trade environment contributed much towards price stability through accelerating the exports to the member nations into the international market.

Table 4.10. Coefficient of variation in turmeric exports at All-India level

Period	Quantity (Tonnes)	Value (Rs. Lakh)	Unit price (Rs/kg)
Pre-WTO regime			
1960-61 to 1969-70	47.38	73.50	57.55
1970-71 to 1979-80	42.48	80.80	49.46
1980-81 to 1994-95	37.50	73.60	45.54
1960-61 to 1994-95	53.62	121.78	82.00
Post-WTO regime			
1995-96 to 2009-10	22.62	55.65	37.45

4.2.4. Item wise Exports of Turmeric

India exports a wide range of products of turmeric into the international market and their shares in total turmeric exports (value) are shown in Table 4.11 during both pre and post-WTO regimes. During post-WTO regime, turmeric powder exports occupy prominent place (39% share) followed by turmeric dry (32% share) and turmeric fresh (16% share) exports. This infers that, over 85 per cent share of total turmeric exports value is realized from these three products. However, this picture of item-wise share of exports of different turmeric products was altogether different during pre-WTO regime, as turmeric dry, turmeric powder and turmeric oleoresins occupy predominant shares in the descending order of their shares in total turmeric exports. The same picture is presented through Fig. 4.13 and 4.14.

Table 4.11. Item wise exports of turmeric (per cent to total value)

Item	Pre-WTO regime (1988-89 to 1994-95)	Post-WTO regime (1995-96 to 2008-09)
Turmeric dry	30.00	32.00
Turmeric powder	25.00	39.00
Turmeric oleoresins	16.00	12.00
Turmeric excluding powder	15.00	0.00
Turmeric Fresh	12.00	16.00
Turmeric oil	2.00	1.00
Total	100.00	100.00

Fig. 4.13. Composition of export basket of turmeric products from India

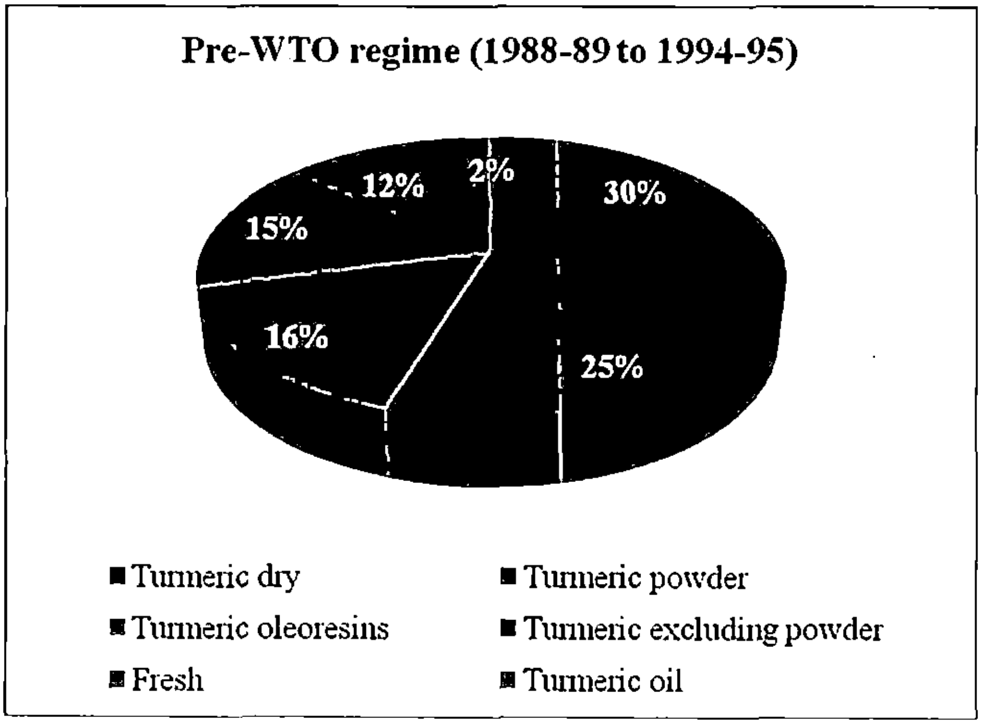
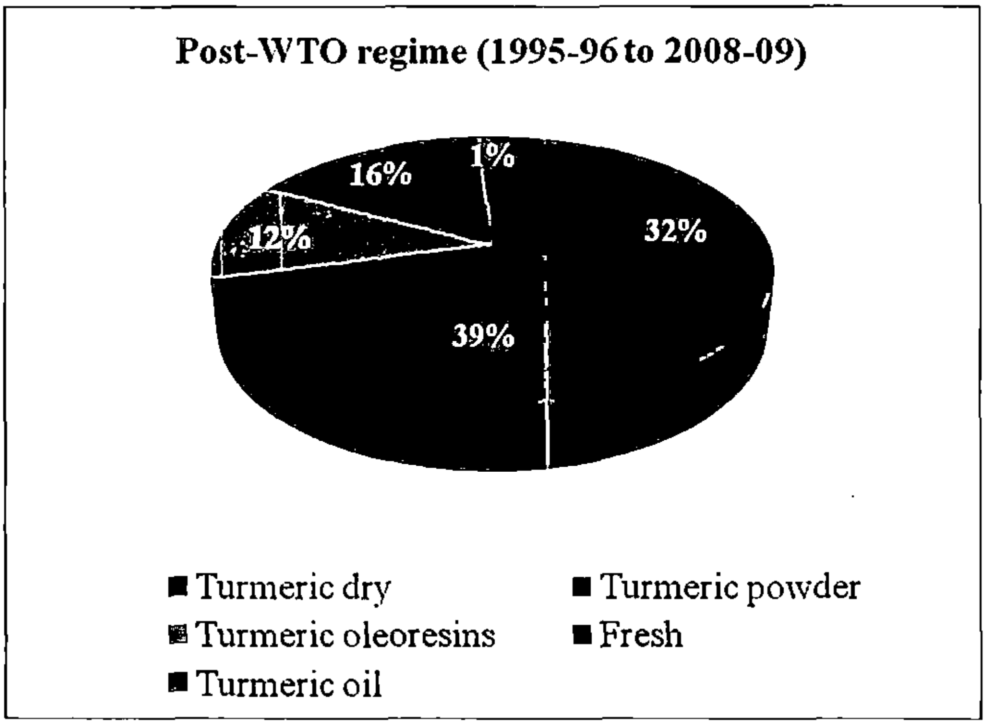


Fig. 4.14. Composition of export basket of turmeric products from India



4.3. IMPORT STATUS

4.3.1. Growth and Instability in Turmeric Imports

During the pre-WTO regime, the imports were highly irregular and during post-WTO regime, the imports were regular and gained momentum into the country and showed positive and significant growth trends in terms of quantity, value and unit price of imports (Table 4.12). This does not mean that, India is dependent on the member countries for turmeric, but for only maintaining the trade relationships with them. This is indicated by favourable net trade position of the country with reference to turmeric in the international market (Table 4.13) and high degree of instability of import trade of turmeric during the post-WTO regime (Table 4.12).

Table 4.12. CGR and instability in turmeric imports

Growth model	1998-99 to 2009-10		
	Quantity (Tonnes)	Value (Rs. Lakh)	Unit price (Rs/kg)
Exponential function	152.93 **	201.99 **	19.40 *
Coefficient of variation	89.01	97.44	37.77

** - Significant at 1 per cent level, * - Significant at 5 per cent level

Table 4.13. Net trade position of India for turmeric

Years	Quantity			Value		
	Exports (Tonnes)	Imports (Tonnes)	Net trade (Tonnes)	Exports (Rs.lakh)	Imports (Rs.lakh)	Net trade (Rs.lakh)
1998-99	37297	102	37195	12914.49	31.06	12883.43
1999-00	37776	210	37566	12351.81	32.13	12319.68
2000-01	44627	83	44544	11557.62	18.10	11539.52
2001-02	37778	120	37658	9073.71	11.74	9061.97
2002-03	32402	1313	31089	10337.99	250.37	10087.62
2003-04	37044	3005	34039	13111.73	841.29	12270.44
2004-05	43000	1615	41385	15650.00	702.25	14947.75
2005-06	46405	4022	42383	15286.02	1676.14	13609.88
2006-07	51500	7003	44497	16480.00	2519.82	13960.18
2007-08	49250	4650	44600	15700.00	1227.30	14472.70
2008-09	52500	2525	49975	24857.75	820.25	24037.50
2009-10	50750	4450	46300	38123.00	2086.75	36036.25

4.3.2. Item wise Imports of Turmeric

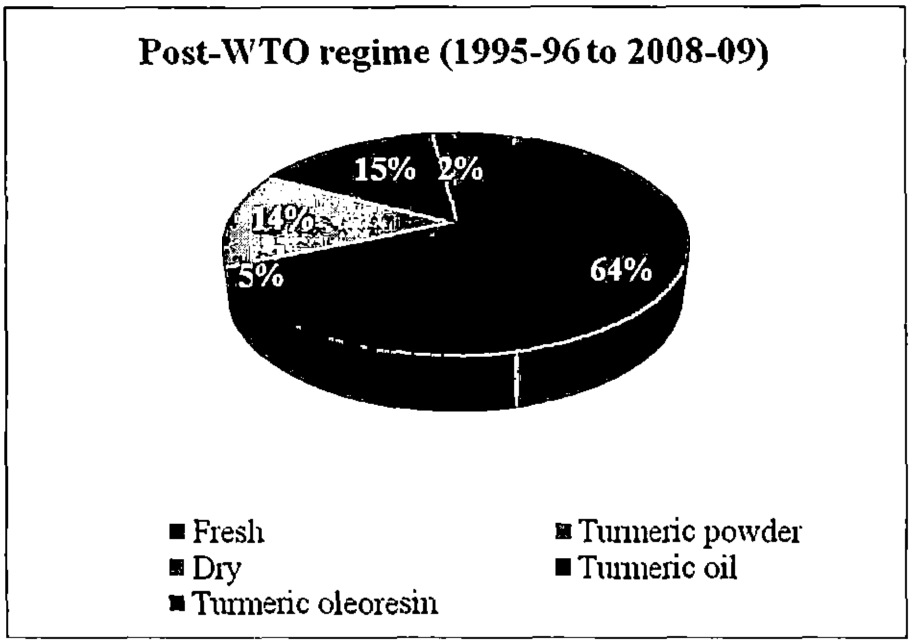
A comparison of item wise import of turmeric during pre and post WTO period is attempted here. It may be noted that we are importing turmeric mainly for value addition and after that it will be exported back.

The import basket of turmeric into India comprises mainly turmeric fresh (64%) followed by turmeric oil and turmeric dry with meagre shares of 15 and 14 per cents respectively of the total imports value of the turmeric during post-WTO regime (Table 4.14). However, it is heartening that, India is not a significant and regular importer of turmeric during pre-WTO regime and India imported only turmeric fresh and none of other products. The same picture is presented through Fig.4.15.

Table 4.14. Item wise imports of turmeric (per cent to total value)

Item	Pre-WTO regime (1988-89 to 1994-95)	Post-WTO regime (1995-96 to 2008-09)
Fresh	100.00	64.00
Turmeric powder	0.00	5.00
Dry	0.00	14.00
Turmeric oil	0.00	15.00
Turmeric oleoresin	0.00	2.00
Total	100.00	100.00

Fig. 4.15. Composition of import basket of turmeric products into India



4.3.3. Trends and Projections of Turmeric Area, Productivity and Net Trade

To boost the net trade of turmeric in the international market, it is essential to increase the production of turmeric in the country. As agricultural production is significantly dependent on the natural factors, it is thought appropriate to conceptualize the relationship between turmeric area and productivity *vis-a-vis* net trade, so that, the major contributing factor(s) can be ascertained. To have a clear picture about the possible opportunities for increasing the net trade of turmeric, trends were worked out for area, productivity and net trade during post-WTO regime and forecasting was done up to 2020-21, so that meaningful policy implications can be drawn. The analytical findings reveals that (Table 4.15 and Fig.4.16 to 4.18), both turmeric area and productivity are contributing factors for increasing the production and hence net trade, as they exhibited positive and significant growth trends during post-WTO regime. Compared to productivity (4.47%), area growth (4.95%) is more and hence, due attention should be given to develop high yielding varieties of turmeric suiting to different agro-ecological situations.

Table 4.15. Trends and projections of turmeric area and productivity *vis-a-vis* net trade of turmeric at All-India level

Years	Area (ha)	Yield (Kg/ha)	Net trade (Tonnes)
1998-99	160700	3721	37195
1999-00	141200	4734	37566
2000-01	191700	3726	44544
2001-02	167100	3368	37658
2002-03	154200	3722	31089
2003-04	150100	3763	34039
2004-05	158700	4525	41385
2005-06	172000	4952	42383
2006-07	178500	4408	44497
2007-08	175300	4532	44600
2008-09	195040	4585	49975
2009-10	183199*	4720*	46300
2010-11	186062*	4821*	47526*
2011-12	188971*	4925*	48695*
2012-13	191925*	5031*	49892*
2013-14	194925*	5139*	51118*
2014-15	197972*	5249*	52375*
2015-16	201066*	5362*	53663*
2016-17	204209*	5477*	54982*
2017-18	207401*	5595*	56333*
2018-19	210643*	5715*	57718*
2019-20	213936*	5838*	59137*
2020-21	217280*	5964*	60591*

* - Projections

Fig. 4.16. Trends and projections of area under turmeric in India after WTO

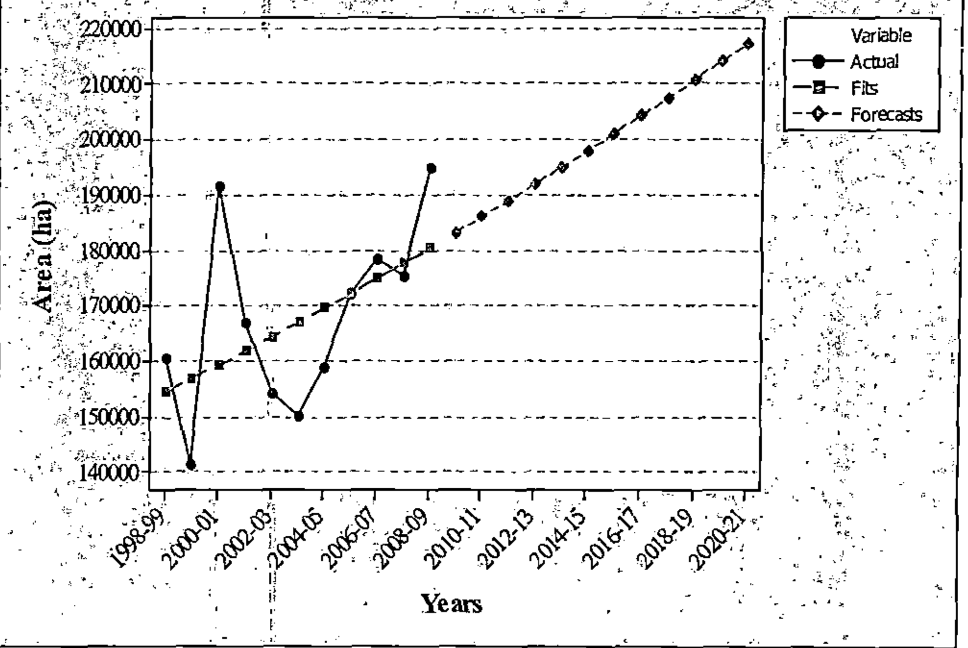


Fig. 4.17. Trends and projections in productivity of turmeric in India after WTO

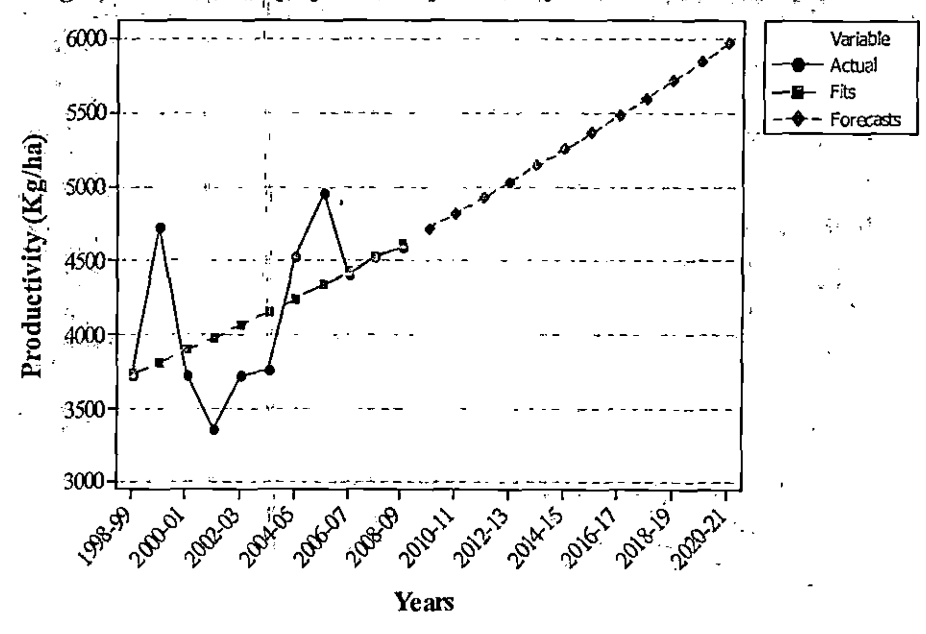
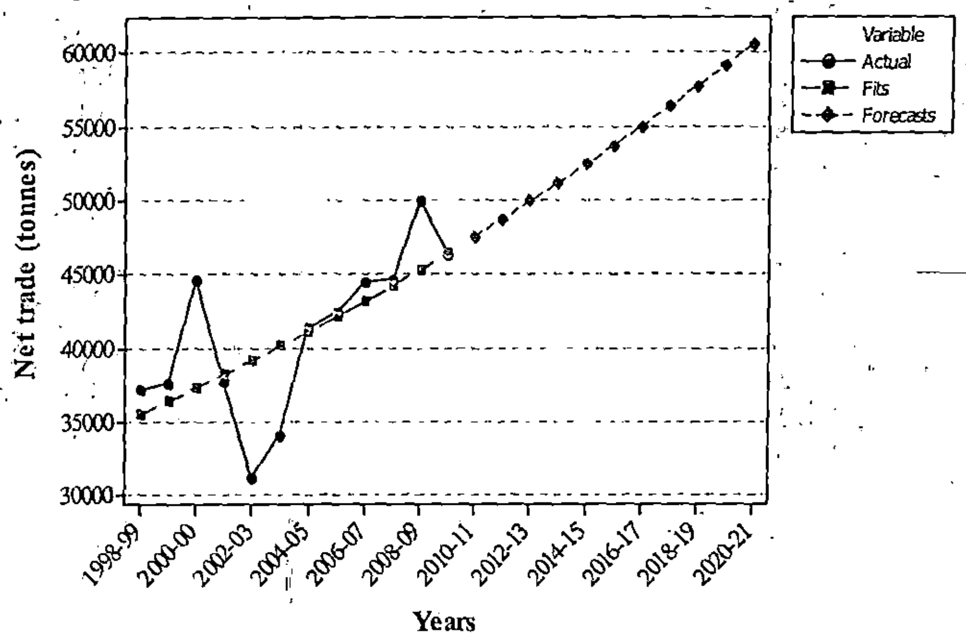


Fig. 4.18. Trends and projections in net trade of turmeric in India after WTO



4.4. PRICE BEHAVIOUR

Instability in the prices of farm products has far reaching consequences. Not only it is necessary that the price of particular commodity should have reasonable stability by permitting it to fluctuate within narrow limits, but it should also be in balance with that of other farm commodities. Price movements tend to effect the decisions of producer, buyer, consumer and the economy as a whole. A precipitous fall in the prices of farm products takes away at a stroke the gains of cultivation accruing to the farmers. Farmers are thus dissuaded from making long-term investments (Government of Kerala, 1974). So it is expedient to analyse the price movements of commodities. The study of price behaviour of crops will provide valuable information to formulate effective price policy to safeguard the interest of growers. With this background, an attempt has been made to analyze the price behaviour of turmeric in the main market centres viz., Kochi (Kerala), Nizamabad (Andhra Pradesh) and Erode (Tamil Nadu) during the period from 1995-96 to 2010-11.

The monthly modal price data of turmeric for three markets was subjected to the techniques of classical time series analysis and decomposed into four components viz., secular trend, seasonal fluctuations, cyclical fluctuations and irregular variations which are described in following section under appropriate headings.

4.5. TREND ANALYSIS OF PRICE OF TURMERIC

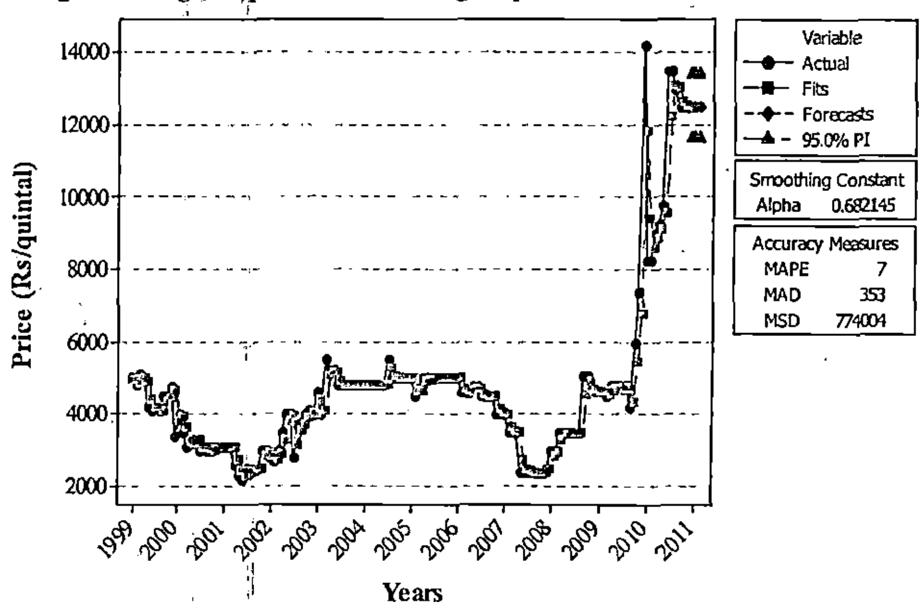
A trend analysis was carried out by using various functional forms like linear, quadratic, compound, growth, logarithmic, cubic, sigmoid, exponential, inverse, power and logistic and no satisfactory fit was observed based on adjusted R^2 values and standard errors (Appendix VII & VIII). This could be due to the fact that a host of factors influence the price of a commodity other than the historical trend. The socio-economic and climatic parameters could not be considered in the study due to constraints of time and resources. The low adjusted R^2 is also suggestive of the presence of the other three components of the time series viz., seasonal, cyclical and irregular variations. The remaining unexplained variation in the time series could be due to these reasons.

When the regression analysis cannot closely approximate the trend, smoothing to represent the simple trend is preferred (Anderson, 1971). Hence, trend lines were fitted with single exponential smoothing, double exponential smoothing and winters' method (multiplicative method). The method which is having the lowest mean absolute percentage error (MAPE) was taken as the best fit. Among all the smoothing methods, single exponential method was found to be the best.

4.5.1. Trends in the Price of Turmeric at Kochi Market

Trend lines were fitted for the turmeric price data at Kochi market (Kerala) with single exponential smoothing as plotted in the Fig.4.19. This fit had a mean absolute percentage error (MAPE) value of 7 per cent.

Fig. 4.19. Single Exponential Smoothing for price of turmeric at Kochi market



As is evident from the above figure, turmeric prices were subjected to considerable fluctuations during the period from 1999 January to 2007 September, depicting a mixed trend. However, the period from October 2007 is characterized by a growth phase in turmeric prices with a record price of Rs. 142/Kg during November 2009.

4.5.2. Trends in the Price of Turmeric at Nizamabad Market

Trend analysis was carried out for the turmeric price data (both bulb and finger) at Nizamabad market (Andhra Pradesh) with single exponential smoothing as plotted in the figures 4.20 and 4.21. This fit had a mean absolute percentage error (MAPE) value of 9 per cent for both bulb and finger types of turmeric.

Fig. 4.20. Single Exponential Smoothing for price of turmeric (bulb) at Nizamabad market

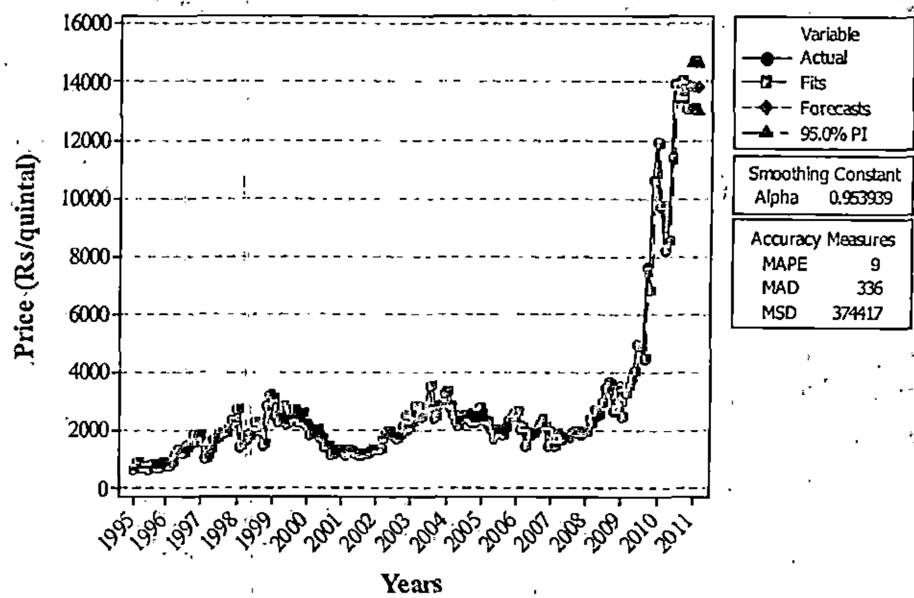
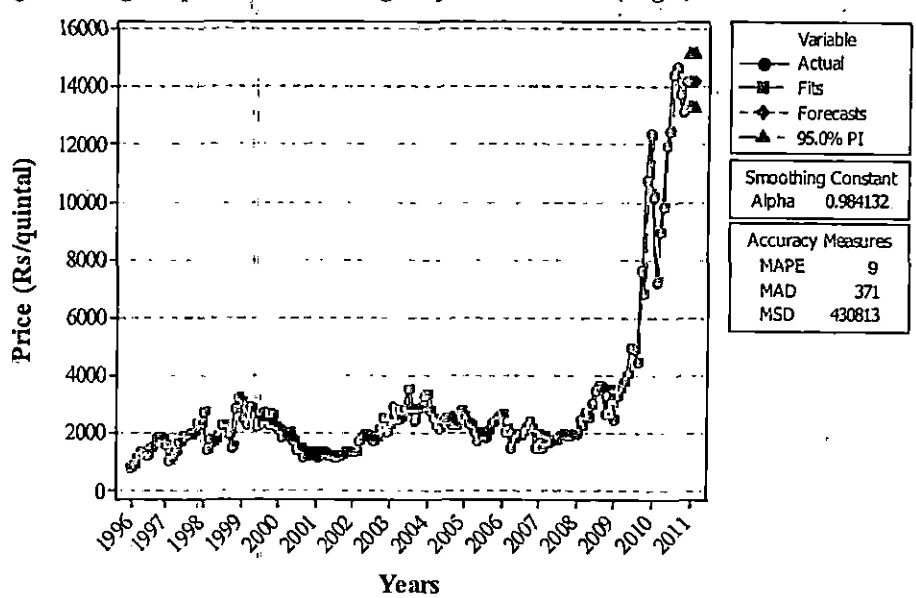


Fig.4.21. Single Exponential Smoothing for price of turmeric (finger) at Nizamabad market

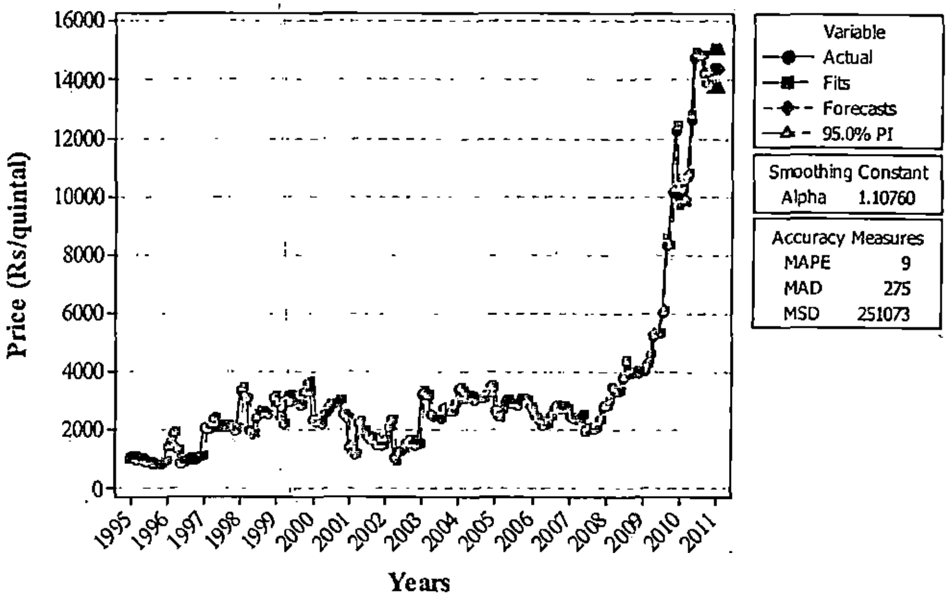


As is evident from the Fig.4.20, the price of turmeric (bulb) in Nizamabad market exhibited no specific trend. There was a mixed trend during the period from 1995 January to 2008 April. The same was the case for turmeric (finger) in Nizamabad market as shown in Fig.4.21 depicting a mixed trend during the period from 1996 January to 2008 April. This may be due to the reason that turmeric experiences considerable price volatility, and hence may not follow any expected trend path. However the period from 2008 May is characterized by a growth phase in turmeric (both bulb and finger) prices in Nizamabad market. A record price of Rs. 141/Kg was recorded for turmeric bulb and Rs. 147/Kg for turmeric finger during July 2010 in Nizamabad market.

4.5.3. Trends in the Price of Turmeric at Erode Market

Trend lines were fitted for the turmeric price data at Erode market (Tamil Nadu) with single exponential smoothing as plotted in the figure 4.22. This fit had a mean absolute percentage error (MAPE) value of 9 per cent.

Fig. 4.22. Single Exponential Smoothing for price of turmeric (finger) at Erode market



As is evident from the above Fig. turmeric prices were subjected to considerable fluctuations during the period from 1995 January to 2007 September, depicting a mixed trend. However, the period from October 2007 is characterized by a growth phase in turmeric prices with a record price of Rs. 149/Kg during July 2010.

4.5.4. Market Integration of Domestic Markets

4.5.4.1 Augmented Dickey Fuller (ADF) unit root test

To check whether the price series of turmeric are stationary or not across the markets, the ADF based unit root test is performed and the analytical findings are shown in Table 4.16. It is evident from the Table 4.16 that, the ADF test values (levels) of the selected markets are higher than the critical value (1%) given by MacKinnon statistical tables. This indicates that, the price series of turmeric across the markets are non-stationary and there is existence of unit root. In order to make the series stationary, the first difference is taken. However, after taking first difference, the ADF test values are below the critical value (1%) indicating that the price series of turmeric are stationary across the markets and they are free from the consequence of unit root.

Table 4.16. ADF Test Results of Turmeric Prices

Market	Level	First difference	Critical value (1%)
Kochi	-0.0384	-10.2025	-3.4773 *
Nizamabad	1.5022	-8.9207	
Erode	2.1313	-7.4747	

* MacKinnon critical values for rejection of hypothesis of a unit root

4.5.4.2 Johansen's Multiple Co integration Analysis

Market integration study was conducted considering the spot prices of turmeric at the selected markets by employing the Johansen multiple co integration analysis using Eviews software and the analytical findings are shown in Table 4.17. The two co-integration equations were found to be significant at five per cent level, indicating that, the selected markets are having long run equilibrium relationship. The Likelihood Ratio (LR) test conducted also reveals that, the two co-integrating equations are also significant at five per cent level.

Table 4.17. Johansen's Multiple Co integration Test

Market	Likelihood Ratio	5 % Critical Value	1 % Critical Value	Hypothesized No. of CE(s)
Kochi	51.02602	29.68	35.65	None **
Nizamabad	20.54369	15.41	20.04	At most 1 **
Erode	3.569733	3.76	6.65	At most 2

** denotes rejection of the hypothesis at 1% significance level

L.R. test indicates two co integrating equation(s) at 5% significance level

4.5.4.3 Granger Causality Test

In order to ascertain the direction of causation of price influences across the markets, Granger Causality test was done. The results portrayed through table 4.18 revealed that, the prices of turmeric in Nizamabad market influences prices of the same at Kochi market and there exists only unidirectional causality from Nizamabad market to Kochi market. This might be due to regularity of arrivals of turmeric in Nizamabad market compared to Kochi market. However, there exists bi-directional causality between Erode and Kochi markets and between Erode and Nizamabad markets with reference to turmeric prices. This is due to regularity of arrivals of turmeric in Erode and Nizamabad markets and due to strong spatial integration between Erode and Kochi markets with reference to turmeric prices.

Table 4.18. Pair wise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
Nizamabad does not Granger Cause Kochi	50.4768 **	5.6E-11
Kochi does not Granger Cause Nizamabad	0.36825 NS	0.54494
Erode does not Granger Cause Kochi	41.2671 **	1.9E-09
Kochi does not Granger Cause Erode	9.33454 **	0.00269
Erode does not Granger Cause Nizamabad	21.6698 **	7.4E-06
Nizamabad does not Granger Cause Erode	3.99202 *	0.04765

** indicates significant at 1 per cent probability level

* indicates significant at 5 per cent probability level

NS indicates non significant

4.6. SEASONAL VARIATIONS

It is an established fact that the seasonality in the production of crops and the consequent changes in market arrival is the main reason for seasonality in the price of agricultural commodities. Many workers have highlighted the importance of seasonal variation in agricultural decision-making (Radhakrishnan *et al.*, 1988; Das, 1991 and Babu and Sebastian, 1996). Since turmeric is a seasonal crop, price fluctuation is an important factor to be considered while planning to grow this crop.

Table 4.19. Seasonal indices for turmeric along with the coefficient of variation

Month	Kochi (Kerala)	Nizamabad (Andhra Pradesh)		Erode (Tamil Nadu)
		Bulb	Finger	
April	98.59	96.36	95.48	101.56
May	99.78	98.93	98.43	97.27
June	94.38	96.93	97.70	95.32
July	98.98	102.13	99.88	99.98
August	98.75	102.00	100.00	101.59
September	100.20	98.72	99.06	100.14
October	102.26	113.13	113.44	100.39
November	104.13	103.41	109.56	96.21
December	102.52	103.82	104.09	102.74
January	99.85	94.68	92.54	104.05
February	97.96	96.18	97.71	99.58
March	102.61	93.71	92.12	101.17
CV	2.51	5.12	6.06	2.49

It is widely believed that price fluctuation is one major reason for the slow pace of area expansion in turmeric. It is against this backdrop an attempt has been made to measure the pattern of seasonal variation in turmeric. For this the seasonal indices were worked out by the ratio to moving average method and are depicted in Table 4.19.

4.6.1. Seasonal Variations in the Price of Turmeric

As shown in Table 4.19, the domestic prices of turmeric exhibited considerable seasonality in all the selected markets.

The peak price for turmeric in the Kochi market was observed during November, whereas the trough price was noted in June. The period from September to December was a buoyant phase whereas the period from February to August was found to be the depressed phase.

In the Nizamabad market, the period from July to December was found to be the buoyant phase for turmeric bulb with prices peaking in October and the period from February to June was observed as the depressed phase with a trough being in March. The period from August to December was found to be the buoyant phase for turmeric finger in Nizamabad market with a peak price observed in October and the period from February to July was observed as a depressed phase with a trough being noted in March.

The peak price for turmeric in the Erode market was observed during January, whereas the trough price was noted in June. The period from August to January was a buoyant phase whereas the period from May to July was found to be the depressed phase.

Thus it can be found that the seasonal price behaviour was more similar for Kochi and Erode markets (Fig.4.23 and 4.26) while, it was different for the Nizamabad market (Fig.4.24 and 4.25). The similarity exhibited by the Kochi and Erode markets was due to their proximity with each other. The Nizamabad market is a far-flung market from these two markets.

The coefficient of variation showed that the seasonal variation in turmeric price was less in Erode followed by Kochi. The highest seasonal variation was seen in Nizamabad market (Table 4.19). It was found that the seasonal variation in turmeric finger price is more when compared to turmeric bulb price in Nizamabad market.

Fig. 4.23. Seasonal indices of turmeric at Kochi market

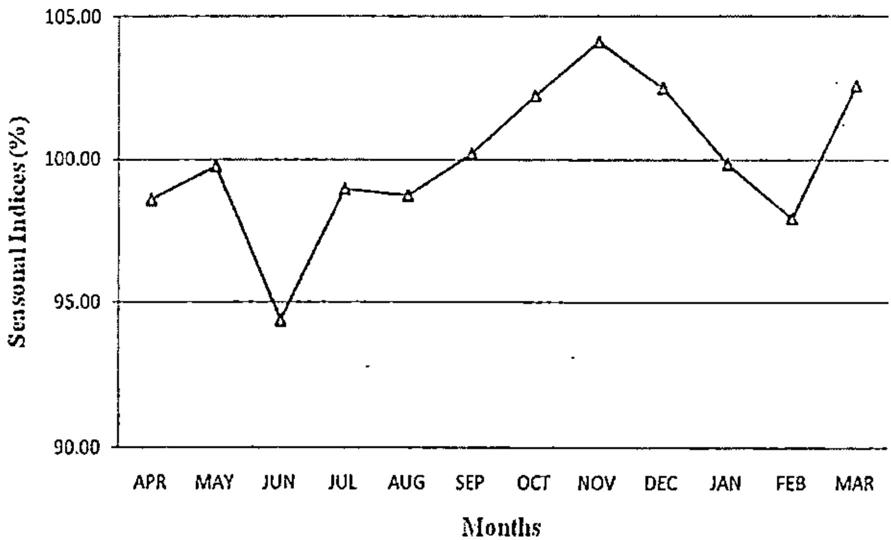


Fig. 4.24. Seasonal indices of turmeric (bulb) at Nizamabad market

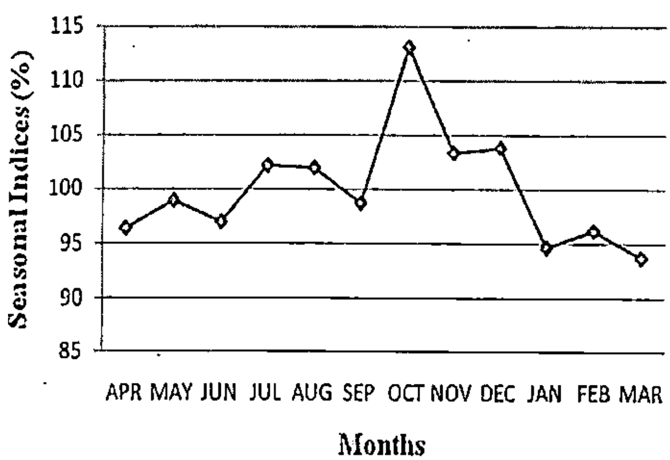


Fig. 4.25. Seasonal indices of turmeric (finger) at Nizamabad market

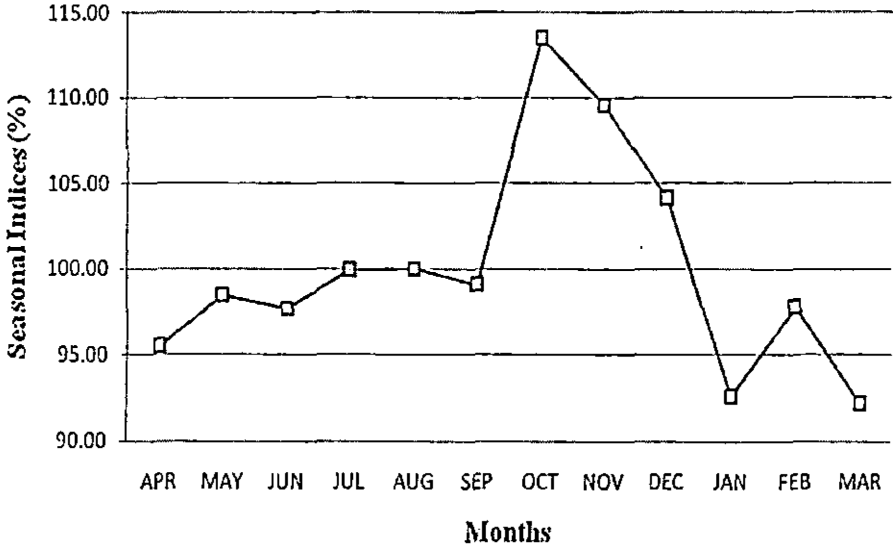
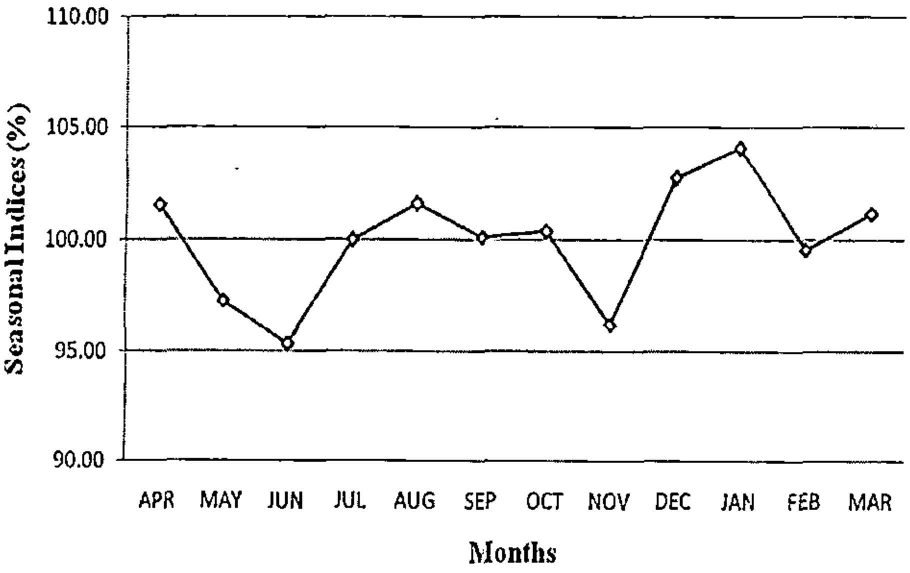


Fig. 4.26. Seasonal indices of turmeric (finger) at Erode market



It is interesting that, the buoyant phase for prices coincide with lean season of marketing, while trough prices coincide with peak marketing season or harvesting season. On these grounds, it is recommended for the farmers or traders to trade the commodity during the buoyant phase and stock the same during trough phase, so as to ensure profitability in the business. The same explanation was shown through Fig. 4.23 to 4.26.

4.7. CYCLICAL VARIATIONS

The indices for the cyclical price variations in turmeric were worked out by eliminating the trend and seasonal variations from the original data to obtain cyclical-irregular indices and irregular fluctuations were ironed by averaging to give the cyclical indices. The cyclical indices computed are represented graphically in Fig.4.27 to 4.30.

The prices of turmeric showed pronounced cyclical variations in all the selected markets. It was observed that, in Kochi market, for turmeric, the length of the cycle lasted for about six years, seven years for turmeric bulb and finger prices in Nizamabad market and six to seven years for turmeric prices in Erode market. It depicts that barring the irregular variations, market high and low price can be expected once in six years in Kochi market, seven years in Nizamabad market and six to seven years in Erode market respectively. These cyclical fluctuations are understandable for turmeric, which is basically an export oriented crop. It was interesting to note that, there was marked similarity in the cyclical variations for the three selected markets. Prices of turmeric were found to be depressed during 2000-2001 and a peak was noted there after with the price approaching high by 2002-03 and prices again depressed by 2006-07 and thereafter reached the peak by 2009-10.

Fig. 4.27. Cyclical variations in turmeric prices at Kochi market

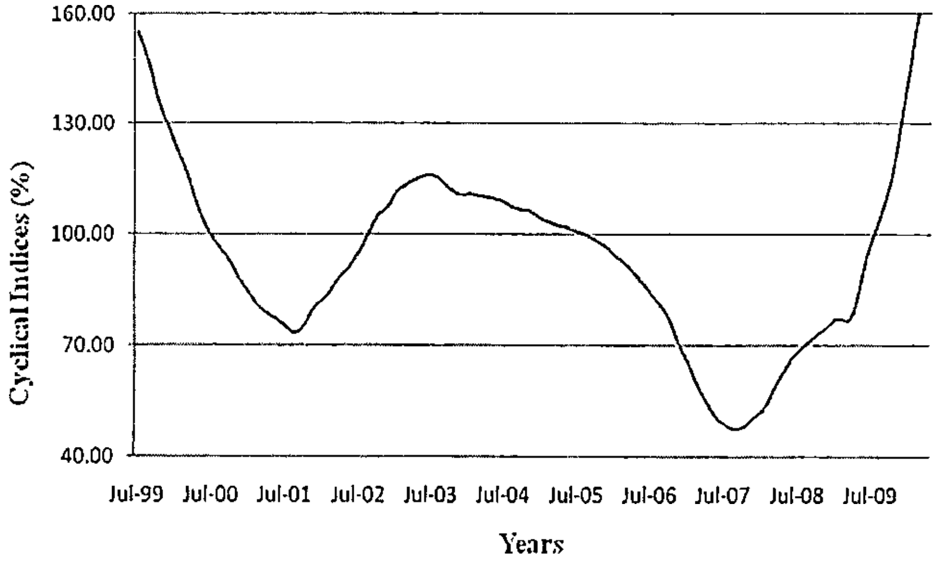


Fig. 4.28. Cyclical variations in turmeric (bulb) prices at Nizamabad market

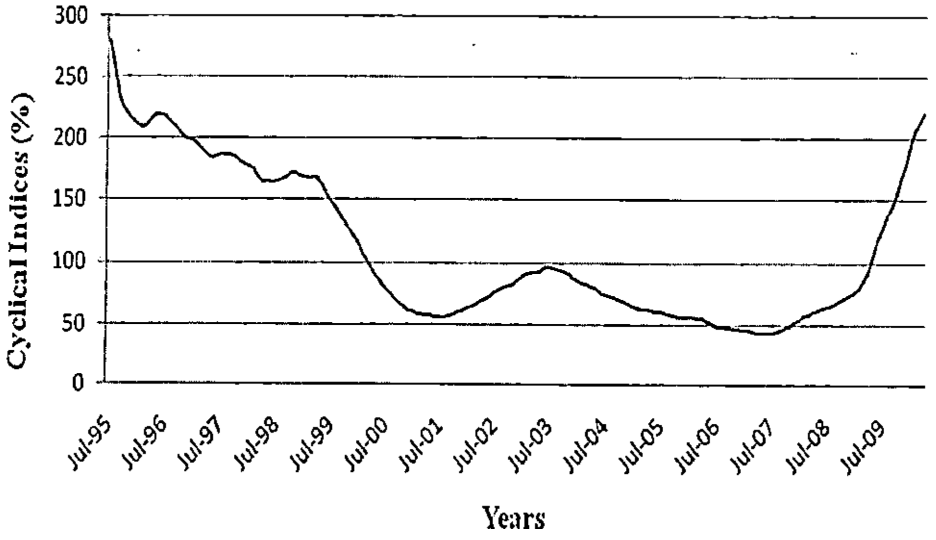


Fig. 4.29. Cyclical variations in turmeric (finger) prices at Nizamabad market

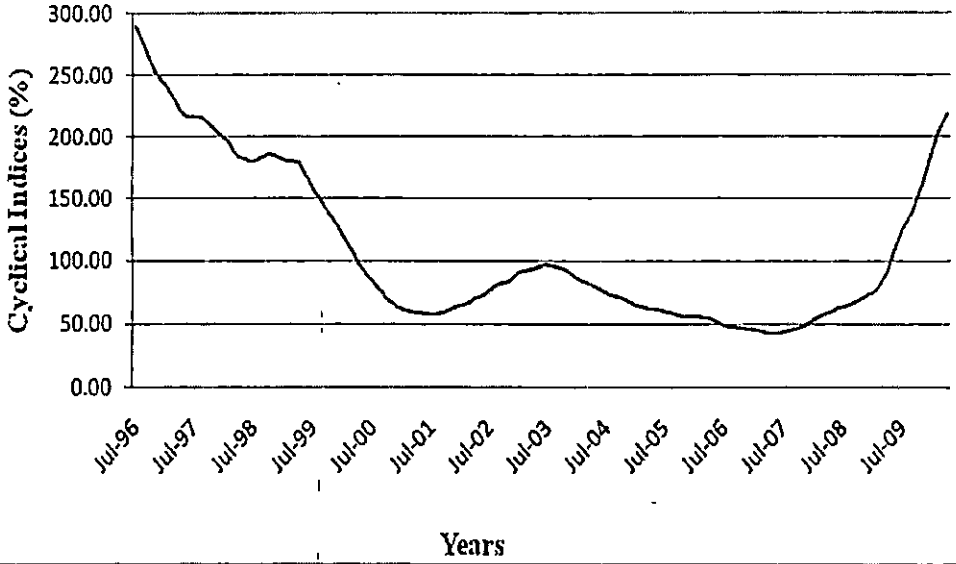
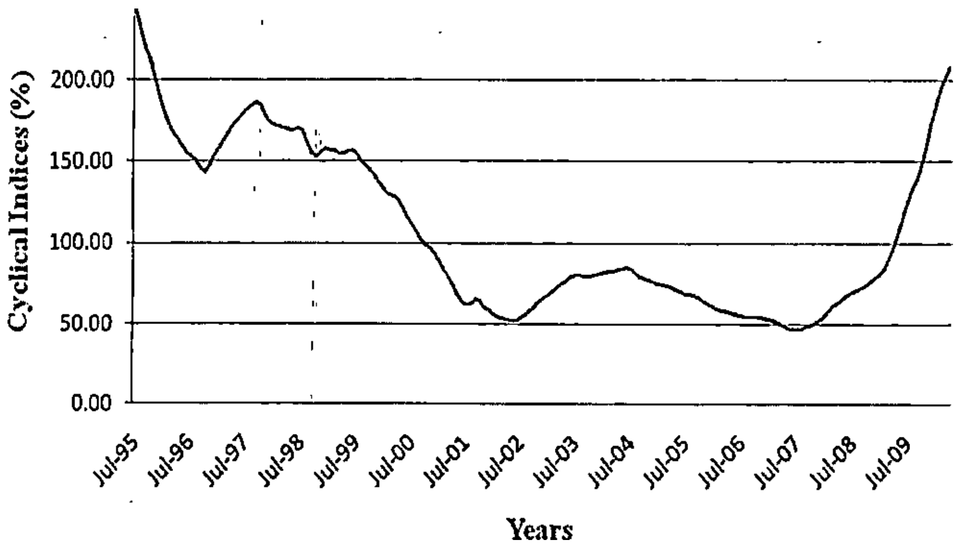


Fig. 4.30. Cyclical variations in turmeric (finger) prices at Erode market



4.8. IRREGULAR VARIATIONS

The indices of irregular variations were computed for turmeric prices using the residual method by eliminating trend, seasonal and cyclical components from the original data in order to capture the random effect across the selected markets (Fig.4.31 to 4.34).The figures reveal that, the prices of turmeric across the selected markets and turmeric bulb prices in Nizamabad market were subjected to considerable irregular variations during the period under consideration and these are due to supply shocks on account of climatic variations or market shocks on account of demand shocks or high speculative factors.

The irregular indices showed that turmeric prices were highly unpredictable and did not maintain any uniform pattern over the period. However there was marked similarity in the irregular price movements of turmeric bulb and finger in Nizamabad market.

Fig. 4.31. Irregular variations in turmeric prices at Kochi market

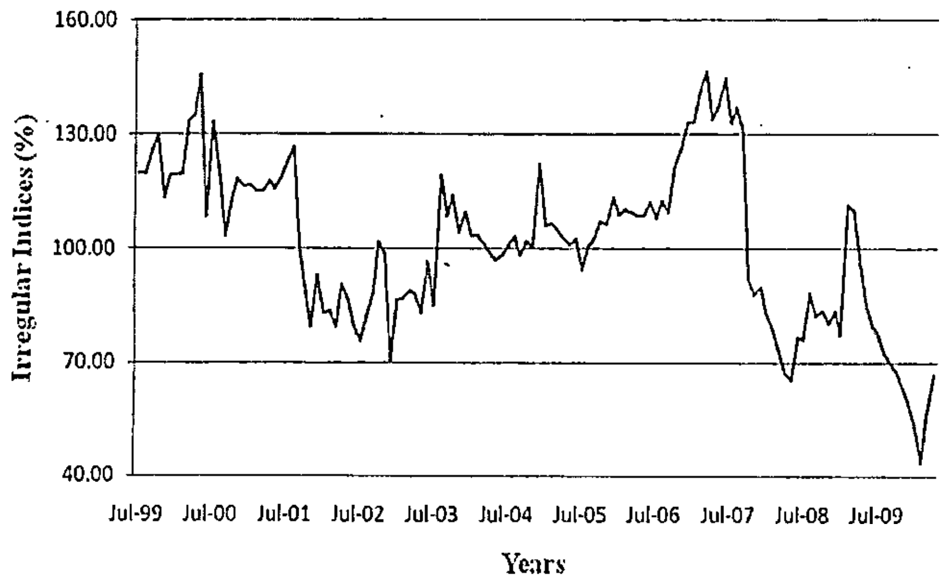


Fig. 4.32. Irregular variations in turmeric (bulb) prices at Nizamabad market

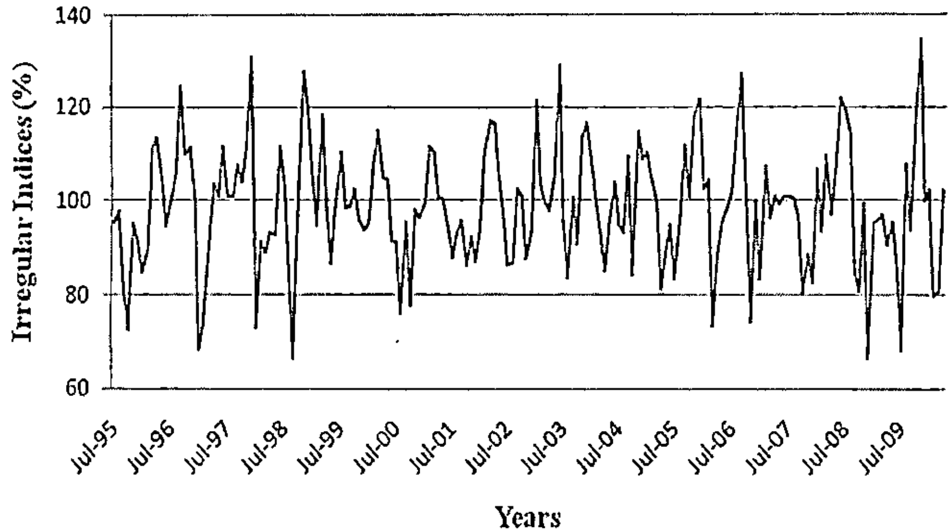


Fig. 4.33. Irregular variations in turmeric (finger) prices at Nizamabad market

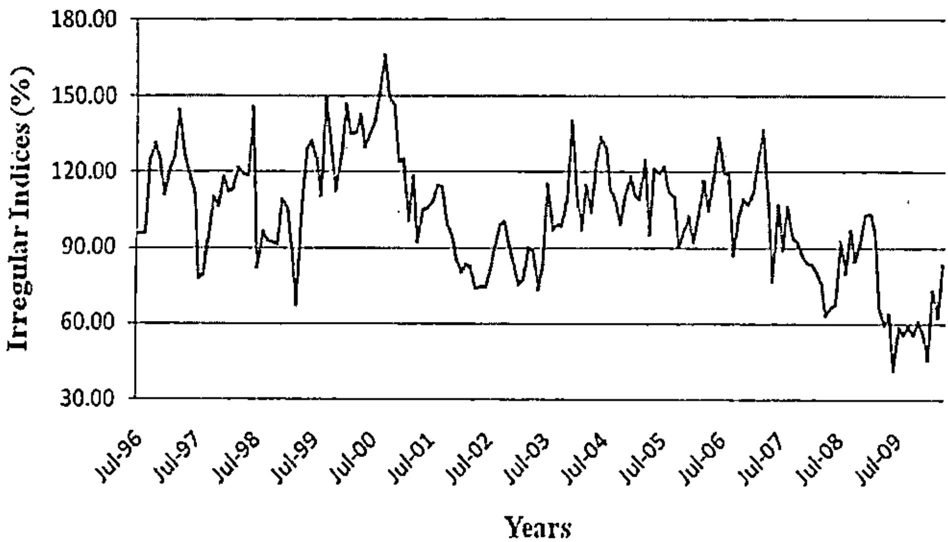
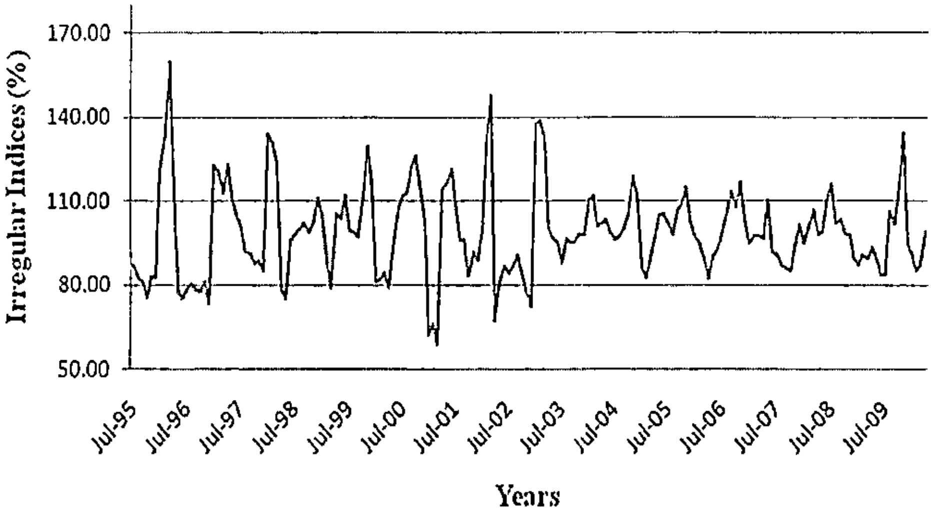


Fig. 4.34. Irregular variations in turmeric (finger) prices at Erode market



But the irregular variations in turmeric prices at Kochi and Erode markets were found to behave differently from that of the irregular variations in turmeric prices at Nizamabad market. This marked dissimilarity with regard to irregular variations in turmeric prices between Kochi and Erode markets vis-a-vis Nizamabad market might be due to geographical separation and lack of spatial price integration between them.

4.9. EXPORT COMPETITIVENESS

Indian agriculture faces both opportunities and challenges with the advent of trade liberalization policies across the countries in the context of WTO. So, there is a need to formulate export promotion strategies for the agricultural commodities that enjoy net trade status from the country. In this context, it is felt appropriate to analyse the export competitiveness of turmeric during both pre and post-WTO regimes and to draw the comparative picture.

India accounts for 80 per cent of the world trade in turmeric and it was in a competitive position with a lower domestic price compared to international price. The export competitiveness of turmeric has been calculated through computing NPC. In computing the NPCs, it is the exportable hypothesis that is taken into consideration, considering the commodity (turmeric) is deemed to be exported from the country into the international market. The analytical findings of NPCs of turmeric are shown through Table 4.20. A perusal of Fig.4.35 shows that the domestic prices of turmeric have been consistently lower than the international prices, indicating that, India enjoys more export competitiveness for turmeric in the international market.

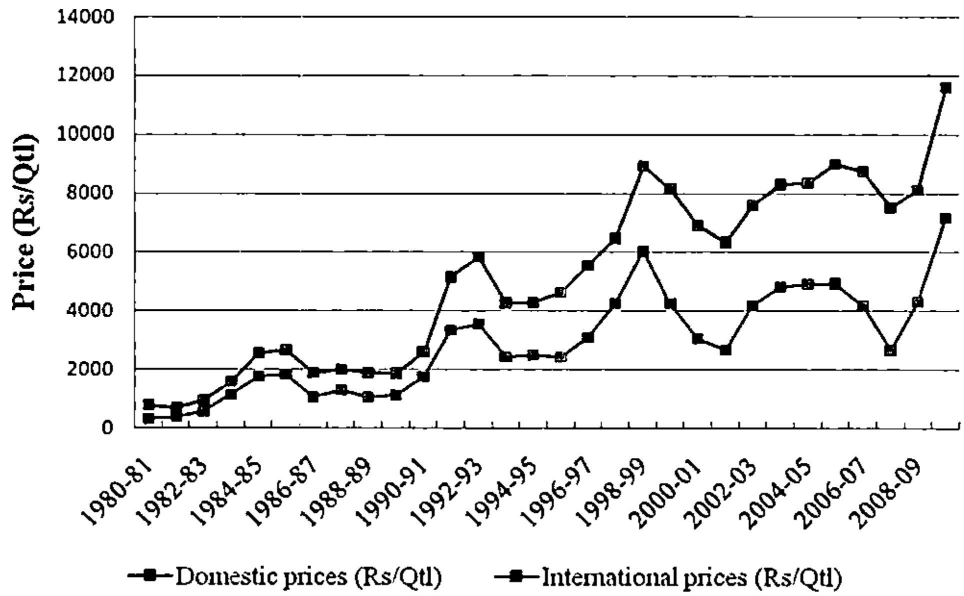
As shown in Table 4.20, during both pre and post-WTO regimes, turmeric enjoyed more export competitiveness in the international market. Further, the NPCs were declined during post-WTO regime compared to pre-WTO regime. This infers that, this crop has tremendous export potential in the international market. In view of this, necessary R&D support, scientific processing facilities, quality promotion, cost-effective production technologies etc., should be given due consideration to brighten the prospects of turmeric trade in the international market. Considering the stiff competition from other major turmeric producing countries, it is essential to promote the quality of output on par with the Sanitary and Phyto-Sanitary (SPS) Standards of the importing countries. Being a traditional crop with religious importance and with a significant farming experience in turmeric cultivation over the centuries in India, it is high time for the researchers to plan for producing HYV of turmeric with desired quality attributes.

The above findings on the NPC values of less than one was in conformity with the result of Divya (2003) where NPC of turmeric during pre-WTO regime (1987-88 to 1994-95) ranged between 0.48 to 0.74 and in post-WTO regime (1995-96 to 2002-03), it ranged from 0.43 to 0.63 which inferred that turmeric is export competitive in the international market.

Table 4.20. NPCs of turmeric during pre and post WTO regimes

Pre WTO regime (1980-81 to 1994-95)		Post WTO regime (1995-96 to 2009-10)	
YEAR	NPC	YEAR	NPC
1980-81	0.42	1995-96	0.52
1981-82	0.56	1996-97	0.56
1982-83	0.60	1997-98	0.66
1983-84	0.73	1998-99	0.68
1984-85	0.69	1999-00	0.52
1985-86	0.68	2000-01	0.44
1986-87	0.56	2001-02	0.42
1987-88	0.66	2002-03	0.55
1988-89	0.56	2003-04	0.58
1989-90	0.60	2004-05	0.59
1990-91	0.68	2005-06	0.55
1991-92	0.65	2006-07	0.48
1992-93	0.61	2007-08	0.35
1993-94	0.57	2008-09	0.53
1994-95	0.58	2009-10	0.62

Fig. 4.35. International and domestic prices of turmeric



Swaminathan (1995) emphasized the role of excellence in quality, reliability of supplies and price competitiveness in international trade and suggested ecologically sound methods of production include post harvest technology and maximum value addition for spices (turmeric) with particular attention to processing, packaging transportation and marketing for boosting the turmeric exports into the international market. The major challenges identified to Indian turmeric were productivity, quality and value addition challenge. So, India has to use high yielding varieties, appropriate production technologies and all the more highly conducive climate for turmeric production. Thus, in order to compete and retain India's position in the world market, the quality expectations in the areas of pesticide residues, mycotoxins and microbial load should be strengthened. Global demand for value added turmeric is on the increase. Convenience in consumption is the characterization of new market and placed enormous demand in value added turmeric. Mainly due to lack of adequate processing facilities the share of value added spices export in general and turmeric in particular from India is very less. So we have to concentrate on product diversification and value addition to be more competitive in the international market.

4.10. PRICE INSTABILITY

The volatility of turmeric prices in both the domestic as well as international markets were studied using the coefficient of variation during the period 1980-81 to 2009-10. The estimated CV in turmeric prices at domestic (Kerala) and international markets (New York) is shown in Table 4.21.

Table 4.21. CV in price of turmeric

	Domestic price	International price
CV (%)	58.80	58.09

As evident from the computed CV values (Table 4.21), both domestic prices (58.80%) and international prices (58.09%) of turmeric exhibited greater degree of volatility. In the context of safe guarding the interests of domestic farmers on one hand and realizing the export competitiveness for turmeric on the other, there is an immense need for strengthening the Market Intervention Scheme duly considering the price (forecasted) volatility in the international market, addressing the post-harvest handling measures of turmeric on scientific scale and provision of safety net (subsidies) measures to the turmeric growing farmers for boosting the cost-effective production. These measures coupled with fruitful negotiations with the importing nations will fetch more comparative advantage for Indian turmeric across the countries in the international market.

4.11. PRICE FORECAST AND ITS VALIDATION

4.11.1. Price forecast of turmeric

Price forecast of turmeric was carried out for the months of March, April and May of the year 2011 for Nizamabad market, Erode market and Kochi market separately by using various price forecasting methods such as single exponential smoothing, double exponential smoothing, Winters' multiplicative method, Winters' additive method, moving average method and Auto Regressive Integrated Moving Average (ARIMA) method. This analysis was carried out by using Minitab package, version 15 and SPSS package, version 16. Among these various price forecasting methods, double exponential smoothing was found to be the best model based on MAPE values for Nizamabad and Erode markets, whereas Winters' multiplicative method and Winters' additive method were found to be the best based on the MAPE values for Kochi market. The prices of turmeric in the selected markets were forecasted by the said models for the months of March, April and May of the year 2011 and they are given in Tables 4.22 to 4.25.

Table 4.22. Price forecast of turmeric bulb in Nizamabad market (Rs/Kg)

Model	March 2011		April 2011		May 2011	
	Forecast	**Range**	**Forecast**	**Range**	**Forecast**	**Range**
Single exponential smoothing	91	82-100	91	82-100	91	82-100
Double exponential smoothing	**83**	**74-96**	**84**	**67-101**	**85**	**60-109**
Winters' multiplicative method	128	116-139	132	121-144	144	132-156
Winters' additive method	134	122-146	139	127-151	144	132-156
Moving average method	125	105-146	125	105-146	125	105-146
ARIMA model	94	81-107	100	77-113	108	86-129

Table 4.23. Price forecast of turmeric finger in Nizamabad market (Rs/Kg)

Model	March 2011		April 2011		May 2011	
	Forecast	Range	Forecast	Range	Forecast	Range
Single exponential smoothing	97	87-107	97	87-107	97	87-107
Double exponential smoothing	**94**	**84-105**	**94**	**77-112**	**95**	**70-120**
Winters' multiplicative method	143	131-154	146	134-158	156	144-168
Winters' additive method	149	137-161	153	141-165	156	144-168
Moving average method	132	110-154	132	110-154	132	110-154
ARIMA model	93	79-107	95	75-114	105	82-128

Table 4.24. Price forecast of turmeric finger in Erode market (Rs/Kg)

Model	March 2011		April 2011		May 2011	
	Forecast	Range	Forecast	Range	Forecast	Range
Single exponential smoothing	103	95-111	103	95-111	103	95-111
Double exponential smoothing	**102**	**94-109**	**102**	**88-117**	**103**	**82-124**
Winters' multiplicative method	158	145-171	157	144-171	160	146-173
Winters' additive method	156	144-168	160	147-172	163	150-176
Moving average method	139	119-160	139	119-160	139	119-160
ARIMA model	105	94-116	110	92-127	113	92-135

Table 4.25. Price forecast of turmeric in Kochi market (Rs/Kg)

Model	March 2011		April 2011		May 2011	
	Forecast	Range	Forecast	Range	Forecast	Range
Single exponential smoothing	111	102-120	111	102-120	111	102-120
Double exponential smoothing	95	85-105	95	78-113	96	71-121
Winters' multiplicative method	**137**	**123-152**	**133**	**118-148**	**139**	**124-154**
Winters' additive method	**137**	**124-151**	**138**	**124-152**	**144**	**130-159**
Moving average method	121	98-145	121	98-145	121	98-145
ARIMA model	119	100-137	120	98-142	125	101-148

4.11.1.1. Price forecast of turmeric at Nizamabad market

Price forecast of turmeric (both bulb and finger) at Nizamabad market was analysed by various models as mentioned earlier. Double exponential smoothing was found to be the best fit model based on the required statistical criteria. The analytical findings are portrayed through the Fig.4.36 and 4.37 for turmeric bulb and finger respectively at Nizamabad market. The same is depicted through the Tables 4.26 and 4.27 for turmeric bulb and turmeric finger respectively.

4.26. Price forecast of turmeric bulb at Nizamabad market by Double Exponential Smoothing (Rs/kg)

Month & Year	Forecasted value	Lower limit	Upper limit
March 2011	83	74	96
April 2011	84	67	101
May 2011	85	60	109

The MAPE value of 9 per cent (Fig.4.36) was obtained by double exponential smoothing with a forecast value of Rs.83/kg, Rs.84/kg and Rs.85/kg for March, April and May months of 2011 respectively. The price range was also shown through the Table 4.26.

4.27. Price forecast of turmeric finger at Nizamabad market by Double Exponential Smoothing (Rs/kg)

Month & Year	Forecasted value	Lower limit	Upper limit
March 2011	94	84	105
April 2011	94	77	112
May 2011	95	70	120

Double exponential smoothing was again used to forecast the prices of turmeric finger with MAPE value of 9 per cent (Fig.4.37). The forecasted value of turmeric finger at Nizamabad market for the March, April and May months of 2011 is Rs.94/kg, Rs.94/kg and Rs.95/kg respectively. The price range is Rs.84/kg to Rs.105/kg for March, Rs.77/kg to Rs.112/kg for April and Rs.70/kg to Rs.120/kg for May month (Table 4.27).

Fig. 4.36. Price forecast of turmeric bulb at Nizamabad market by Double Exponential Smoothing

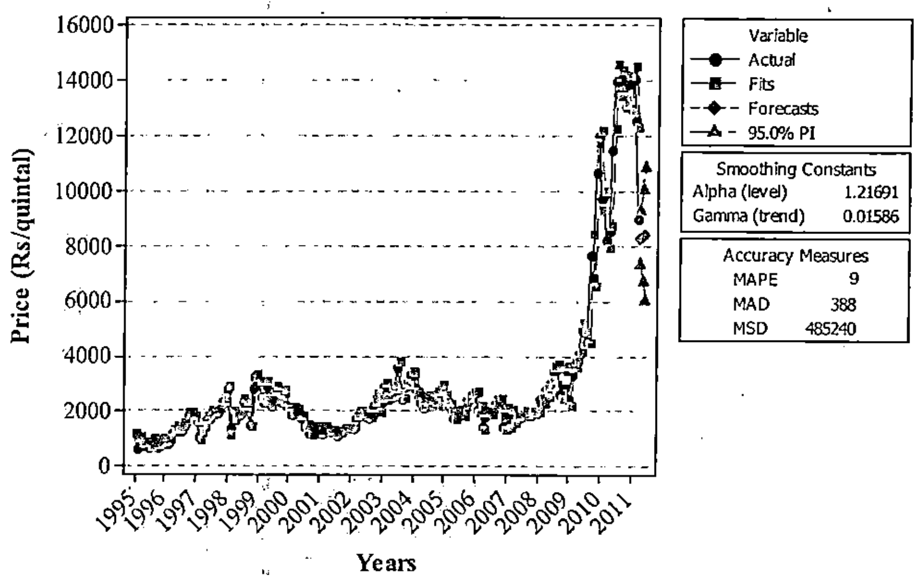
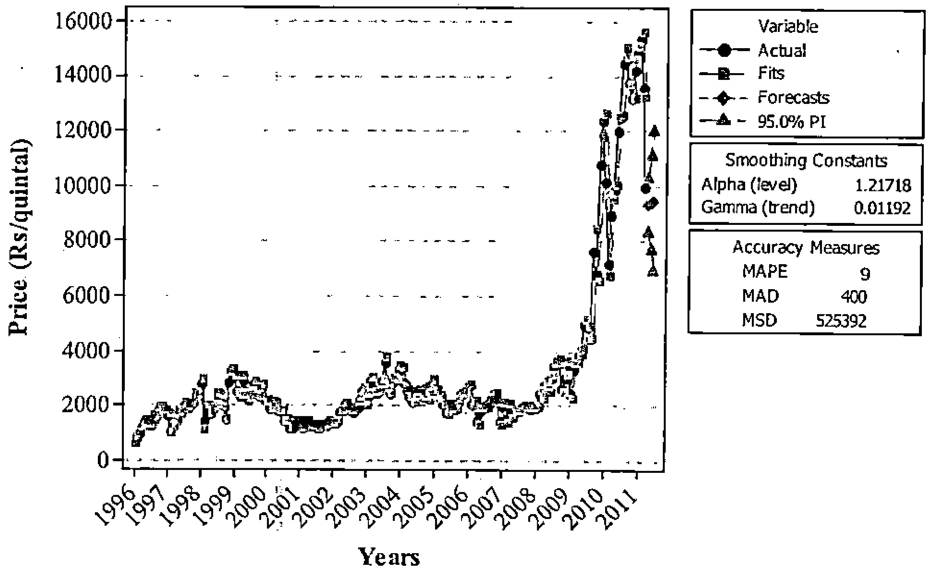


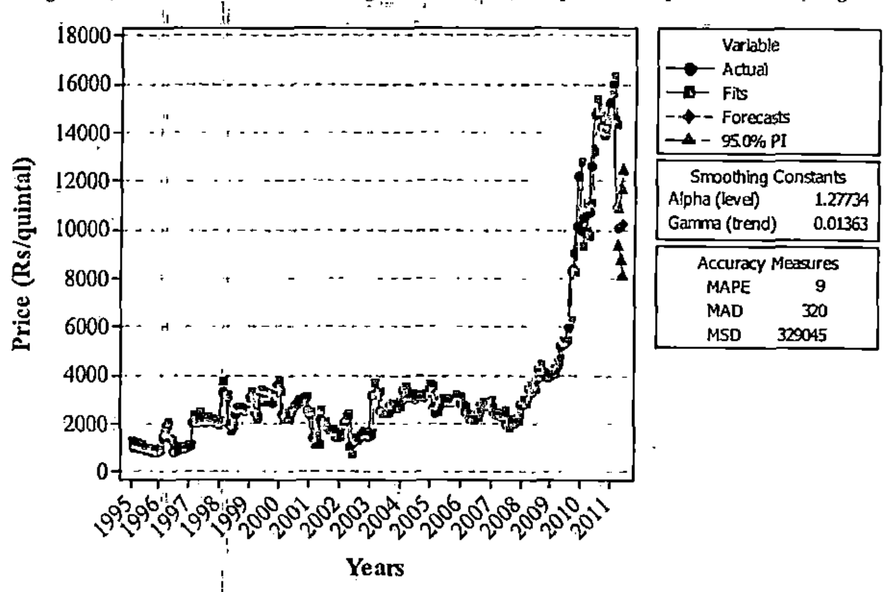
Fig. 4.37. Price forecast of turmeric finger at Nizamabad market by Double Exponential Smoothing



4.11.1.2. Price forecast of turmeric at Erode market

As in Nizamabad market, double exponential smoothing was again identified as the best fit model based on the MAPE value for forecasting turmeric finger prices at Erode market. The analytical findings portrayed through the Fig.4.38 and table 4.28 revealed that, the forecasted prices of turmeric finger for the March, April and May months of 2011 are Rs.102/kg, Rs.102/kg and Rs.103/kg respectively. The price ranges were also shown through the Table 4.28.

Fig. 4.38. Price forecast of turmeric finger at Erode market by Double Exponential Smoothing



4.28. Price forecast of turmeric finger at Erode market by Double Exponential Smoothing (Rs/kg)

Month & Year	Forecasted value	Lower limit	Upper limit
March 2011	102	94	109
April 2011	102	88	117
May 2011	103	82	124

4.11.1.3. Price forecast of turmeric at Kochi market

Regarding Kochi market, Winters' multiplicative model (Fig.4.39 and Table 4.29) was employed with the MAPE value of 10 per cent to forecast the prices of turmeric. The forecasted prices of turmeric for the months of March, April and May, 2011 are Rs.137/kg, Rs.133/kg and Rs.139/kg respectively. As the prices are in the range of lower and upper limits, it implies that the forecasted prices are reliable.

Similar findings were obtained from the Winters' additive model (Fig.4.40 and Table 4.30) with the MAPE value of 10 per cent. The forecasted prices of turmeric for the months of March, April and May, 2011 also lie in the range of lower and upper limits indicating that the forecasted prices are reliable.

4.29. Price forecast of turmeric at Kochi market by Winters' multiplicative method (Rs/kg)

Month & Year	Forecasted value	Lower limit	Upper limit
March 2011	137	123	152
April 2011	133	118	148
May 2011	139	124	154

4.30. Price forecast of turmeric at Kochi market by Winters' additive method (Rs/kg)

Month & Year	Forecasted value	Lower limit	Upper limit
March 2011	137	124	151
April 2011	138	124	152
May 2011	144	130	159

Fig. 4.39. Price forecast of turmeric at Kochi market by Winters' Multiplicative Method

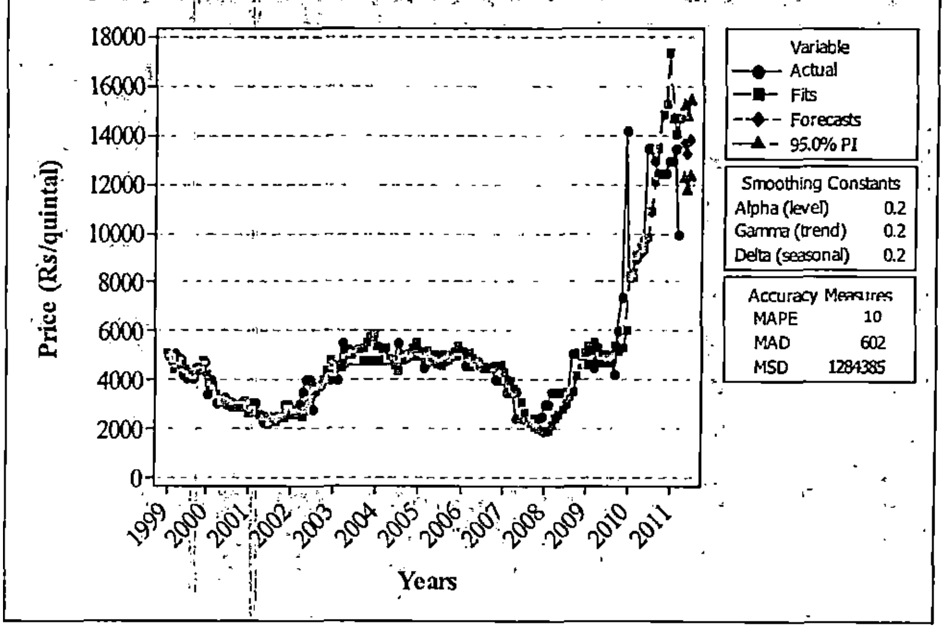
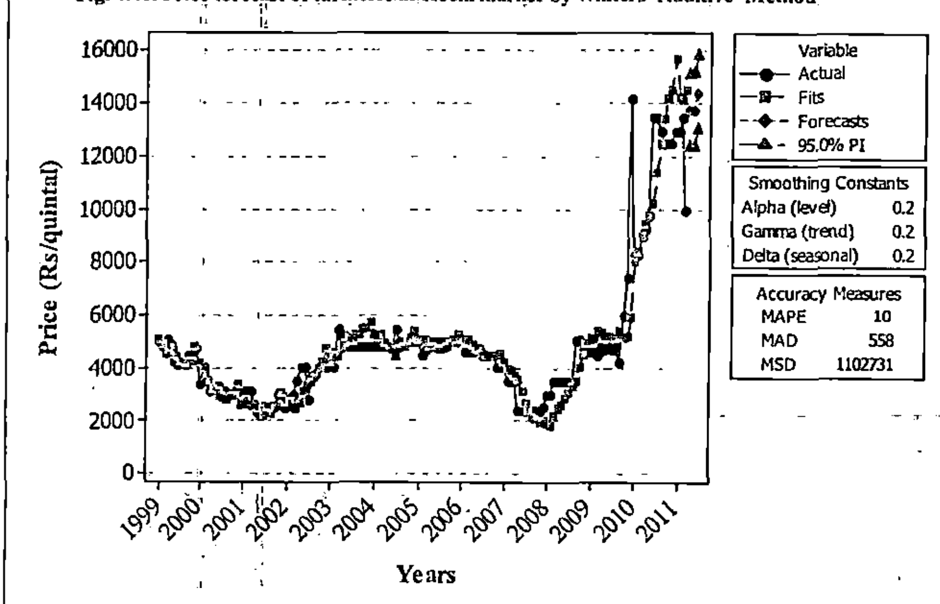


Fig. 4.40. Price forecast of turmeric at Kochi market by Winters' Additive Method



4.11.2. Validation of turmeric price forecast

The prices so forecasted by the considered best fit models across the selected markets are validated for the same period by comparing the actual modal price of the month with that of the predicted price, such that, the actual modal price for the particular month fall within the range of the predicted price or not.

4.11.2.1. Validation of turmeric price forecast for the month of March 2011

The validation of the prices using the actual modal prices that prevailed at Nizamabad market, Erode market and Kochi market during the month of March 2011 along with the forecasted prices is shown in Appendix IX. In all the selected markets, the monthly (March) modal price lies in the range of forecasted price of the reference commodity indicating that, the forecasted prices are reliable in the month of March, 2011.

4.11.2.2. Validation of turmeric price forecast for the month of April 2011

The forecasted prices of the reference commodity across the selected markets during the month of April 2011 were validated as in March and the details are shown in Appendix X. The forecasted prices are found to be reliable for April 2011 in all the selected markets as the monthly (April) modal price lies in the range of forecasted price of the reference commodity.

4.11.2.3. Validation of turmeric price forecast for the month of May 2011

The analysis is extended for the month of May, 2011 to validate the forecasted prices of the reference commodity across the selected markets. The findings shown in Appendix XI reveals that, the forecasted prices are found reliable in all the selected markets as the monthly (May) modal price lies in the range of forecasted price of the reference commodity for the May, 2011.

4.11.3. Accuracy of turmeric price forecast (%)

The accuracy of price forecast can be estimated by deducting the percentage ratio (the ratio will be obtained by taking the absolute deviation of actual modal price and predicted price to the predicted price. This ratio will be expressed in terms of percentage) from 100 and the details of accuracy of price forecast across the selected markets for the months of March, April and May of the year 2011 are portrayed in Table 4.31. As evident from the Table 4.31, the accuracy of price forecast (in terms of percentage) is above 90 both for turmeric (bulb) and turmeric (finger) in Nizamabad market (Double Exponential Smoothing method), turmeric (finger) in Erode market (Double Exponential Smoothing method) and turmeric in Kochi market (Winters' Multiplicative Method and Winters' Additive Method) implying that, the forecast is reliable for the selected commodity in all the selected markets.

Table 4.31. Per cent of forecast accuracy in selected markets

Market/Month & Year	Modal price	Predicted price		% of forecast accuracy
		Forecast	Range	
For turmeric bulb in Nizamabad market by Double Exponential Smoothing				
March 2011	85	83	74-96	98
April 2011	88	84	67-101	95
May 2011	77	85	60-109	91
For turmeric finger in Nizamabad market by Double Exponential Smoothing				
March 2011	97	94	84-105	97
April 2011	97	94	77-112	97
May 2011	89	95	70-120	94
For turmeric finger in Erode market by Double Exponential Smoothing				
March 2011	105	102	94-109	97
April 2011	97	102	88-117	95
May 2011	93	103	82-124	90
For turmeric in Kochi market by Winters' Multiplicative method				
March 2011	145	137	123-152	94
April 2011	125	133	118-148	94
May 2011	140	139	124-154	99
For turmeric in Kochi market by Winters' Additive method				
March 2011	145	137	124-151	94
April 2011	125	138	124-152	91
May 2011	140	144	130-159	97

Summary & Conclusion

5. SUMMARY AND CONCLUSION

Turmeric, though a native of South East Asia, is widely cultivated in India, China, Taiwan, Sri Lanka, Java, Peru, Australia and the West Indies. India is the largest producer, consumer and exporter of turmeric in the world. Turmeric occupies about 6 per cent of the total cultivated area under spices and condiments in India. At global level, India constitutes 78 per cent of total production of turmeric followed by China (8%), Myanmar (4%), Nigeria (3%) and Bangladesh (3%) during triennium ending 2008-09.

In India, the domestic consumption of turmeric accounts for nearly 94 per cent of total production, as it has diversified uses such as food adjunct in many vegetables, meat and fish preparations, colouring agent for cheese, pickles, liquor, fruit drinks, cakes, confectionery and food industry, as an ingredient in the preparation of medicinal oils and ointments. In view of its diversified uses, there is significant increase in area and productivity of turmeric at All-India level and hence in production during the overall reference period, 1980-81 to 2008-09. However, compared to pre-WTO regime (1980-81 to 1994-95), the growth in area and productivity of turmeric showed declining trend and hence, growth in production during post-WTO regime (1995-96 to 2008-09). Further, in the recent period, the prices of turmeric showed greater degree of fluctuations due to irregularity in the monsoon rains and consequent fluctuations in acreage under turmeric. This adversely influenced the trade prospects of turmeric from the country. Further, with the onset of trade liberalization, the international prices of turmeric are supposed to influence the domestic competitiveness of turmeric. It is against this background that the study entitled "Price behaviour of turmeric in India" was undertaken with the specific objective of investigating the secular trend, seasonality, cyclical and irregular movements in the price of turmeric in India and to evolve a reliable price forecasting model for turmeric.

The study was conducted during the year 2010-11 in three selected states viz., Kerala, Andhra Pradesh and Tamil Nadu. The study was based on secondary data published from various institutions and organization. Secondary data were collected from the head quarters of Spices Board, Kochi, the official website of Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi, Agmarknet and from various issues of Spices Board Journals.

The exponential function was found as the best fit to analyze the trends in area, production and productivity of turmeric at the All-India level and in the selected states. During mid-nineties and 2000-01, the actual area under turmeric was greatly increased at All-India level and this is due to favourable climatic conditions congenial for the cultivation of turmeric. In Kerala, with the advent of WTO regime and due to trade liberalization, the farmers have increased the area under turmeric to produce and export more. Regarding Andhra Pradesh, during the first decade of the 21st century, there is decline in area under turmeric cultivation due to decline in its export prospects. However, in Tamil Nadu, the actual area under turmeric cultivation showed frequent fluctuations compared to trend projections and this also proves the fluctuations in area in tune with the price volatility of turmeric in the state. The actual production of turmeric at All-India level and in selected states is below the trend projections for a significant period during post-WTO regime, due to both area and productivity fluctuations. Similarly, the actual productivity of turmeric at All-India level and in Kerala and Andhra Pradesh is below the trend projections for a significant period especially during the post-WTO regime. However, in Tamil Nadu, the actual productivity levels of turmeric are more than trend projections for most of the reference period and this infers that, weather uncertainties are less and further the varieties under cultivation are suiting to different agro-ecological farming situations.

With reference to CGR of area, production and productivity of turmeric at All-India level, compared to pre-WTO regime, the rate of growth in area and productivity of turmeric showed declining trend during post-WTO regime and hence, the growth rate in production also showed declining trend. This infers that, during post WTO regime, this crop has not received adequate attention, as the farmers might have shifted to other lucrative crops, which enjoy more export competitiveness in the international market. In Kerala, during the pre-WTO regime, the growth rates in area, production and productivity of turmeric showed declining trend and the declining trend in terms of area and production are more prominent during post-WTO regime compared to pre-WTO regime. In Andhra Pradesh, the rate of growth in area, production and productivity of turmeric showed declining trend during post-WTO regime compared to pre-WTO regime, but still, all the parameters showed positive and significant growth rates during the post-WTO regime. However, in Tamil Nadu, the crop witnessed insignificant growth rates in terms of area, production and productivity of turmeric during both the sub-periods.

The instability in area under turmeric is more in Tamil Nadu (even higher than at All-India level) followed by Andhra Pradesh and Kerala during the overall reference period (1980-81 to 2008-09). The comparative picture between Pre-WTO and Post-WTO regimes reveals that, instability in area under turmeric is declined during post-WTO regime compared to pre-WTO regime across all the states and at All-India level. However, with reference to production, the instability is highest in Andhra Pradesh (even higher than at All-India level) followed by Tamil Nadu and Kerala during the overall reference period (1980-81 to 2008-09). But, the instability in turmeric production declined during post-WTO regime compared to pre-WTO regime among all the selected states (except Kerala) and even at All-India level. For Kerala, the rise in instability under production during post-WTO regime is due to rise in area instability during post-WTO regime. The instability under turmeric productivity is highest in Andhra Pradesh (even higher than at All-India level) followed by Tamil Nadu and Kerala during the overall reference period (1980-81 to 2008-09). It is heartening to note that, the instability with reference to productivity declined during post-WTO regime compared to pre-WTO regime across all the selected states and at All-India level.

Turmeric exports occupy a meagre share in terms of turmeric production and total spices exports and the share of turmeric exports in total spices exports showed declining trend during the post-WTO regime. However, in terms of growth trends, during pre and post-WTO regimes, the exports of turmeric in terms of quantity, value and unit price showed significant positive growth rates. But, the rate of growth in exports in terms of the above parameters showed declining trend during post-WTO regime compared to pre-WTO regime, indicating that, India could not exploit the trade advantage with the opening up of market in the era of liberalized regime. But, the turmeric exports in terms of quantity, value and unit price showed more stability during post-WTO regime compared to pre-WTO regime, as indicated by the fall in CV. This is mainly due to regularity in the supply of turmeric into the international market with the advent of trade liberalization policies. Among total turmeric exports, India enjoys more reputation with respect to turmeric powder, turmeric dry and turmeric fresh exports and this infers that, over 85 per cent share of total turmeric exports value is realized from these three products. With reference to imports, they are not regular into the country during the pre-WTO regime, but they are regular and gained momentum during the post-WTO regime. This does not mean that, India is dependent on the member countries for turmeric, but these imports are meant for only maintaining the trade relationships with the member countries. This is further confirmed by the favourable net trade position of the country with reference to turmeric in the international market and high degree of instability of import trade of turmeric during the post-WTO regime.

Single exponential method was employed to analyze trends in prices of turmeric. In Kochi market, turmeric prices showed greater degree of fluctuations between January 1999 to September 2007 and the period beyond October, 2007 represents growth phase in turmeric prices. For turmeric (bulb) and turmeric (finger) in Nizamabad market, prices have not shown a specific trend, implying a greater degree of price volatality for these commodities. The trend behaviour of turmeric prices in Erode market are similar to Kochi market. ADF unit root test, Johansen's Multiple Co integration Analysis and Granger Causality Test are employed to study the market integration among selected markets. ADF unit root test revealed that, the ADF test values (levels) of the selected markets are higher than the critical value (1%) indicating that, the price series of turmeric across the markets are non-stationary and there is existence of unit root. However, after taking first difference, the ADF test values are below the critical value (1%) indicating the price series of turmeric are stationary across the markets and they are free from the consequence of unit root. Johansen's Multiple Co integration Analysis revealed that, the selected markets are having long run equilibrium relationship, as indicated by the significance of two co-integration equations. Granger Causality Test employed to ascertain the direction of causation of price influences across the markets revealed that, there exists only unidirectional causality from Nizamabad market to Kochi market, but there exists bi-directional causality between Erode and Kochi markets and between Erode and Nizamabad markets with reference to turmeric prices.

Seasonal indices of turmeric prices computed through employing ratio to moving average method revealed that, the domestic prices of turmeric exhibited considerable seasonality in all the selected markets. The buoyant phase for turmeric prices in Kochi market was during September to December, in Erode market during August to January, for turmeric (finger) in Nizamabad market the buoyant phase is between August to December and the same for turmeric bulb is between July to December. The depressed phase for turmeric prices in Kochi market was during February to August, in Erode market during

May to July, for turmeric (finger) in Nizamabad market the depressed phase is between February to July and the same for turmeric (bulb) is between February to June. The seasonal price behaviour further inferred that, it was almost similar among Kochi and Erode markets because of their proximity, while it was totally different for the Nizamabad market, as it is distantly separated compared to the earlier two markets. Cyclical variations in turmeric prices are more pronounced in all the selected markets. In Kochi market, the length of the cycle lasted for about six years, seven years for turmeric bulb and finger prices in Nizamabad market and six to seven years in Erode market. Residual method employed to study the irregular variations revealed that, the prices of turmeric across the selected markets and turmeric bulb prices in Nizamabad market were subjected to considerable irregular variations and these are due to supply shocks on account of climatic variations or market shocks on account of demand shocks or high speculative factors.

NPCs computed to analyze export competitiveness of turmeric in the international market revealed that, the domestic prices of turmeric are far below its international prices, indicating that, India enjoys more export competitiveness for turmeric in the international market.

Among different price forecasting methods considered for the study, double exponential smoothing was found to be the best model with MAPE value of 9 per cent for both Nizamabad and Erode markets, whereas Winters' multiplicative method and Winters' additive method were found to be the best with MAPE value of 10 per cent for Kochi market. The modal prices of three months fall in the range of forecasted prices in all the markets indicating that, the price forecasts were reliable. The accuracy percentage of turmeric price forecast ranges from 90 to 99 per cent.

The main findings of the study are

- ➢ The rate of growth in area, production and productivity of turmeric showed declining trend during post-WTO regime in India.
- ➢ India enjoyed favourable net trade position, as indicated by the significant positive growth rates in the exports of turmeric compared to import scenario.
- ➢ Turmeric enjoys more export competitiveness in the international market as indicated by the low NPC values.
- ➢ Single exponential smoothing was found as the best model in explaining the trend in turmeric prices.
- ➢ Mixed trend was observed which implies that turmeric prices were volatile.
- ➢ Domestic prices of turmeric exhibited considerable seasonality, cyclical and irregular variations in all the selected markets.
- ➢ Winters' (multiplicative and additive) method was found as the best price forecasting method for Kochi turmeric.
- ➢ Double exponential smoothing was found as the best price forecasting method for Nizamabad and Erode turmeric.
- ➢ Price forecasting of turmeric in major markets of the country was found reliable.

The following are the policy interventions formulated for boosting the production and trading scenarios of turmeric in the light of liberalized trade regime in relevance to the findings of the present study:

- Though India is the leading producer of turmeric in the world, it still lags behind in terms of productivity compared to other countries like China, Sri Lanka, Taiwan etc. In view of this, it is essential to strengthen R&D to develop and release HYV of turmeric and fine tune the crop production strategies with reference to different agro-ecological situations.

- The seasonal indices of prices indicated the higher prices of turmeric during July to December in Nizamabad market, September to December in Kochi market and August to December in Erode market indicating that, prices of the turmeric were higher during lean marketing season and vice versa. So the Market Committees should come forward to provide necessary storage facilities and other infrastructural facilities in order to avoid market glut and price.

- Majority (above 80%) of the turmeric is exported in fresh form. So, there is a greater need to establish processing units in the market areas to create value addition to the turmeric. These would help the farmers to get better income on the one hand and reducing price fluctuation on the other hand. For processing, modern technology should be employed, as the quality standards of the processed turmeric should match with the SPS standards prescribed by the importing countries.

- There is a greater need for the Government intervention in stabilizing the prices of turmeric in the forms of Market Intervention Scheme, institutional and legislative measures. The primary objectives behind interventions were to provide remunerative prices to the farmers, reduce price risks and uncertainty and to boost the trade prospects.

- Input price subsidies are at insignificant level for turmeric in the country. If input price subsidies had strained the public exchequer, it is likely that output price supports would also strain the exchequer much more. So, offering price support as an incentive for farmers to raise turmeric would certainly prove socially costly. Hence, extension of credit facilities to turmeric growing farmers and its regulation in order to allow them to adjust their decisions in line with market signals, while focusing on continuous yield improvements appears to be the most appropriate policy to boost turmeric production.

- Better information about the availability, location and prices of turmeric products and about what product attributes are valued by the customers could significantly enhance the functioning of the markets in the country. This will definitely help to improve export competitiveness of turmeric in the international market.

- Market information systems should be specifically designed for the turmeric and they should be piloted and scaled up where appropriate. Such activity would definitely reduce marketing margins, stabilize prices and boost the domestic and export competitiveness of turmeric.

- Even though India enjoys a near monopoly status in the field of turmeric exports, it has not fully captured the world market. In the light of this, it is essential for taking up priority interventions like strengthening agricultural innovation systems, enhancing the ability of farmers to respond to improving market signals, analyzing how to use existing trading systems effectively and determining the most appropriate targeting criteria for boosting the exports.

- Futures markets perform important functions like transferring the price risk and in facilitating the price discovery to the traders, processors, speculators etc. However, these markets are accessed by an insignificant number of farmers compared to other stakeholders of turmeric trade. In view of this, the farmers should be educated to utilize the futures contracts to hedge or insure their crops or inventories against the risk of fluctuating prices.

- The Government must resort to a variety of measures in the context of WTO that may be called as 'Market management policies'. These could include measures such as price controls through administrative orders, restrictions on stockholding by private traders, quality enhancement of turmeric on the lines of SPS standards fixed by the importing countries, restrictions on futures trading (when it causes severe price volatility), fine tuning the import tariff structure to check excessive imports, liberalizing the export policies, as India enjoys export competitiveness in the international market etc. Such well-designed complementary policy measures can encourage risk-averse turmeric farmers to take the risks necessary to invest on improved technologies. They can stimulate local market development, increasing volumes and reducing volatility. So, non-distorting safety net measures are essential to meet the investment and productivity growth of turmeric on one hand and price security to the turmeric farmers on the other. Such a twin-track approach provides a coherent policy strategy that avoids the price volatility of turmeric.

- Johansen test proves that, there exists long run structural relationship between the price series across the selected markets. In view of this, it is essential to formulate the strategies to reduce the price volatility of turmeric, as the turmeric prices behaviour in one state are transmitted fast across the states, thereby, posing profit risk to different stakeholders. At present, there is no risk management tool available for the traders, farmers, industry, exporters to hedge their risk out of price uncertainty. As India is having major share in the international turmeric export market, it is equally exposed to global price volatility which affects the trade from time to time and thus, on price. In such a scenario, offering future trading would provide an opportunity to the hedge risk for market participants against volatile price movements. Other factors that indicate success of future trading is well developed spot market and large number of participants such as traders, farmers, exporters, industrial consumer etc., that provide depth and width to the market.

Considering the above policy suggestions in the context of price volatility of turmeric, both production and export scenarios can be streamlined in the context of liberalized trade regime. However, keeping in view the prospects of domestic farmers and other stakeholders involved in turmeric trade, it is essential to focus on the following future lines of scientific investigation, so as to enhance the country's prospects in turmeric trade.

- Risk factors associated with production and trade of turmeric
- Demand and supply gap analysis both at domestic and international levels
- Quality standards of turmeric as per the Sanitary and Phyto-Sanitary standards (SPS) prescribed by the importing countries
- Subsidy allocation to the crop in the context of international price movements
- Streamlining and simplifying the procedural formalities at the ports for smooth EXIM trade

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Appendices

APPENDIX I

Models fitted to area of turmeric in India along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.875	238.798	-6.534E6	3.345E3		
Logarithmic	0.875	475998.6	-5.055E7	6.671E6		
Inverse	0.875	9.488E8	6.808E6	-1.330E10		
Quadratic	0.875	238.798	-6.534E6	3.345E3	.000	
Cubic	0.879	238.798	-6.534E6	3.345E3	.000	.000
Compound	0.883	0.002	2.303E-17	1.025		
Power	0.884	3.426	5.393E-161	50.124		
S	0.884	6819.35	61.938	-9.997E4		
Growth	0.883	0.002	-38.310	.025		
Exponential	0.890	0.002	2.303E-17	.025		
Logistic	0.883	0.002	4.341E16	.975		

Models fitted to area of turmeric in Kerala along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.430	9.830	-1.825E4	10.798		
Logarithmic	0.430	19600.18	-1.605E5	2.156E4		
Inverse	0.430	3.908E7	2.488E4	-4.306E7		
Quadratic	0.430	9.830	-1.825E4	10.798	.000	
Cubic	0.430	9.830	-1.825E4	10.798	.000	.000
Compound	0.410	0.003	6.182	1.003		
Power	0.410	5.813	6.329E-18	6.277		
S	0.420	11589.59	14.375	-1.253E4		
Growth	0.410	0.003	1.822	.003		
Exponential	0.450	0.003	6.182	.003		
Logistic	0.410	0.003	.162	.997		

APPENDIX II

Models fitted to area of turmeric in Andhra Pradesh along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.818	144.94	-3.205E6	1.632E3		
Logarithmic	0.819	288351.4	-2.468E7	3.255E6		
Inverse	0.820	5.737E8	3.305E6	-6.494E9		
Quadratic	0.818	144.94	-3.205E6	1.632E3	.000	
Cubic	0.818	144.94	-3.205E6	1.632E3	.000	.000
Compound	0.789	0.004	4.738E-29	1.039		
Power	0.790	7.368	7.462E-247	76.003		
S	0.791	14653.48	86.787	-1.516E5		
Growth	0.789	0.004	-65.219	.038		
Exponential	0.828	0.004	4.738E-29	.038		
Logistic	0.789	0.004	2.111E28	.963		

Models fitted to area of turmeric in Tamil Nadu along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.459	113.417	-1.106E6	564.483		
Logarithmic	0.459	226231.1	-8.529E6	1.125E6		
Inverse	0.458	4.513E8	1.144E6	-2.243E9		
Quadratic	0.460	0.028	-5.438E5	.000	.142	
Cubic	0.460	0.000	-3.563E5	.000	.000	4.736E-5
Compound	0.442	0.006	2.056E-22	1.030		
Power	0.442	12.412	1.613E-193	59.717		
S	0.441	24755.25	69.497	-1.190E5		
Growth	0.442	0.006	-49.936	.030		
Exponential	0.472	0.006	2.056E-22	.030		
Logistic	0.442	0.006	4.864E21	.970		

APPENDIX III

Models fitted to production of turmeric in India along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.860	1740.768	-4.514E7	2.289E4		
Logarithmic	0.860	3.471E6	-3.463E8	4.564E7		
Inverse	0.860	6.920E9	4.615E7	-9.101E10		
Quadratic	0.860	1740.768	-4.514E7	2.289E4	.000	
Cubic	0.860	1740.768	-4.514E7	2.289E4	.000	.000
Compound	0.850	0.004	2.342E-39	1.052		
Power	0.851	8.058	.000	102.020		
S	0.851	16030.83	115.090	-2.035E5		
Growth	0.850	0.004	-88.950	.051		
Exponential	0.860	0.004	2.342E-39	.051		
Logistic	0.850	0.004	4.269E38	.950		

Models fitted to production of turmeric in Kerala along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.446	28.971	-1.646E5	86.000		
Logarithmic	0.446	57763.55	-1.296E6	1.715E5		
Inverse	0.446	1.152E8	1.785E5	-3.421E8		
Quadratic	0.446	28.971	-1.646E5	86.000	.000	
Cubic	0.446	28.971	-1.646E5	86.000	.000	.000
Compound	0.460	0.004	1.242E-7	1.012		
Power	0.460	8.022	1.778E-78	24.723		
S	0.460	15993.72	33.545	-4.931E4		
Growth	0.460	0.004	-15.901	.012		
Exponential	0.470	0.004	1.242E-7	.012		
Logistic	0.460	0.004	8.049E6	.988		

APPENDIX IV

Models fitted to production of turmeric in Andhra Pradesh along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.819	1245.566	-2.779E7	1.406E4		
Logarithmic	0.819	2.483E6	-2.128E8	2.804E7		
Inverse	0.819	4.950E9	2.828E7	-5.591E10		
Quadratic	0.819	1245.566	-2.779E7	1.406E4	.000	
Cubic	0.819	1245.566	-2.779E7	1.406E4	.000	.000
Compound	0.856	0.006	3.184E-55	1.072		
Power	0.857	10.614	.000	137.774		
S	0.858	21107.43	150.063	-2.748E5		
Growth	0.856	0.005	-125.484	.069		
Exponential	0.861	0.005	3.184E-55	.069		
Logistic	0.856	0.005	3.140E54	.933		

Models fitted to production of turmeric in Tamil Nadu along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.328	788.89	-5.919E6	3.020E3		
Logarithmic	0.328	1.573E6	-4.564E7	6.020E6		
Inverse	0.327	3.137E9	6.121E6	-1.200E10		
Quadratic	0.328	0.198	-2.909E6	.000	.757	
Cubic	0.328	0.000	-1.905E6	.000	.000	.000
Compound	0.327	0.009	6.143E-24	1.033		
Power	0.327	16.895	7.105E-210	64.890		
S	0.327	33867.05	76.333	-1.294E5		
Growth	0.327	0.009	-53.447	.033		
Exponential	0.336	0.009	6.143E-24	.033		
Logistic	0.327	0.008	1.628E23	.968		

APPENDIX V

Models fitted to productivity of turmeric in India along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.703	10.367	-1.661E5	85.077		
Logarithmic	0.704	20653.28	-1.286E6	1.697E5		
Inverse	0.704	4.115E7	1.733E5	-3.385E8		
Quadratic	0.703	10.367	-1.661E5	85.077	.000	
Cubic	0.703	10.367	-1.661E5	85.077	.000	.000
Compound	0.715	0.003	1.016E-19	1.026		
Power	0.716	6.137	1.933E-168	51.898		
S	0.717	12218.50	60.062	-1.035E5		
Growth	0.715	0.003	-43.734	.026		
Exponential	0.720	0.003	1.016E-19	.026		
Logistic	0.715	0.003	9.847E18	.974		

Models fitted to productivity of turmeric in Kerala along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.449	3.952	-3.639E4	19.296		
Logarithmic	0.449	7883.203	-2.902E5	3.846E4		
Inverse	0.449	1.572E7	4.054E4	-7.667E7		
Quadratic	0.449	0.001	-1.716E4	.000	.005	
Cubic	0.450	0.000	-1.075E4	.000	.000	1.619E-6
Compound	0.426	0.002	2.013E-5	1.009		
Power	0.429	3.953	2.845E-58	18.445		
S	0.426	7883.912	26.076	-3.677E4		
Growth	0.426	0.002	-10.813	.009		
Exponential	0.452	0.002	2.013E-5	.009		
Logistic	0.426	0.002	4.967E4	.991		

APPENDIX VI

Models fitted to productivity of turmeric in Andhra Pradesh along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.673	18.265	-2.739E5	139.713		
Logarithmic	0.673	36422.64	-2.112E6	2.786E5		
Inverse	0.672	7.263E7	2.833E5	-5.555E8		
Quadratic	0.673	0.005	-1.346E5	.000	.035	
Cubic	0.673	0.000	-8.819E4	.000	.000	1.171E-5
Compound	0.703	0.004	6.722E-24	1.031		
Power	0.703	7.527	6.694E-201	61.770		
S	0.703	15002.57	70.184	-1.232E5		
Growth	0.703	0.004	-53.357	.031		
Exponential	0.723	0.004	6.722E-24	.031		
Logistic	0.703	0.004	1.488E23	.970		

Models fitted to productivity of turmeric in Tamil Nadu along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.420	20.315	-1.207E4	8.686		
Logarithmic	0.420	40506.79	-1.270E5	1.741E4		
Inverse	0.420	8.077E7	2.274E4	-3.489E7		
Quadratic	0.420	20.315	-1.207E4	8.686	.000	
Cubic	0.420	20.315	-1.207E4	8.686	.000	.000
Compound	0.432	0.004	29.905	1.003		
Power	0.432	7.632	4.435E-14	5.172		
S	0.432	15217.67	13.743	-1.035E4		
Growth	0.432	0.004	3.398	.003		
Exponential	0.434	0.004	29.905	.003		
Logistic	0.430	0.004	.033	.997		

APPENDIX VII

Models Fitted to turmeric prices in Kochi market along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.242	49.678	-6.713E5	337.227		
Logarithmic	0.242	99596.46	-5.131E6	6.755E5		
Inverse	0.242	1.997E8	6.798E5	-1.353E9		
Quadratic	0.243	0.012	-3.335E5	.000	.084	
Cubic	0.243	0.000	-2.209E5	.000	.000	2.801E-5
Compound	0.217	0.009	3.242E-43	1.054		
Power	0.217	16.778	.000	106.152		
S	0.217	33635.61	114.469	-2.127E5		
Growth	0.217	0.008	-97.835	.053		
Exponential	0.217	0.008	3.242E-43	.053		
Logistic	0.217	0.008	3.085E42	.948		

Models Fitted to turmeric (bulb) prices in Nizamabad market along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.335	34.301	-6.709E5	336.471		
Logarithmic	0.335	68711.62	-5.115E6	6.732E5		
Inverse	0.334	1.376E8	6.755E5	-1.347E9		
Quadratic	0.336	0.009	-3.343E5	.000	.084	
Cubic	0.336	0.000	-2.221E5	.000	.000	2.801E-5
Compound	0.490	0.007	2.313E-77	1.096		
Power	0.490	13.637	.000	184.117		
S	0.489	27315.23	191.774	-3.686E5		
Growth	0.490	0.007	-176.461	.092		
Exponential	0.490	0.007	2.313E-77	.092		
Logistic	0.490	0.006	4.324E76	.912		

APPENDIX VIII

Models Fitted to turmeric (finger) prices in Nizamabad market along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.308	39.756	-7.081E5	355.030		
Logarithmic	0.307	79658.31	-5.399E6	7.105E5		
Inverse	0.307	1.596E8	7.129E5	-1.422E9		
Quadratic	0.308	0.010	-3.529E5	.000	.089	
Cubic	0.309	0.000	-2.345E5	.000	.000	2.955E-5
Compound	0.400	0.008	1.581E-69	1.087		
Power	0.400	15.236	.000	166.106		
S	0.399	30529.04	173.792	-3.325E5		
Growth	0.400	0.008	-158.420	.083		
Exponential	0.400	0.008	1.581E-69	.083		
Logistic	0.400	0.007	6.325E68	.920		

Models Fitted to turmeric (finger) prices in Erode market along with Adjusted R^2 Values and Standard Errors (SE)

Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
Linear	0.381	35.100	-7.577E5	380.007		
Logarithmic	0.380	70316.59	-5.777E6	7.604E5		
Inverse	0.380	1.409E8	7.631E5	-1.522E9		
Quadratic	0.381	0.009	-3.775E5	.000	.095	
Cubic	0.382	0.000	-2.507E5	.000	.000	3.163E-5
Compound	0.541	0.007	2.252E-81	1.101		
Power	0.541	12.941	.000	193.527		
S	0.541	25920.59	201.356	-3.874E5		
Growth	0.541	0.006	-185.698	.097		
Exponential	0.541	0.006	2.252E-81	.097		
Logistic	0.541	0.006	4.441E80	.908		

APPENDIX IX

Validation of turmeric price forecast for the month of March 2011

Date	Day	Nizamabad Bulb price (Rs/Kg)	Nizamabad Finger price (Rs/Kg)	Erode Finger price (Rs/Kg)	Kochi price (Rs/Kg)
1/03/2011	Tuesday	93	105	111	100
2/03/2011	Wednesday	93	105	111	100
3/03/2011	Thursday	94	103	109	NR
4/03/2011	Friday	93	103	109	150
5/03/2011	Saturday	94	105	110	150
6/03/2011	Sunday	95	107	111	150
7/03/2011	Monday	97	105	116	NR
8/03/2011	Tuesday	100	105	109	150
9/03/2011	Wednesday	100	105	109	150
10/03/2011	Thursday	100	105	109	150
11/03/2011	Friday	100	100	107	150
12/03/2011	Saturday	97	100	107	150
13/03/2011	Sunday	95	97	105	150
14/03/2011	Monday	95	97	108	NR
15/03/2011	Tuesday	95	97	105	145
16/03/2011	Wednesday	90	100	105	145
17/03/2011	Thursday	90	97	105	145
18/03/2011	Friday	85	97	105	145
19/03/2011	Saturday	85	97	105	145
20/03/2011	Sunday	85	97	105	145
21/03/2011	Monday	85	NR	NR	NR
22/03/2011	Tuesday	85	97	100	145
23/03/2011	Wednesday	85	95	93	145
24/03/2011	Thursday	85	90	95	145
25/03/2011	Friday	75	85	95	145
26/03/2011	Saturday	77	83	93	145
27/03/2011	Sunday	77	83	93	145
28/03/2011	Monday	NR	NR	95	NR
29/03/2011	Tuesday	77	85	95	115
30/03/2011	Wednesday	77	85	95	115
31/03/2011	Thursday	NR	NR	93	113
	Modal price	85	97	105	145
	Predicted price	74-96 (DES)	84-105 (DES)	94-109 (DES)	123-152 (WMM)
					124-151 (WAM)

Note: NR-Not reported, DES-Double Exponential Smoothing, WMM-Winters' Multiplicative Method, WAM-Winters' Additive Method

APPENDIX X

Validation of turmeric price forecast for the month of April 2011

Date	Day	Nizamabad Bulb price (Rs/Kg)	Nizamabad Finger price (Rs/Kg)	Erode Finger price (Rs/Kg)	Kochi price (Rs/Kg)
1/04/2011	Friday	NR	NR	97	113
2/04/2011	Saturday	88	97	97	113
3/04/2011	Sunday	88	97	97	113
4/04/2011	Monday	88	97	NR	NR
5/04/2011	Tuesday	88	97	97	113
6/04/2011	Wednesday	88	NR	100	125
7/04/2011	Thursday	88	97	108	125
8/04/2011	Friday	88	97	110	125
9/04/2011	Saturday	88	97	110	125
10/04/2011	Sunday	88	97	110	125
11/04/2011	Monday	88	92	NR	NR
12/04/2011	Tuesday	85	92	NR	NR
13/04/2011	Wednesday	85	92	91	125
14/04/2011	Thursday	80	85	91	NR
15/04/2011	Friday	80	85	91	125
16/04/2011	Saturday	80	85	91	125
17/04/2011	Sunday	79	85	93	125
18/04/2011	Monday	79	89	93	NR
19/04/2011	Tuesday	79	89	96	125
20/04/2011	Wednesday	79	89	98	120
21/04/2011	Thursday	75	90	93	120
22/04/2011	Friday	70	85	93	113
23/04/2011	Saturday	70	85	NR	NR
24/04/2011	Sunday	70	85	97	120
25/04/2011	Monday	70	83	97	NR
26/04/2011	Tuesday	70	83	97	120
27/04/2011	Wednesday	70	80	96	120
28/04/2011	Thursday	70	80	NR	120
29/04/2011	Friday	70	80	95	113
30/04/2011	Saturday	70	80	95	NR
	Modal price	88	97	97	125
	Predicted price	67-101 (DES)	77-112 (DES)	88-117 (DES)	118-148 (WMM)
					124-152 (WAM)

Note: NR-Not reported, DES-Double Exponential Smoothing, WMM-Winters' Multiplicative Method, WAM-Winters' Additive Method

APPENDIX XI

Validation of turmeric price forecast for the month of May 2011

Date	Day	Nizamabad Bulb price (Rs/Kg)	Nizamabad Finger price (Rs/Kg)	Erode Finger price (Rs/Kg)	Kochi price (Rs/Kg)
1/05/2011	Sunday	70	80	90	113
2/05/2011	Monday	70	80	90	113
3/05/2011	Tuesday	77	89	90	140
4/05/2011	Wednesday	77	89	93	140
5/05/2011	Thursday	77	89	93	150
6/05/2011	Friday	77	89	93	150
7/05/2011	Saturday	77	89	NR	150
8/05/2011	Sunday	77	89	93	150
9/05/2011	Monday	77	89	93	150
10/05/2011	Tuesday	77	89	93	150
11/05/2011	Wednesday	70	80	94	140
12/05/2011	Thursday	70	78	93	140
13/05/2011	Friday	70	78	93	140
14/05/2011	Saturday	70	78	88	140
15/05/2011	Sunday	70	79	88	140
16/05/2011	Monday	NR	NR	88	140
17/05/2011	Tuesday	70	80	85	140
18/05/2011	Wednesday	70	75	80	140
19/05/2011	Thursday	70	80	82	140
20/05/2011	Friday	69	77	NR	140
21/05/2011	Saturday	77	89	81	135
22/05/2011	Sunday	77	89	81	135
23/05/2011	Monday	77	89	81	135
24/05/2011	Tuesday	77	88	78	135
25/05/2011	Wednesday	77	89	79	135
26/05/2011	Thursday	77	89	74	135
27/05/2011	Friday	77	88	74	135
28/05/2011	Saturday	75	80	79	135
29/05/2011	Sunday	75	80	79	135
30/05/2011	Monday	75	80	79	135
31/05/2011	Tuesday	75	80	79	135
	Modal price	77	89	93	140
	Predicted price	60-109 (DES)	70-120 (DES)	82-124 (DES)	124-154 (WMM)
					130-159 (WAM)

Note: NR-Not reported, DES-Double Exponential Smoothing, WMM-Winters' Multiplicative Method, WAM-Winters' Additive Method

PRICE BEHAVIOUR OF TURMERIC IN INDIA

By

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ABSTRACT OF THE THESIS

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ABSTARCT

The present study on the "Price behaviour of turmeric in India" was undertaken with the specific objective of investigating the secular trend, seasonality, cyclical and irregular movements in the price of turmeric in India and to evolve a reliable price forecasting model for turmeric. The study was conducted during the year 2010-11 with reference to three major markets in the country viz., Kochi, Nizamabad and Erode markets employing secondary data.

With reference to CGR of area, production and productivity of turmeric at All-India level, compared to pre-WTO regime, the rate of growth in area and productivity of turmeric showed declining trend during post-WTO regime and hence, growth rate in production also showed declining trend. Both in Kerala and Andhra Pradesh, the crop has not received due attention during post-WTO regime compared to pre-WTO regime, as indicated by the declining trends in terms of area, production and productivity. However, in Tamil Nadu, the crop witnessed insignificant growth rates in terms of area, production and productivity of turmeric during both pre-WTO and post-WTO regimes. Despite slow growth in production of turmeric in the era of liberalized regime, India enjoyed favourable net trade position, as indicated by the significant positive growth rates in the exports of turmeric in terms of quantity, value and unit price compared to import scenario. Further, the instability in exports of turmeric declined during post-WTO regime compared to pre-WTO regime, as indicated by the fall in CV. However, there is much scope to increase the export prospects of turmeric, as even today, India's export basket comprises of fresh produce only rather than processed products. This favourable net trade position is further confirmed by the low NPCs indicating that, India enjoys more export competitiveness for turmeric in the international market.

Regarding price behaviour, the analysis based on single exponential method revealed that, in Kochi and Erode markets, turmeric prices showed greater degree of fluctuations up to September 2007 and the period beyond October, 2007 represents growth phase in turmeric prices. For turmeric (bulb) and turmeric (finger) in Nizamabad market, prices have not shown a specific trend, implying a greater degree of price volatality for these commodities.

Market integration study was conducted considering the spot prices of turmeric at the selected markets by employing the Johansen multiple co integration analysis. The two co-integration equations were found to be significant at five per cent level, indicating that, the selected markets are having long run equilibrium relationship.

Seasonal indices of turmeric prices computed through employing ratio to moving average method revealed that, the domestic prices of turmeric exhibited considerable seasonality in all the selected markets. The seasonal price behaviour further inferred that, it was almost similar among Kochi and Erode markets because of their proximity, while it was totally different for the Nizamabad market, as it is distantly separated compared to the earlier two markets. Cyclical variations in turmeric prices are more pronounced in all the selected markets. In Kochi market, the length of the cycle lasted for about six years, seven years for turmeric bulb and finger prices in Nizamabad market and six to seven years in Erode market. Turmeric prices were subjected to considerable irregular variations and these are due to supply shocks on account of climatic variations or market shocks on account of demand shocks or high speculative factors.

Different price forecasting methods were employed viz., double exponential smoothing (Nizamabad and Erode markets) and Winters' multiplicative method and Winters' additive method (Kochi market) for price forecasting of turmeric during the months of March, April and May, 2011 and the findings revealed that, the modal prices of three months fall in the range of forecasted prices across all the markets indicating that, the price forecasts were reliable. The accuracy percentage of turmeric price forecast ranges from 90 to 99 per cent. The prices so forecasted across the markets are validated for the same period and the findings revealed that, the monthly modal prices of selected commodity fall within the range of predicted prices.. The accuracy percentage of price forecast is above 90 for the reference commodity and this implies that the forecast is reliable in all the selected markets.

Considering the above findings with reference to production and trading scenarios of turmeric, it is essential to formulate multi-pronged strategy such as strengthening R&D to develop and release HYV of turmeric and fine tune the crop production strategies with reference to different agro-ecological situations, strengthening processing, storage and market information network, effective implementation of Market Intervention Scheme, improving the access of farmers towards futures markets to overcome price risk, quality enhancement of turmeric on the lines of SPS standards fixed by the importing countries, price forecasting to regulate area and production of turmeric in tune of its export prospects etc., so as to enhance both domestic and export competitiveness and to gain due share in the international market.