PRICE BEHAVIOUR OF NATURAL RUBBER IN INDIA

By

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(2009-11-112)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Agriculture

Faculty of Agriculture
Kerala Agricultural University, Thrissur

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COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2011

DECLARATION

I, hereby declare that this thesis entitled **"Price behaviour of natural rubber in India"** is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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ACKNOWLEDGEMENT

First and foremost I bow my head before the Almighty God who enabled me to successfully complete the thesis work in time.

With immense pleasure I avail this opportunity to express my deep sense of reverence, gratitude and indebtedness to my major advisor ***Dr. K. Satheesh Babu,*** *Professor, Department Agricultural Economics and Chairperson of my Advisory Committee for his sustained and valuable guidance, constructive suggestions, unfailing patience, constant support and encouragement during the course of this research work and preparation of the thesis.*

I sincerely thank ***Dr. Jesy Thomas K.,*** *Professor and Head, Department of Agricultural Economics, College of Horticulture, Vellanikkara and member of my Advisory Committee for her unwavering encouragement, valuable suggestions, well timed mental support and help rendered which made the successful completion of this thesis.*

I am deeply indebted to ***Dr. E. K. Thomas,*** *Professor, Department of Agricultural Economics, College of Horticulture, Vellanikkara and member of my advisory committee for his constructive criticism, precious suggestions and generous support during the entire study and completion of the thesis.*

I deeply express my whole hearted thanks to ***Dr. C. Laly John,*** *Associate Professor, Department of Agricultural Statistics, College of Horticulture, Vellanikkara and member of my advisory committee for her wholehearted* cooperation, valuable suggestions during various stages of the study and critical scrutiny of the manuscript.

Words cannot really express the true friendship that I experienced from **Swapna chechi, Jayasree chechi, Anjaly chechi and Silja chechi** for the heartfelt help, timely suggestions and back-up which gave me enough mental strength for the successful completion of my thesis work.

I have no words to express my deep sense of gratitude to my dear friends **Chandana, Divya, Jyothi, Malu, Raji, Anu, Lisma, Seeshma, Susha and all my M.Sc. Classmates and Juniors,** for their moral support and encouragement.

I thank Mr. Aravind, Computer Club, College of Horticulture, for his valuable help in computer work. .

I deeply indebted to **my Parents and brother** without whose moral support, blessings and affection this would not have been a success. It would be impossible to list out all those who have helped me in one way or another in the successful completion of this work. I once again express my heartful thanks to all those who helped me in completing this venture in time.

Reeja Varghese

Dedicated

to

my beloved parents and brother

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Introduction

1. INTRODUCTION

The Para rubber, *Hevea brasiliensis* is the most important source of natural rubber (NR) and meets around 98 per cent of the global requirement. It is a native of Amazon basin and introduced from there to countries in the tropical belts of Asia and Africa during the late 19th century. The rubber plantation industry in India has completed more than a century of growth since the crop was first introduced in the country on a commercial scale in 1902. Over the years, this industry has registered a spectacular growth in terms of expansion in area, increase in production, productivity, and a wide array of rubber based ancillary units. About 50,000 products are manufactured out of this versatile raw material and it supports an annual turnover of more than Rs.15, 000 crores (Varghese *et al.*, 2006). On account of the multifarious and increasing uses for which rubber is being put to the consumption of NR in the world as well as in India has been increasing steadily. This is expected to bring buoyancy to NR prices globally in the years to come.

1.1 GLOBAL SCENARIO OF NR

Asian countries dominated the NR sector, occupying 93 per cent of the total area under rubber cultivation in the world. Indonesia is having the largest area under rubber cultivation (34 lakh ha), followed by Thailand (31 lakh ha), Malaysia (10.20 lakh ha), China (9 lakh ha), and finally India is in fifth position with an area of 6.55 lakh ha during the year 2008-09 (ANRPC, 2010 a).

The total NR production during 2009-10 was 9.62 million tonnes and about 81 per cent of it is contributed by the major producers of rubber in Asia. Thailand is the largest producer of NR with an annual production of 31.64 lakh tonnes, contributing to 32.90 per cent of the world NR production (Table 1.1), followed by Indonesia with 24.40 lakh tonnes (25.50%), and Malaysia with 8.56

Table 1.1 Production of NR in the World (Tonnes)

Country	1980	1985	1990	1995	2000	2005	2009
Thailand	501 (13.50)	724 (17.67)	1275 (25.86)	1805 (31.10)	2346 (36.87)	2937 (33.10)	3164 (32.90)
Indonesia	1020 (27.42)	1130 (27.57)	1262 (25.60)	1455 (25.07)	1501 (23.60)	2271 (25.57)	2440 (27.37)
Malaysia	1530 (41.13)	1470 (35.87)	1291 (26.20)	1089 (18.76)	615 (9.67)	1126 (12.68)	856 (8.90)
India	155 (4.17)	198 (4.83)	324 (6.60)	500 (8.60)	629 (9.90)	772 (8.70)	820 (8.50)
Vietnam	46 (1.24)	52 (1.27)	103 (2.10)	154 (2.65)	291 (4.60)	469 (5.28)	724 (7.53)
China	113 (3.04)	188 (4.60)	264 (5.35)	424 (7.30)	445 (7.00)	510 (5.74)	637 (6.62)
Others	355 (9.54)	336 (8.20)	441 (8.90)	377 (6.50)	436 (6.85)	797 (9.00)	976 (10.15)
Total	**3720 (100.00)**	**4098 (100.00)**	**4930 (100.00)**	**5804 (100.00)**	**6363 (100.00)**	**8882 (100.00)**	**9617 (100.00)**

Source: Rubber Board, 2010 a

Figures in parentheses indicate percentage to the respective totals

lakh tonnes (8.90%). India is the fourth largest producer of NR with 8.64 lakh tonnes and contributing to 8.53 per cent of the world NR production during 2008-09 period (Rubber Board, 2010 a). Thailand was the major producer of NR in the world by contributing 31 per cent of the world production and India was in fourth position with 9 per cent of the world NR production during mid nineties (Fig.1.1). An increase in NR production was noticed in Thailand, India and Vietnam by 2000, whereas the production declined in Malaysia from 19 per cent during 1995 to 10 per cent by 2000 (Fig.1.2).

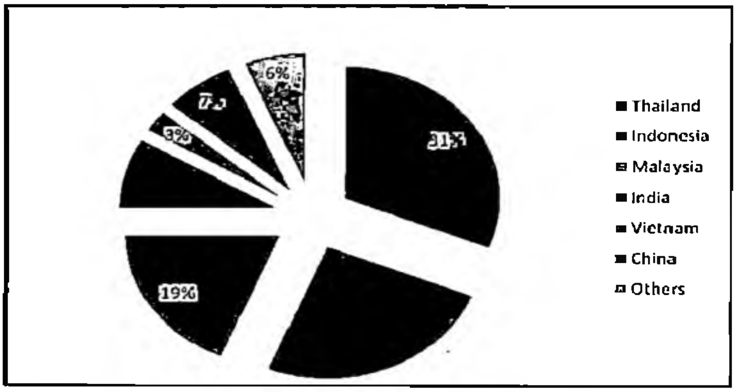

Fig. 1.1 World NR production -1995

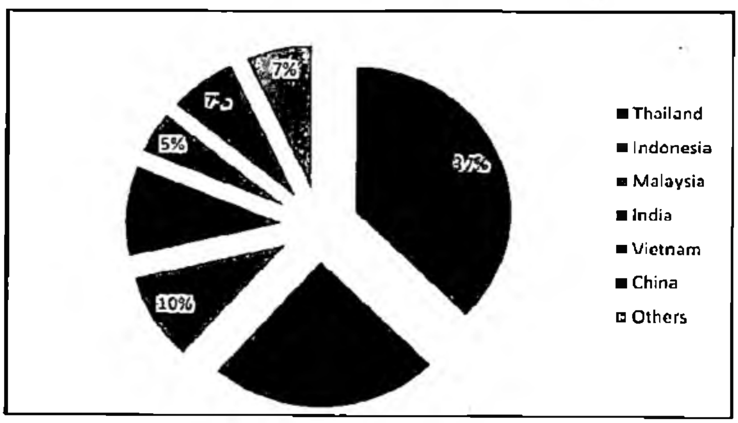

Fig. 1.2 World NR production -2000

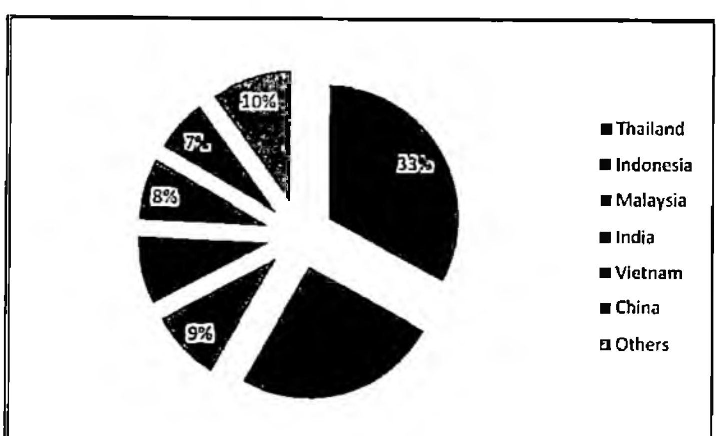

Fig. 1.3 World NR production -2009

The NR production in India decreased by 2009 due to adverse weather conditions, while the production of China remained fairly stagnant during this period (Fig.1.3). It was Vietnam that showed consistent increase in NR production throughout the period under reference. Its share increased from mere 5 per cent in 2000 to 8 per cent in 2009.

It is widely believed that this country is expected to emerge as a great competitor in the NR production and export soon. The major rubber exporting countries in the world are Malaysia (28.8%), USA (17.7%), China (11.8%) and Pakistan (4.7%) during 2008-09. Major importers of NR in the world are China, USA, Japan and India. The consumption of NR in the world during 2009-10 was 9.39 million tonnes. The major NR consuming countries in the world are China (37 %), India (9.64%), USA (7.32%) and Japan (6.77%). India has now overtaken USA and Japan in NR consumption and emerging as the second largest consumer after China (Rubber Board, 2010 c).

1.2 INDIAN SCENARIO OF NR

In India the rubber producing areas are divided in to two zones, the traditional zone comprising of Kerala and Kanyakumari district in Tamil Nadu, and non traditional zone comprising of coastal regions of Karnataka, Goa, Andhra Pradesh, Orissa, Parts of Maharashtra, Tripura and Andaman and Nicobar Islands. Rubber plantations are spread over 6.87 lakh hectares in the country. Small holdings, accounting for 88 per cent of the NR production and area in India with an average size of 0.53 ha dominate the production sector. Nearly one million producers and about 0.4 million workers are engaged in the plantation sector. The farm gate price realization in India remains the highest in the world (Rubber Board, 2010 a).

The area, production and productivity of NR have been increasing steadily over the years (Table 1.2 and Fig.1.4). Though in terms of production of NR, India's position is only fourth, the country has attained the first position in yield among the major producing countries. The productivity of NR in India during 2009-10 was 1784 Kg/ha (Rubber Board, 2010 b).

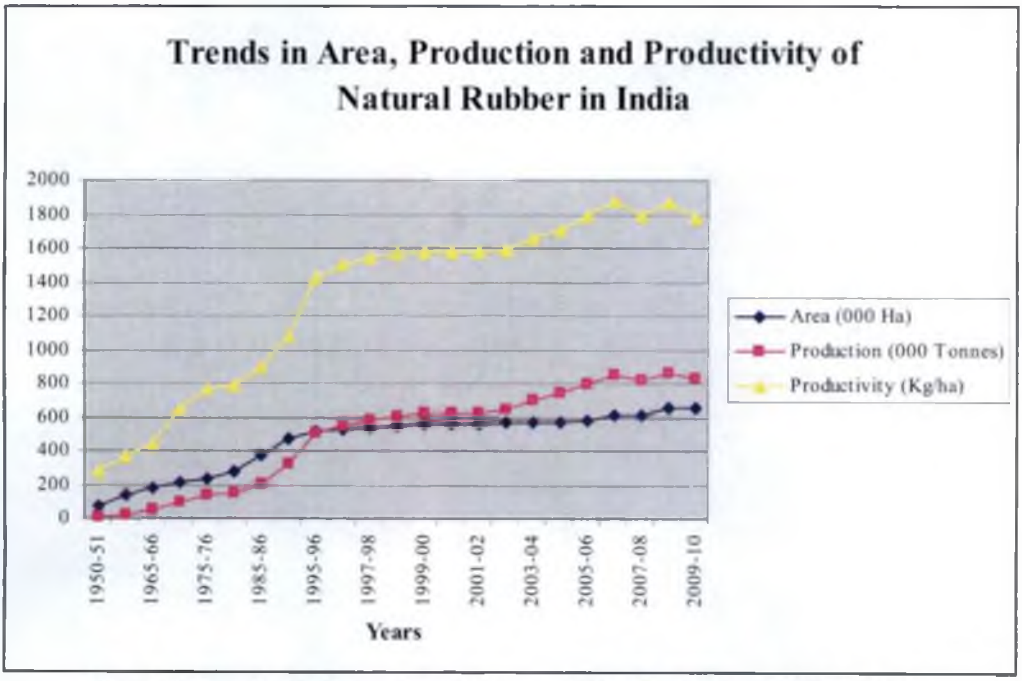

Fig. 1.4 Trends in Area, Production and Productivity of NR in India

In India, Kerala alone account for 81.67 per cent of the total NR growing area and 91.50 per cent of the India's NR production. The NR production in Kerala was 7.83 lakh tonnes during 2008-09 indicating a 4.03 per cent increase over the previous year. The increasing trend in productivity continued during 2008-09 and was 1514Kg/ha (Government of Kerala, 2009).

The total consumption of NR in India in 2009-10 was 9.30 lakh tonnes with a growth rate of 6.8% and emerging as the second largest consumer of NR after China. During the year 2009-10, there was a considerable increase in consumption of NR in the rubber goods manufacturing sector (Rubber Board, 2010 c). The total import of NR in India during 2009-10 was 1.76 lakh tonnes and the quantity exported was only 25,090 tonnes. India is importing NR from USA, Canada, Germany, UK, France, Belgium, Thailand and Malaysia.

Table 1.2 Area, Production and Productivity of NR in India

Year	Area (Hectare)	Production (Tonnes)	Productivity (Kg/ha)
1950-51	74915	15800	284
1960-61	143905	25697	365
1970-71	217198	92171	653
1975-76	235876	137750	772
1980-81	284166	153100	788
1985-86	382831	200465	898
1990-91	475083	329615	1076
1995-96	524075	506910	1422
1996-97	533246	549425	1503
1997-98	544534	583830	1549
1998-99	554000	605045	1563
1999-00	558584	622265	1576
2000-01	562670	630405	1576
2001-02	566558	631400	1576
2002-03	570000	649000	1592
2003-04	573980	708000	1663
2004-05	578000	749000	1705
2005-06	581000	802625	1796
2006-07	615000	853000	1879
2007-08	615000	823000	1800
2008-09	655000	864500	1867
2009-10	662000	831400	1784

Source: Rubber Board, 2010 a

1.3 IMPORTANCE OF THE STUDY

The agricultural market environment is changing with unprecedented speed and in very diverse ways both locally and globally. These dynamics affect farm prices and thereby farm income. The majority of the rural producers are unable to understand and interpret the market and price behaviour into their advantages (Ajjan *et al.*, 2009 b).The study of temporal and spatial variations in the price of agricultural commodities provides a better insight to design and implement appropriate policies for reducing price fluctuations. This will not only benefit the producers, but the consumers as well as the traders. Instability in farm income dampens the producer's enthusiasm to invest in the agricultural sector, which in turn results in reduced production and productivity.

1.4 OBJECTIVES OF THE STUDY

The present study entitled **"Price Behaviour of Natural Rubber in India"** is undertaken against this background, with the specific objectives of investigating the secular trend, seasonality, cyclical and irregular movements in the price of NR in India, and to evolve a reliable price forecasting model.

1.5 LIMITATIONS OF THE STUDY

The analysis is being carried out using secondary data on monthly prices of NR at Kottayam and Bangkok markets. The market dynamics in any commodity markets are complex and being influenced by many factors like price of competing commodities (synthetic rubber for instance), area, production and productivity of the crop in other producing countries, consumption pattern, export and import policy changes etc. However, due to non availability of up-to-date monthly time series data on such parameters, a multivariate Auto Regressive Integrated Moving Average (ARIMA) could not be attempted. Instead, a univariate time series analysis only could be attempted.

1.6 ORGANIZATION OF THE THESIS

The study is organized in to five chapters including the present one. Chapter two is a review of literature relevant to the study. The third chapter deals with brief description of the methodological aspects, analytical tools and conceptual issues. The results of the study and discussion of the findings are presented in chapter four. The fifth chapter summarizes the major findings and conclusions drawn from the analysis, along with the policy implications thereof.

Review of Literature

2. REVIEW OF LITERATURE

A comprehensive review of the past literature is useful to formulate concepts, methodologies and tools of analysis to be used for any research. In this chapter an attempt has been made to review the important past studies relevant to the present study from the point of view of objectives as well as methodology. The review of literature is presented under the following heads:

2.1 PRICE BEHAVIOUR

Prices in general are volatile. Prices of farm products fluctuate more than those of industrial goods. Remunerative and steady price for any agricultural produce plays a crucial role in increasing production of that commodity. Wide price fluctuations, on the other hand, discourage farmers from taking up large-scale investment to improve productivity. Moreover, rubber being a perennial crop, which involves high investment when compared to seasonal and annual crops, price and price behavior, assumes more significance. It will provide valuable information about the different components of the price and their interplay that will be of interest to millions of growers, traders and the processing industry, which is heavily dependent on the commodity.

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. Therefore, the price behaviour is reviewed under the above four headings.

2.1.1 Secular Price Movements

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).

The tendency of prices to move up or down over a longer period of time is termed as trend or secular price movements. A trend is usually established based on at least 10 to 15 years data. The long-term trend in 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).

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.

Krishnankutty (1989) studied the secular trend in the price of construction timber in Kerala for the period from 1956-57 to 1984-85. Moving averages of real prices were used in order to smoothen out the effect of year to year fluctuations in prices. From the real prices plotted, it was observed that the real price was increasing over the whole period. But the increase was not monotonic and three distinct periods could be identified during which the prices followed more or less linear pattern. It was found that prices registered a small decline prior to the period from 1966 to 1969 but thereafter increased at a normal rate. The period from 1976-77 to 1984-85 was characterized by a drastic increase in prices, which could be due to stoppage of clear felling of natural forest and the consequent drastic reduction in the timber supply.

Agarwal and Sharma (1990) analyzed inter and intra year price variation in pulse crops in Rajasthan during the period from 1975 to 1990. The result showed that prices of pulses exhibited a general increasing trend over the whole period of study. The annual compound growth rate was high indicating that the rate of price increase was high for all the pulse crops.

Borah and Dutta (1991) studied the price behaviour of rape and mustard in Assam during the period from 1971-72 to 1989-90. They fitted linear trend equation to the wholesale price data of both the crops. The study revealed the existence of a positive price trend for rape and mustard in all the major markets of Assam.

Kesavan and Geetha (1992) subjected the wholesale price data of dairy and meat products from the four metropolitan centres of India for the period from 1978 to1989 to trend analysis using simple linear equation. The trend analysis showed that the prices of milk always showed an upward trend, which could be due to the pressure of demand from the ever increasing population as well as the influence of cost factors.

Nawadkar *et al.* (1992) analyzed the arrivals and prices of selected commodities at Gultekadi regulated market in Pune district in Maharashtra. The analysis was carried out for the period from 1983-84 to 1990-91 using data from annual reports of the market committee. An increasing trend was observed for the average price of all cereals, sesame and chickpea during the period.

Salam *et al.* (1992) analyzed the trends in cashew production in Kerala. They fitted trend lines to the area, production and productivity indices using linear, quadratic, exponential, modified exponential and logistic functions. As these functional forms did not yield a satisfactory fit in terms of R^2 values and standard errors, a three year moving average was used to depict the trend.

Selvarajan *et al.* (1993) examined the data on the wholesale price of potato in Nilgiri district for a period of 30 years from 1961-62 to 1990-91. The trend value was calculated for production and price by using a second-degree polynomial function and noted that the prices in general exhibited an increasing trend though wide spread seasonal fluctuations were there.

Lekshmi *et al.* (1996) attempted to delineate the secular trend of natural rubber price, covering a period of 27 years from 1967-68 to 1994-95. The trend in price was examined by using a random test supplemented by an analysis of three-year moving average intended to even the seasonal fluctuations to capture the secular trend in price movements. A semi-log quadratic equation was fitted to detect the direction of price movements. The analysis revealed that natural rubber price in India did not show any statistically significant trend to move consistently towards particular direction in the long run.

Hosmani (2001) conducted a trend analysis in price of groundnut and cotton using the monthly market prices. 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.

Kanchana (2002) analyzed the trend, cyclical, seasonal and irregular variations in seed, oil and oil cake prices of groundnut and gingelly in Tamil Nadu. The time series data on wholesale prices in groundnut and gingelly for the period from 1985-86 to 1999-2000 were used for the analysis. The linear trend equation fitted for price data revealed the existence of positive trend in prices of oilseeds, oils and oilcakes of groundnut and gingelly.

Pradeep (2003) estimated the trends in tapped area, production, yield and consumption of natural rubber in India during the period from 1960-61 to 2000-01 using different functional forms like linear, compound, quadratic, cubic and logarithmic models. The study revealed that a growth model of the form $Y = e^{(a + bt)}$ captured the trend in tapped area, production and yield of natural rubber while an exponential functional form was best to capture the trend in natural rubber consumption in India.

Chahal *et al.* (2004) conducted a study to estimate the trend and seasonal variations in arrivals and prices of green peas. The time series data for market arrivals and prices of green peas in the main markets of Hoshiarpur and Ludhiana were collected for the period from 1994-95 to 2002-03. An increasing trend was observed in both the markets and it can be attributed to increased demand over time and general rise in prices.

Varghese (2004) analyzed the price behaviour of cardamom in Kerala based on the data collected for the auction, wholesale and export prices of cardamom from 1970-71 to 2000-01. It was observed that the auction, wholesale and export prices have shown an upward trend and these three prices were moving almost in the same manner.

Murthy *et al.* (2008) determined the price trends and seasonal variations in onion, over the years in Belgaum, Dharwad and Bijapur markets in Karnataka. The price trends of onion were analyzed from 1991 to 2005 in the Dharwad market, 1990-2005 in Belgaum and 2001-2005 in Bijapur. The trend was studied using power function analysis. Findings showed that the price of onion in these three markets showed an increasing trend.

Babu *et al.* (2009) conducted a study to segregate the secular trend, seasonal, cyclical and irregular components in the price of coconut and major coconut products like copra and coconut oil in India based on month wise price data for the period from 1976-77 to 2004-05. The prices showed an increasing secular trend. The pre WTO situation was explained by a power function for Kochi whereas the compound function explained the trend for Alapuzha and Kozhikode. The post WTO situation was explained by quadratic function in the case of Kochi market whereas cubic function found to give better fit in the case of the other two markets viz., Kozhikode and Alapuzha. The domestic price of copra and coconut oil were found to be higher than the international price. It was also found that the domestic markets were well integrated among themselves and with the international market.

Anjaly *et al.* (2010) analyzed the price behavior of black pepper (ungarbled and garbled) using the data on domestic price at Kochi market for Malabar Ungarbled Pepper and international price at US (New York) market for Garbled Pepper. Month wise modal price data for the period from January 1996 to September 2009 were analyzed using various functional forms, but no satisfactory fit was observed based on R^2 values and standard errors. Hence, trend lines were fitted with single exponential smoothing. It was observed that the price of ungarbled pepper at Kochi market exhibited no specific trend.

Anjaly *et al.* (2010) analyzed the price behavior of cardamom using the data on domestic price at Vandanmettu market in Kerala. Month wise modal price data for the period from August 1996 to October 2009 were analyzed using various functional forms, but no satisfactory fit was obtained based on R^2 values and standard errors. Hence, trend lines were fitted with single exponential smoothing. It was observed that cardamom prices were subjected to considerable fluctuations during the period from 1996 August to 2003 October, depicting a mixed trend. The period from July 2007 was characterized by a growth phase in cardamom prices.

Anjaly *et al.* (2010) analyzed the price behavior of partially dehusked coconut, using the data on month wise modal price prevailed at Thrissur market for a period from 2000 to 2009. The trend analysis was carried out using various functional forms, but no satisfactory fit was observed based on R^2 values and standard errors. Hence, trend lines were fitted with single exponential smoothing which had a mean absolute percentage error (MAPE) value of 4.18 per cent.

Jayasree *et al.* (2011) analyzed the secular trend in the domestic price of black pepper at Kochi market for a period of 15 years from January 1995 to December 2010. Trend lines were fitted with single exponential smoothing and the fit had a mean absolute percentage error (MAPE) value of 7 per cent. The price of ungarbled pepper in Kochi market exhibited no specific trend. The prices were increasing steadily to reach the peak price of Rs. 247/Kg in October 1999, and declined thereafter. It reached the trough price of Rs. 56/Kg in November 2004, thereafter it is showing an increasing trend.

As evident from the above literature review, the various authors tried trend analysis in price of various commodities by fitting different functional forms. Generally, the prices of most of the commodities showed an increasing trend. The prices of commodities like cereals, pulses, oilseeds, onion, milk, timber, coconut and coconut products like copra, coconut oil, potato and cotton showed an increasing secular trend, whereas the prices of natural rubber and black pepper exhibited no specific trend during the concerned period under study. The cardamom prices in Vandanmettu market depicted a mixed trend.

2.1.2 Seasonal Price Movement

Seasonal movements refer to the identical or almost identical patterns of movement followed by a time series during corresponding months of successive years. Those movements, which recur, with some degree of regularity, with in a year are referred to as seasonal movements (Croxton *et al.*, 1979; Spiegel, 1992). Seasonal or intra-year price variations are regularly occurring upswings and downswings in prices that occur with some regularity during the year. Seasonal price variations resemble a cycle covering a period of 12 months or less. The seasonal variation in prices is mainly due to the seasonality in supply and factors affecting the stocking decisions of the traders (Acharya and Agarwal, 1991).

Chandrakanth *et al.* (1978) analyzed the prices and arrivals of ragi in Bangalore market. They used multiplicative model to estimate seasonal variation and concluded that the short run seasonal fluctuation in the prices with arrivals of ragi was significant.

Ipe (1988) conducted a study to analyze the seasonal variations in rubber prices. The analysis showed that the seasonal index was the highest in July and the lowest in December. Production of rubber showed marked seasonality. The analysis of price in relation to production and consumption showed that seasonality in prices was not much pronounced during months in which production change was predominant, which in turn point to the possibility of oligopsont in the buying market. During the peak production period, consumption was found to fall resulting in low prices. This creates the need for buffer stock operations.

Singh *et al.* (1993) studied the trends in arrivals and prices of potatoes in Jalandhar district of Punjab state during the period from 1975-76 to 1989-90 and identified the seasonal patterns in the movement of potato prices. They reported that during the post harvest period, the indices of prices remained low and fluctuated widely. These fluctuations were mainly because of the seasonal and perishable nature of the crops. They concluded that the seasonal nature of agricultural production resulted in price fluctuations.

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 slightly lower than corresponding milk prices. Prices for ghee varied within a narrower range than those for milk or curd.

Babu and Sebastian (1996) studied the price behaviour of coconut and coconut products in Kerala using monthly data from 1971 to 1990. They reported that the price of coconut was subjected to pronounced seasonal fluctuations despite the production of nuts round the year. The prices of coconut, copra and coconut oil showed seasonal buoyant phase from November to February for coconut and August to December for copra and coconut oil. A depressed phase was noted from March to October for coconut and February to June-July for copra and coconut oil. The 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 coconut growers as bulk of their produce was disposed as raw nuts immediately after harvest when prices were abysmally low. It was also found that the seasonal behavior of coconut was influenced by seasonality in copra and coconut prices. Correlation among seasonal indices revealed that the seasonal indices of copra prices and coconut prices were highly associated and seasonal price behavior in coconut was following seasonality in copra and coconut prices with one month, two month and three months lag.

The seasonal nature of market arrivals in red chillies and its effect on price seasonality were studied by Kasar *et al.* (1996) in the Dondaicha market in Maharashtra during the period from 1979-80 to 1991-92. The study revealed that the arrivals of red chillies were high during the period from December to March, when the corresponding prices were low. Likewise, the price index was high during the period from October and November when the market arrivals were low.

Agarwal and Dhaka (1998) studied the relationship between the arrivals and prices of spice crops in Rajasthan. The study revealed that arrivals of chillies were higher in February and the wholesale prices of dry chillies were also higher in February when the first lots of new chillies arrived in the market. Prices reached to the peak level in September when arrivals were low. The pattern of market arrivals of cumin and coriander seed also revealed the existence of seasonality.

Karunakaran *et al.* (2001) observed that the fluctuation in the import and export prices of cashew nut and kernels was mainly because of seasonality in production, processing and also because of market forces. During the harvesting time of the crop in India i.e. in May and June, the seasonal index of cashew nut import price were found to be less than 100. Maximum seasonal index was during July to September as it was the off-season for the crop. Seasonal index of less than 100 per cent during months of November, December, January and May, could be due to higher supply from the raw nut exporting countries.

Srinivasan *et al.* (2001) transformed the secondary data on monthly prices of tapioca, tapioca starch and sago from 1983 to 1995 into quarterly data and seasonal indices were constructed using ratio to trend method for tapioca, tapioca starch and sago price. Linear regression analysis was done to study the influence of starch and sago price on tapioca prices. Seasonal price index for starch price was lowest for January-March and highest for April-June. The range of difference between the minimum and maximum value of price indices was 11.09 and indicated that there was significant fluctuation in tapioca prices.

Kanchana (2002) examined the seasonal variations in seed, oil and oil cake prices of groundnut and gingelly in Tamil Nadu. The time series data on wholesale prices in groundnut and gingelly markets for the period from 1985-86 to 1999-2000 were used for the analysis. It was found that like other agricultural commodities the seasonal price indices of these commodities were found higher during sowing months.

Mali *et al.* (2002) studied the seasonal fluctuations in arrivals and prices of important oilseeds such as groundnut in Dhule and Kolhapur markets and soybean in Sangli and Jasigpur markets of Western Maharashtra. The data was taken for 1986-87 to 2000-01. The monthly arrivals of groundnut and soybean were higher immediately after the post harvest period and the prices were low during that period.

Edirisinghe and Herath (2004) opined that prices play a key role in the profitability of an enterprise. The study attempted to investigate the seasonality in the prices of rubber in different markets of the world. The market prices of New York, London, Singapore, Kuala Lumpur and Sri Lanka (Colombo) were studied. Data for the period from 1980 to 2002 were used for the analysis and the seasonal indices were calculated using the decomposition technique in time series analysis. Study of the seasonal indices revealed that there were considerable differences in the seasonality of prices in different markets. The markets in the major consuming areas selected (New York and London) had differences in peaks and troughs achieved in a typical year. While Kuala Lumpur and Singapore prices were above average in the first half of the year, the Colombo price was above average in the middle and latter part of the year. Indepth analysis of Colombo market showed that crepe grades of rubber had higher variability than ribbed smoked sheets.

Pawar *et al.* (2004) studied the behaviour of prices and arrivals of pomegranate in Solapur market in Maharashtra from 1991 to 2000 and found that the arrivals of pomegranate were high during the months of July, August, September and December and the lowest arrivals in the month of April. The price indices of pomegranate revealed that the highest price was in the month of February, followed by January and March. The prices were observed lowest in the month of April, May and September. The coefficient of correlation between arrivals and prices exhibited negative relationship.

Khunt *et al.* (2006) analyzed the seasonal indices of potato in Ahmedabad for the period from 1981 to 2000. The results of the study indicated that the highest index of arrivals was observed in the month of March. The price index of potato was lowest in the month of March when the corresponding arrival was highest. The price index was below average (100) from January to May and above average from June to December.

Asmatoddin *et al.* (2009) analyzed the arrivals and price behaviours in APMC market Parbhani during the year 2004-05 to determine price index fluctuations for important pulse crops. The data on monthly arrivals and prices were obtained from the record of APMC, Parbhani for nine years from 1996-97 to 2004-05. The result revealed that the peak arrivals of greengram were in the month of October and the highest price index recorded was in the month of March. The price index touched to the lowest 83 per cent and to the peak value of 105 per cent. In pigeon pea, the arrival index was the highest in the month of January whereas, the price index was highest in the month of September, and the price index varies in the range of 93 to 107 per cent.

Babu *et al.* (2009) analyzed the seasonal components in the price of coconut and major coconut products like copra and coconut oil in India. The study was based on month wise price data for the period from 1976-77 to 2004-05. It was observed that there were marked seasonal variations in the prices of coconut and its products, with coconut prices remaining low during the months of peak production in March to April; and high when production was low during July to August.

Kumar *et al.* (2009) analyzed the seasonality in arrivals and prices of important vegetable crops in Bangalore market for the period from 1999 to 2008. The secondary data pertaining to monthly arrivals (Qtls) and prices (Rs/Qtls) of green-chilly, onion, potato and tomato were collected from Agricultural Produce Market Committee (APMC) and Karnataka State Agricultural Marketing Board, Bangalore. For the evaluation of seasonality in arrivals and prices, multiplicative time series analysis, twelve month centered moving average and two-way ANOVA were used. In all the crops with respect to arrivals and prices, the seasonality was present within a year and seasonal pattern did not change over the years in the market except in onion price.

In a study conducted by Anjaly *et al.* (2010), an attempt has been made to analyze the seasonal movements in price of black pepper based on the month wise modal price data for the period from January 1996 to September 2009. It was observed that the domestic as well as international price of pepper exhibited considerable seasonality. The buoyant phase for ungarbled pepper in Kochi market was observed during July to October, with the peak price in October, while the trough price was during February, which coincided with the peak harvest season and higher market arrival in Kerala. In the case of international price of garbled pepper, the peak was found during April to May, whereas the trough was occurring in the months of December and January.

Anjaly *et al.* (2010) studied the seasonal variations in price of cardamom in Vandanmettu market. The study was based on month wise modal price data for the period from August 1996 to October 2009. It was observed that cardamom price exhibited considerable seasonable effect. April and September months were characterized by peak prices, whereas December represented the trough month and the prices were low during the period from October to March. The harvest period of cardamom in Kerala synchronizes from October to February, with peak harvest takes place in October, November and December months.

Anjaly *et al.* (2010) worked out the seasonal indices for the prices of partially dehusked coconut to capture the seasonal patterns in the price data. The study was conducted with month wise modal price data for the period from January 2000 to December 2009. It was observed that the prices were found to be peak during December to January, while the prices were found to be under downward pressure during the period from March to August. The period from October to December marks a period of low arrivals of coconut in the domestic market and the period from March to September marks the maximum arrival of coconut in Kerala, synchronizing with the peak in production.

The study by Jayasree *et al.* (2011) by reworking out the seasonal variations in black pepper prices using monthly modal prices from 1995 January to December 2010 reconfirmed the presence of pronounced seasonality in black pepper spot prices in Kochi, the major terminal market for the commodity in India. The buoyant phase remained the same from July to October, but the peaking of prices shifted to August. The trough prices remained the same, from November to March, which synchronized with the harvest period and maximum market arrivals.

The review of the above literature confirms the existence of the negative relationship between market arrivals and prices of various commodities. Generally, the low price of the commodity is coinciding with peak production and the prices are high when the production is low. Hence, seasonality is an important component in the price behavior of agricultural commodities.

2.1.3 **Cyclical Movements**

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). 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.

Satish *et al.* (1983) attempted to detect the presence of cycle of twelve month duration and a long term cycle in the arrivals and price series of Jowar by harmonic analysis. Monthly modal data on arrivals and prices for the period from 1970 to 1978 for Hubly market and for the period from 1956 to 1978 for Gadang market were subjected to time series analysis. The results had shown that there were the presence of cycles of length 3 and 4 years for prices and arrivals respectively.

Borah and Dutta (1991) analysed the wholesale price data of rape and mustard in Assam state for the period from 1971-72 to 1989-90, and found that price of rape and mustard exhibited cyclical variation. They reported that the length of price cycle for these crops varied from one to four years.

Selvarajan *et al.* (1993) using harmonic analysis reported that there existed nine complete cycles (from trough to trough) in the price of potato in Nilgiri district during the past 30 years with the maximum length of cycle being six years. He attributed the cyclic behaviour to the variation in production characterized by the occurrence of drought, incidence of pest and diseases and favorable monsoon that in turn influenced price levels. The length of price cycle was less as compared to production cycle indicating that fluctuation in price was comparatively high. The price cycle fluctuated about 61 per cent above and 38 per cent below the average. Perishability, bulkiness and seasonality explained the greater amplitude in price cycle. Also the magnitude of the swing was high in the early years due to the lack of organized marketing facilities and absence of market information.

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 cyclic 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 centered 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 neighboring state.

Jayasekhar *et al.* (2005) analyzed the cocoa economy with special reference to Indian scenario. The time series analysis of cocoa prices revealed a regular cyclical pattern of price movement resulting from structural deficits and surpluses of cocoa bean stocks.

Murugananthi *et al.* (2008) analyzed the price behavior of turmeric based on the 20 years of price data collected from the Erode regulated market in Tamil Nadu. The study concluded that five year price cycles were observed in the turmeric price data.

Babu *et al.* (2009) studied the cyclical components in the price of coconut and major coconut products like copra and coconut oil in India. The study was based on month wise price data for the period from 1976-77 to 2004-05. Price cycles of three to four years were observed for all the considered products. It was also interesting to note that the amplitude of cycle was found to wane in the post WTO period of the study.

Anjaly *et al.* (2010) analyzed the cyclical variations in the price of black pepper (ungarbled and garbled) using the month wise modal price data for the period from January 1996 to September 2009. The prices of pepper showed pronounced cyclical variations both in the domestic as well as international markets. It was observed that the length of the cycle lasted for about six years.

Anjaly *et al.* (2010) studied the cyclical movements in price of cardamom in Vandanmettu market based on the month wise modal price data for the period from August 1996 to October 2009. It was observed that the price cycles do appear in the cardamom prices. The analysis revealed that the cardamom prices from the period March 1998 to October 2002, represents a boom phase lasting for about five years, while the period from November 2002 to March 2006 represents a recession phase, lasting for about three and half years. The length of the total cycle is estimated to about eight years.

Price cycles represent deviations in price levels from the average trend due to business cycle that appears in the economy. As evident from the above literature, the cyclical movements are of longer duration and are of different periodicity. The length of the price cycle varies with commodities and it depends mainly up on the boom and depression in the economy and also the nature of the commodity under study.

2.1.4. **Irregular Movements**

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 components are also scanty.

Acharya and Agarwal (1991) argued that irregular price fluctuations are non-systematic price behavior. 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.

According to Agarwal (1991), oilseeds and edible oils were highly sensitive crops capable of misuse for speculative activities on a large scale. Unscrupulous traders and stockists resorted to large-scale black marketing and hoarding on the slight excuse of damage to the standing crops or increase in demand owing to approaching festival season. This resulted in making the edible oil price volatile with rampant and unpredictable day to day price movements.

Selvarajan *et al.* (1993) estimated the price of potato in Nilgiri district market using regression equation and accounted the difference between the computed price and actual price of potato to the cyclic and irregular variation arising as production and price were mainly influenced by the exogenous variables viz., vagaries of climate, perishability, seasonality and bulkiness.

Hosmani (2001) while studying the price behavior 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.

Mathew (2002) explained that extraneous factors like drought and flood were contributing to irregularity in price. He reported the *El Nino* phenomenon in 1997 when whole of south India was reported to be under the grip of a draught. As a result the production declined and the price of coconut and coconut products went up phenomenally.

Babu *et al.* (2009) analyzed the irregular components in the price of coconut and major coconut products like copra and coconut oil in India, based on month wise price data for the period from 1976-77 to 2004-05. There was wide spread irregular movements in the price of coconut and its products under reference. Widespread irregular movements were found to contribute to higher price fluctuations.

Anjaly *et al.* (2010) analyzed the irregular variations in price of black pepper for both ungarbled and garbled pepper using month wise modal price data for the period from January 1996 to September 2009. The study has shown that the pepper prices were subjected to high irregular variations during the period under consideration. The random variations differed considerably among the two different markets trading in the two different forms of commodity, but the pattern of random shocks appeared to be similar.

The review of the above literature reveals that the prices of agricultural commodities are subjected to considerable irregular variations. These irregular variations are due to random effects such as supply shocks on account of climatic deviations, or market shocks on account of demand shocks or high speculative factors.

2.2. ARIMA MODELS

Nabi and Shahabuddin (1988) used Box-Jenkins univariate model for forecasting the price of various grades of natural rubber (NR). The data for the analysis were based on the monthly average daily free on board (f.o.b) prices of natural rubber for the period from January 1977 to May 1987. The price of the various grades of rubber was forecasted using a single model comprising a backward shift operator and two parameters for autoregressive and moving average respectively. The percentage of absolute errors, the measure used to indicate the precision of the estimated price, ranged between 2.64 and 3.30 per cents.

Mani (1993) conducted a study to forecast the egg production, egg price and feed price in Salem, Coimbatore, Thanjavore and Madhurai districts of Tamil Nadu. Egg production details for the period from 1977-78 to 1988-89 and average monthly wholesale egg price for the period from 1959-60 to 1989-90 were collected and analyzed. Time series models viz., simple extrapolation models (linear trend model, exponential growth curve, and autoregressive trend model), single exponential smoothing method, decomposition method (ratio to moving average decomposition method) and stochastic time series models (ARIMA) were used for the analysis. The results had shown that ratio to moving average decomposition method was obtained as the appropriate model for forecasting egg production, egg price and feed price in all the four markets.

In a study conducted by Vroomen and Douvelis (1993), an autoregressive-integrated-moving-average (ARIMA) model was used to forecast the season-average soybean price in USA for the marketing years 1989-90 to 1991-92. These forecasts, made during each month of the marketing year, were compared with USDA forecasts. Results indicated that ARIMA models typically outperform USDA forecasts, especially early in the marketing year, indicating that within-season USDA forecasts may be improved by incorporating information from ARIMA models.

Douvelis (1994) used an autoregressive-integrated-moving average (ARIMA) model to forecast the season-average sunflower seed price for the marketing years 1991-92 to 1993-94. The model forecasted the price for each month of the marketing year. These forecasts were then weighted by the average estimated volume of farmer sales during each month of the marketing year, to calculate the season average price received by farmers. The ARIMA forecasts came very close to the actual price early during the marketing season.

Aal and Garni (1997) used univariate Box-Jenkins time-series analysis for modeling and forecasting monthly domestic electric energy consumption in the Eastern Province of Saudi Arabia. ARIMA models were developed using data for five years and evaluated on forecasting new data for the sixth year. The optimum model derived was a multiplicative combination of seasonal and nonseasonal autoregressive parts, each being of the first order, following first differencing at both the seasonal and nonseasonal levels. Compared to regression and abductive network machine-learning models previously developed on the same data, ARIMA models required less data, had fewer coefficients, and were more accurate.

RunSheng (1999) forecasted the timber price with univariate autoregressive integrated moving average (ARIMA) models employing the standard Box-Jenkins modeling strategy. Using quarterly price series from Timber Mart-South, results showed that most of the selected pine pulpwood and saw timber markets in six southern US states can be evaluated using ARIMA models, and that short-term forecasts, especially those of one-lead forecasts, are fairly accurate. It was suggested that forecasting future prices could aid timber producers and consumers alike in timing harvests, reducing uncertainty, and enhancing efficiency.

In a study conducted by Krishnankutty (2001), the future prices of teak (*Tectona grandis*) in three girth classes (based on mid-girth, under bark and of logs) in Kerala, India were predicted using the autoregressive integrated moving average (ARIMA) models. The data used for price forecasting was based on the average annual current prices of teak girth class 1, 2 and 3. The prices in girth classes for the period from 1999-2000 to 2015-16 were forecasted.

Sarada and Prajneshu (2002) studied the pattern of pesticide consumption in India in the post-Green Revolution era using the annual data from 1966 to 1999. An autoregressive integrated moving average (ARIMA) approach was adopted to forecast pesticide consumption and to examine how long this trend is likely to continue. It was concluded that the declining trend in India's pesticide consumption is likely to be reversed in the near future.

Rajaraman and Datta (2003) fitted univariate ARIMA models to past agricultural outcomes for forecasting the state level agricultural production. Forecasting was conducted for five states viz., Punjab, Rajasthan, Karnataka, Andhra Pradesh, and Uttar Pradesh. The forecasts for 2002-03 showed negative growth for Rajasthan (-1.7%) and Andhra Pradesh (-3.5%). The forecasts for Punjab and Karnataka were positive, 1.8 and 5%, respectively.

Menon *et al.* (2006) forecasted the cardamom price using Box and Jenkins Autoregressive Integrated Moving Average (ARIMA) model. The study was based on the data on monthly cardamom price for the period from August 1985 to December 2005.The results showed that an ARIMA model with parameters as (2, 1, 0) provided satisfactory forecast of the cardamom price with 80 per cent accuracy. The model satisfied the stationary conditions and residuals were independent and had non-significant autocorrelations.

Yayar and Bal (2007) conducted a study to predict corn oil price based on ARIMA (Autoregressive Moving Average Processes) methodology. ARIMA models have been applied to forecast commodity price. These models are based on time series analysis and provide reliable and accurate forecasts. This approach is suitable for short term price forecasting, i.e. a weeks, a month, a quarter, a year. In this study monthly corn oil price were used from January 1994 to December 2005. Monthly corn oil price of 2006-2007 year were forecasted.

Murugananthi *et al.* (2008) presented an overview of the price forecasting methods (autoregressive integrated moving average (ARIMA) models and artificial neural networks (ANNs)) used by the Domestic and Export Market Intelligence Cell (DEMIC) of the Centre for Agricultural and Rural Development Studies, Tamil Nadu Agricultural University. It then presented two case studies of forecasting reports prepared by DEMIC: the first concerned with the price forecasts for making sowing and selling decisions for chillies, and the other concerned with the price forecasts for turmeric in Tamil Nadu. Chilli price was forecasted using monthly price data collected from Virudhunagar regulated market for the period of January 2000 to December 2007. They also analyzed and forecasted the scenario of turmeric prices based on the 20 years of price data collected from Erode regulated market and concluded that there could be upward trend in turmeric prices in the forthcoming season. The case studies confirmed the validity of the forecasts.

Assis *et al.* (2010) compared the forecasting performance of different time series methods for forecasting cocoa bean prices. The monthly average price data of cocoa bean graded SMC 1B for the period from January 1992 – December 2006 was used. Four different types of univariate time series models were compared viz., exponential smoothing, ARIMA, generalized autoregressive conditional heteroscedasticity (GARCH) and the mixed ARIMA/ GARCH models. Root mean square error (RMSE), mean absolute percentage error (MAPE), mean absolute error (MAE) and Theil's inequality coefficient (U- STATISTICS) were used as the selection criteria to determine the best forecasting model. This study revealed that the time series data were influenced by a positive linear trend factor while a regression test result showed the non-existence of seasonal factors. The Autocorrelation Function (ACF) and Augmented Dickey Fuller (ADF) tests have shown that the time series data was not stationary but became stationary after the first order of the differentiating process was carried out. Based on the results of the expost forecasting (starting from January until December 2006), the mixed ARIMA/ GARCH model outperformed the exponential smoothing, ARIMA and GARCH models.

The above literature shows that price forecasting using ARIMA model will give accurate results with less rigorous data and fulfills the parsimony principles. The various authors forecasted the price of various commodities using ARIMA models with different parameters. Therefore, ARIMA models are widely used for short term price forecasting, with reasonable reliability.

2.3 ANN MODEL

The artificial neural network models (ANN models) are new generation analytical models for solving many forecasting and decision modeling problems (Hiew and Green, 1992). Investigators have been attracted by ANN's freedom from restrictive assumptions such as linearity that are often needed to make the traditional mathematical models rigid. Kozhadi *et al.* (1995) applied neural networks to forecast the corn futures and found that the forecast error of the neural network model was between 18 and 40 per cent lower than that of the ARIMA model.

Moody (1995) had presented empirical result for forecasting the US index of industrial production and argued that superior performance can be obtained using state-of-the-art neural network models than using conventional linear time series and regression methods. Recently, the ANNs have been extensively studied and used in macroeconomic forecasting (Zhang *et al.*, 1998).

The two-layered feed-forward network can be a useful forecasting alternative to the widely popular Box-Jenkins linear model (Hwarng and Ang, 2001). The neural networks had been shown to be a promising tool for forecasting financial time series and it was shown that neural networks with an appropriate amount of historical knowledge had a better forecasting performance than neural networks trained with a larger training set (Walczak, 2001). Prudence (2002) had shown that the ANN model outperformed the ARIMA model in within the sample predictions of core inflation in Jamaica and captured all the turning points.

But the use of neural networks in agriculture especially for predicting the price of commodities is still in its relative infancy. There was very few developmental application of ANN in agriculture in India on commodity price forecasting. Ajjan *et al.* (2009 a) reported that ANN models out performed ARIMA models in forecasting turmeric prices in Tamil Nadu.

Ajjan *et al.* (2009 a) also forecasted the price of Poovan banana in Tamil Nadu using ANN model. Trichy market was selected for the study. The price of Poovan banana in Trichy market was forecasted using different ARIMA models and ANN. Among the different ARIMA models ARIMA 101was preferred because of the lowest standard error and AIC. The results had shown that ANN was the best model for forecasting the Poovan banana price due to the less MAPE value when compared to the ARIMA 101.

Thus, there are a wide array of tools and techniques like the classical time series decomposition, ARIMA, artificial neural network models and cointegration techniques currently available to study and understand the underlying relations in a price time series. It is left to the nature of data, commodity and market before any conclusive inferences can be made because each commodity and each market are unique.

2.4. EXPORT COMPETITIVENESS

The theory of comparative advantage in its simplest form states that a nation can enhance efficiency in resource use and hence net welfare by producing and exporting commodities in which it is relatively efficient and importing commodities in which it is relatively not efficient (Lipsey, 1975).

Pearson and Meyer (1974) studied the comparative advantage of African coffee producers in Uganda, Ethiopia, Tanzania, and Ivory Coast using the Domestic Resource Cost (DRC) ratio. The study revealed that Uganda had the greatest comparative advantage in the production of coffee followed by Ethiopia and Tanzania. Ivory Coast had the least comparative advantage in coffee production among the countries considered.

Gotsch and Brown (1980) used the Domestic Resource Cost (DRC) to analyze the comparative advantage of crops in Pakistan from 1960 to 1976. The study revealed that incentives to keep sugarcane in the cropping pattern would result in misuse of domestic resource and hence led to a comparative disadvantage. Their study also revealed that comparative advantage of various crop combinations is seriously influenced by methods of production adopted.

Appleyard, (1987) used the DRC ratio to analyze the comparative advantage of Pakistan Agriculture. The study revealed that there was comparative advantage for crops like basmati rice, wheat, seed cotton and sugar cane. However, comparative advantage did not exist for crops like traditional varieties of paddy, cotton and maize.

Tweeten (1992) reviewed the different measures to assess competitive and comparative advantage. According to him the four most widely used measures from the least to most comprehensive were the Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Producer (Consumer) Subsidy Equivalent (PSE) and the Classical Welfare Analysis (CWA). He concluded the last three were ideal to measure competitive advantage and protection under different assumptions, the Domestic Resource Cost Ratio (DRC) was a good measure for measuring the comparative advantage.

Gozales *et al.* (1993) analyzed the comparative advantage of Indonesian food crops using the Domestic Resource Cost (DRC) method. Five crops *viz.,* rice, corn, soybean, sugarcane and cassava were considered for the study. The results revealed that Indonesia had comparative advantage in rice production, but did not have comparative advantage in rice exports. Corn was found to have better export potential than rice crop. The result also indicated that soybean was not a comparatively advantageous crop while, cassava was an economically export efficient crop.

Naik (2001 b) studied the comparative advantage of cotton in India using the DRC ratio. The study revealed that comparative advantage in production of cotton was eroding over time in all the major cotton producing States and that only few States are now retaining the comparative advantage for cotton production in India.

Using the DRC analysis Naik (2001 a), calculated the comparative advantage of Indian wheat during the four years viz 1995-96, 1996-97, 1997-98 and 1998-99 for five sates namely Madhya Pradesh, Gujarat, Haryana, Punjab and Rajasthan. His study revealed that comparative advantages in producing wheat by these states are declining. He warned that if the present trend continues, Indian wheat would be non-competitive in the world market and this would lead to heavy imports and consequent pressure on domestic price would occur.

Porter (1990) argued that the theory of international trade must move beyond the comparative advantage to the competitive advantage. The idea of competitive advantage is more comprehensive as it involves segmented markets, differential products, technology differences and economics of scale. He concluded that price cum cost comparisons are the best preliminary indicators of competitiveness.

Gulati *et al.* (1994) calculated the export competitiveness of 17 agricultural commodities from India using the Nominal Protection Coefficient (NPC) methodology. They concluded that rice among the cereals, grapes, banana and sapota among fruits, tomato among the vegetables and mushrooms among processed vegetables were highly export competitive. Sorghum among cereals and apples juice among processed fruits were not competitive during the study period.

Umapathi *et al.* (1995) calculated the comparative advantage of DCH 32 seed cotton variety from Karnataka during the period from 1983-84 to 1991-92, using the Nominal Protection Coefficient (NPC). The results revealed that the government policy had discriminated against the cotton cultivators of the study area and that DCH –32 seed cotton variety was an efficient export competitive crop.

Dahiya (2001) analyzed the competitiveness of potato export from India during a period from 1992 to 2000 using the Nominal Protection Coefficient (NPC). The study showed that during the years 1994, 1995, 1997, 1999, and 2000, the NPC was less than one and hence competitive in exports during these year. He concluded that cash compensatory scheme for non-competitive years, strengthening the infrastructure, higher bound rates and export oriented research and sound database on prices grade standards, Sanitary and Phyto-sanitary standards are policy implications for promotion of potato exports.

The indicators such as Effective Protection Coefficient (EPC), Producer Subsidy Equivalent (PSE), Policy Analysis Matrix (PAM) and Constant Market Share (CMS) were also used by different authors to study the trade competitiveness of different crops. However, the uses of these measures were limited by underlying assumptions.

Alias and Suleiman (1993) used the Constant Market Share (CMS) approach to study the export competitiveness of natural rubber in Thailand, Malaysia and Indonesia. The study revealed that export from Thailand is the most competitive followed by Indonesia and Malaysia during the study period from 1976 to 1990. However, the CMS analysis has certain limitations. Firstly, the CMS analysis cannot elucidate the reasons for changing export competitiveness. The CMS analysis compares export competitiveness between two points of time and it cannot reveal the changing nature of competitiveness during a time period.

Jha (2000) used the Export Performance Ratio (EPR) to calculate the competitive advantage of several agricultural commodities in India. This study revealed that competitive advantage of traditional export items like tea has blurred during the study period. However, one of the limitations in the estimate of EPRs is that it imposes many export restricting assumptions in the analysis. It also does not explain the potential of commodities in an opening economy. Under these cases it be becomes imperative to depend on the superior measures of competitiveness like the NPC.

Datta and Gupta (2001) estimated the global competitiveness of Indian sugar industry using the NPC, EPC and ESC. The results of the study revealed that Indian sugar was export competitive in the global market.

Pradeep (2003) assessed the trade competitive advantage of natural rubber as an exportable commodity by comparing the domestic price of natural rubber at Kottayam market and the fob price at Kaulalampur for 23 years from 1979-80 to 2001-02. The study indicated that natural rubber production and trade in India under the exportable hypothesis was not in an advantageous position at the existing levels of yield and cost return structure. An examination of the year wise NPC values under exportable hypothesis for the years from 1979-80 to 2001-02 indicated that natural rubber was not export competitive for the entire period, except for the year 1997-98.

Jayasree *et al.* (2011) evaluated the export competitiveness of Indian black pepper by working out NPC, using the spot prices at Kochi market with that of Vietnam black pepper at the fob prices during the period from 2005-06 to 2010-11.

They concluded that Indian black pepper was not export competitive with their Vietnamese counterpart at the existing levels of cost, productivity or price.

2.5 MARKET INTEGRATION

Earlier works on market integration depended upon the intercorrelation matrices to arrive at the degree of association until the researchers came up with better methods like cointegration techniques.

According to Lele (1967), market integration is the interrelationship between price movements in two markets. The degree of correlation can be taken as an indicator of the extent to which the markets are integrated.

Market integration exists when prices of homogeneous commodities in spatially separated markets move mutually in response to the forces of demand and supply. The speed at which prices in the markets adjust to departures from their equilibrium relationship is taken as an indicator of marketing efficiency. The integration of markets is thus captured through the movement of prices across regions and time (Blyn, 1973).

Ravallion (1986) in his study explained that there were a number of inferential dangers in studying market integration by price correlation and by calculating the variance of prices and test for long run convergence to zero or close to it. He recommended his own model i.e. Ravallion model to study market integration both in short run and long run. According to him, when trade takes place between any two regions, then the price in the importing region would equal to the price in the exporting region plus the unit transport cost incurred in moving between the two. If it holds true, then the markets could be said to be spatially integrated.

Baharumshah and Habibullah (1994) examined whether the prices of black and white pepper in a market were in parity with the prices in a reference market. Cointegration tests were applied to spatial price relationships among regional pepper markets in order to show that regional markets for pepper in Malaysia are closely interrelated. The cointegration technique was applied to weekly pepper prices for six regional markets in the state of Sarawak, Malaysia, The period of observations spans from the first week of January 1986 to the last week of December 1991. The empirical results suggested that regional pepper markets in Sarawak in Malaysia were highly cointegrated.

Sinharoy and Nair (1994) examined whether the movements in international prices of Indian pepper reflect the variations in such prices of other economies viz., Indonesia and Brazil and whether the domestic price of pepper moved synchronously with the international price using cointegration analysis. The study was based on the monthly spot prices of pepper for a period from 1980 to 1990. The OLS estimates had shown that the coefficient for Brazilian prices was statistically insignificant. But the international prices of pepper for Indonesia and India have moved synchronously in the long run despite short run drifts. For international and domestic prices of pepper for India, the same Engle-Granger two step procedures were followed. The coefficient of e_{t-1} was found to be negative and significant and the standard error of regression was insignificant.

Bahura and Pradhan (1998) conducted a study to find out whether marine fish markets in Orissa are integrated to bring about efficiency in the marketing system. The data pertaining to marine fish prices prevailed in different fish markets in the state were collected for the period from January 1984 to December 1992. Bivariate price correlation as well as the methodology developed by Engle and Granger (1987) was used for the analysis. The results had shown that these markets were not integrated, though there was some evidence of integration among the Cuttak and

Paradip markets due to close proximity of these two markets and good communication.

Ghosh (2000) empirically evaluated the spatial integration of rice markets in India using the maximum likelihood (ML) method of cointegration developed by Johansen (1988) and extended by Johansen and Juselius (1990). The data set used in the cointegration exercise consists of monthly wholesale prices of rice for the period from March 1984 to April 1997. They investigated the intra-state as well as inter state regional integration of rice markets. Intra-state regional integration of rice markets have been evaluated by investigating the long run relationship between the prices of the state specific variety of rice quoted in spatially separated locations in each state. In order to examine whether the inter-state regional rice markets are integrated or not, they investigated the long-run linear relationships between the prices of the state specific variety of rice quoted in four regional markets represented by Allahabad (UP), Balasore (Orissa), Patna (Bihar), and Sainthia (West Bengal). The results had shown that the prices of the four markets were cointegrated to long run equilibrium and hence regional rice markets across the states were integrated. Results revealed that the regional rice markets across the states were spatially linked in the long run.

Ramakumar and Sundaresan (2000) attempted to study the horizontal integration in the pricing of coconut, copra, and coconut oil between the regional markets within Kerala and between Kerala and Mumbai markets using the cointegration method. For testing the regional integration of coconut markets within Kerala, monthly price data for the last 20 years were used and the weekly prices for the two years (1995 and 1996) were used for a comparative study of the prices in the Kerala and Mumbai markets. The results showed that prices in the major markets within Kerala were spatially integrated and the prices in the Mumbai market and the Kerala market were not cointegrated.

Goodwin and Nicholas (2001) evaluated spatial price linkages and daily price dynamics among regional corn and soybean markets in North Carolina by utilizing asymmetric, threshold autoregressive and error correction models. The prices were observed continuously between 2 January 1992 and 4 March 1999. The results had shown that the markets were highly integrated.

Basu and Dinda (2003) conducted a study to evaluate empirically the spatial integration of potato markets in Hooghly district of West Bengal. Bivariate correlation as well as cointegration test and error correction method had been used to show whether potato markets were integrated or not. The data pertaining to potato prices (wholesale and retail) were collected from the three market intelligence centers viz., Champadanga, Tarakeswar, and Sheoraphully. All possible pair wise combinations of price series of potato markets were chosen for the study. It was found that the test statistic obtained for all the pair wise markets seem to be greater than the critical value at one per cent level of significance. Therefore, all the market pairs like Champadanga-Sheoraphully, Champadanga-Tarakeswar, and Sheoraphully-Tarakeswar in terms of both wholesale and retail prices were co-integrated. Similarly, the wholesale price of one market and retail price of the other market pairs were also co-integrated.

Babu (2005) conducted a study to know the similarities in the price movement of copra and coconut oil in the domestic market with that in the international market. Inter correlation matrices were worked out separately for the pre WTO period and post WTO period. For copra, cif price to Europe from Indonesia/ Philippines was taken as the international price and for coconut oil cif price to Rotterdam was considered as the international price. The results had shown that both during pre WTO and post WTO periods, prices prevailed in the three main domestic markets in India viz., Kochi, Alapuzha and Kozhikode were found to be correlated with the international price, but the level of association was low.

Philip (2008) analyzed the market integration and causal nexus between two market prices of rubber in Kerala economy during the pre and post-reform period. Augmented Dickey Fuller (ADF) test was used to ascertain whether the variables are exact order of integration. Cointegration technique was used to examine the validity of the market integration hypothesis with reference to prices of rubber in Kerala. After cointegration test, error correction model was used to identify the market prices of peripheral price on main market price and vice versa. The analysis showed a strong evidence of the existence of market integration in rubber price during the post-reform period. Moreover, the price changes of rubber were transmitted from the peripheral to the main market and vice versa during the reform period.

Hussain *et al.* (2010) made an attempt to study the integration of seven selected gram markets in Pakistan using cointegration analysis. The study was based on the monthly wholesale price (Rs. /40 Kg) data from January 1991 to December 2006. The co-integration results had shown that all the seven gram markets in Pakistan were highly co-integrated in the long-run.

Jayasree *et al.* (2010) conducted a market integration study on pepper spot prices at Kochi with international price at the New York market using the cointegration method as suggested by Johansen 1991. The analysis was based on the month wise price data for a period of 15 years from January 1995 to December 2010. The cointegration equation was found to be significant at one per cent level, indicating that the two series were highly integrated. There were indications of mutual influence being exerted by the two markets on each other.

Materials and Methods

3. MATERIALS AND METHODS

A scientific study requires appropriate research design to draw meaningful inferences. The present study entitled "Price behaviour of natural rubber in India" was undertaken with the specific objective of investigating the secular trend, seasonality, cyclical and irregular movements in the price of natural rubber in India and to evolve a reliable price forecasting model. The relevant methodology of the study is presented under the appropriate heads given below.

3.1 TYPE OF DATA

The present study named "Price behaviour of natural rubber in India" is mainly based on the secondary data published by Rubber Board, Kottayam. The data regarding the area, production and productivity of natural rubber in the major producing countries in the world, India and Kerala were collected for the period from 1995-96 to 2009-10. The main items of observation were the month wise modal prices of natural rubber grade RSS-4 in the domestic market at Kottayam and the international price of the same grade at Bangkok over a period of 16 years from January 1995 to February 2011. The consumption, export and import details of natural rubber in India were also collected for the period from 1995-96 to 2009-10.

3.2 SOURCE OF DATA

The secondary data pertaining to the area, production and productivity of natural rubber in the major producing countries of the world were collected from the official website of FAO, Rome. The area, production and productivity of natural rubber in India and Kerala were collected from the Marketing Department of Rubber Board, Kottayam. The month wise modal prices of RSS-4 in Kottayam market and the same grade in the Bangkok market were also collected from the Rubber Board, Kottayam. The details about consumption, export and import of natural rubber in India were obtained from Rubber Statistical News, published by the Rubber Board.

3.3 PERIOD OF STUDY

The data on area, production and productivity of natural rubber in the world, India and Kerala were collected for the period from 1995-96 to 2009-10. But in Kerala, the data were available only up to 2007-08. The data regarding the consumption, export and import details of natural rubber in India were also collected for the same period. The data on monthly modal price of natural rubber for the two market centres at Kottayam and Bangkok were collected for the period from January 1995 to February 2011.

3.4 MARKETS SELECTED FOR THE STUDY

The domestic market at Kottayam was selected for studying the price behaviour of natural rubber in India because Kottayam is a reference market for rubber prices in throughout India. Since the rubber prices in the domestic market are influenced by the international prices, the price behaviour of natural rubber in a major international market at Bangkok was also studied.

3.5 CONCEPTS USED IN THE STUDY

3.5.1 **Time Series:** A time series is a set of observations on the values that a variable takes at different times and are collected at regular intervals (Gujarati, 2004).

3.5.2 **Time Series Analysis:** Time series analysis provides tools for selecting a model that describes the time series and using that model to forecast future events.

3.5.3 **Stationary Time Series:** A time series with constant mean and variance are called as stationary time series.

3.5.4 **White Noise Process:** It is a sequence of uncorrelated random variables with mean zero and variance σ^2. i.e. when there is no pattern in a time series, it is said to represent white noise (analogous to white colour in spectral analysis).

3.5.5 **Autocorrelation Function (ACF):** The ACF is an important guide to the properties of a time series. It measures the correlation between observations at different distances apart and is a powerful tool to identify a preliminary model for the time series. When all autocorrelation coefficients are not significantly different from zero, it forms a stationary series. When all the ACFs are close to zero, it represents a white noise.

3.5.6 **Partial Autocorrelation Function (PACF):** It measures the value of a series with the values lagged by one or more cases after the effects of the correlations at the intervening lags have been removed. It must be closer to zero for a series to be stationary.

3.5.7 **Moving Average:** The moving average method consists of computing an average of the most recent n data values for the series. This average is then used for forecasting the value of the time series for the next period ahead.

3.5.8 **Mean Absolute Percentage Error (MAPE):** The mean absolute percentage error is the mean or average of the sum of all the percentage errors for a given data set taken without regard to sign. It is one measure of accuracy commonly used in quantitative methods of forecasting.

$$MAPE = 100/n \sum e_t / X_t \quad \text{........ (3.1)}$$

3.5.9 **Mean Percentage Error (MPE):** The mean percentage error is the average of all the percentage errors for a given data set. This average allows positive and negative percentage errors to cancel one another.

3.5.10 **Mean Squared Error (MSE):** The mean squared error is a measure of accuracy computed by squaring the individual error for each item in a data set and then finding the average or mean value of the sum of those squares.

$$MSE = 1/n \sum e^2_t \text{.........} (3.2)$$

3.5.11 **Error:** Error is simply the difference between the actual and forecasted value.

3.6 TREND ANALYSIS USING INDEX NUMBERS

Index numbers are devices for measuring differences in the magnitude of a group of related variables having different units (Croxton *et al.*, 1979). Index numbers on area, production and productivity of natural rubber in the world, India and Kerala were worked out using the formula;

$$I_t = (P_t / P_0)\, 100 \text{ ....} (3.3)$$

where,

I_t = Index number

P_t = Current year value for the variable

P_0 = Base year value for the variable

The index number for area, production and productivity of natural rubber during 1995 to 2010 were worked out. Index numbers were also estimated for consumption, export and import time series for natural rubber in India.

3.7 COMPOUND GROWTH RATE

Growth rate of a variable is defined as the rate of change per unit time, usually a year. The Compound Growth Rates (CGR) of area, production, productivity, consumption, export and import of natural rubber was estimated by fitting the exponential function.

$$Y = AB^t \text{............} (3.4)$$

where,

Y = Area/ production/ productivity/ consumption/ export/import of NR

A = Intercept

B = Regression coefficient of the equation assumed as (1 + r)

t = No. of years

Taking logarithmic transformation

$$\ln Y = \ln A + t \ln B \text{ .... } (3.5)$$

$$Y' = a + bt \text{ .... } (3.6)$$

where,

$Y' = \ln Y$, $a = \ln A$, $b = \ln B$

$$\text{Compound Growth Rate} = (\text{antilog } b - 1)*100 \text{ .... } (3.7)$$

3.8 ANALYSIS OF PRICE BEHAVIOUR

Trend, seasonal, cyclical and irregular components of price movements of natural rubber were estimated as per Croxton *et al.*, 1979 and Enders, 1995. A multiplicative model of the following form was used for the same.

$$Y(p) = T \times C \times S \times I \text{ .... } (3.8)$$

where,

Y (p) = Monthly modal price of natural rubber grade RSS-4

T = Trend Component

C = Cyclical Component

S = Seasonal Component

I = Irregular/ Random Component

The decomposition of time series in to the above four different components was made using Minitab 16.0 and SPSS 16.0.

3.8.1 Estimation of Trend Values

Trend analysis was carried out separately for domestic as well as international markets by the method of least squares. Various functional forms viz., linear, quadratic, exponential, logarithmic etc. were tried to explain the underlying trend in natural rubber prices. But no satisfactory fit was obtained based on R^2 values and standard errors. Hence, trend lines were fitted with exponential smoothing methods viz., single and double exponential smoothing.

Exponential smoothing is a particular type of moving average technique applied to time series data to produce smoothed data for presentation. The exponential smoothing method weighs past observations by exponentially decreasing weights to forecast future values.

3.8.1.1 *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.

The specific equation for single exponential smoothing is

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

where,

S_t = Smoothed observation at time period t (X_{t+1})

X_t = Original observation at time period t

α = Smoothing constant

3.8.1.2 ***Double exponential smoothing***

When the data shows a trend, double exponential smoothing method is employed to study the underlying trend in the time series data.

Double exponential smoothing is defined in the following manner,

$$S_t = A_t + B_t \text{..........} \quad (3.10)$$

where,

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

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

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.

3.8.2 **Estimation of Seasonal Variations**

Seasonal variations in a time series are due to the rhythmic forces which operate in a regular and periodic manner over a period of 12 months. In order to obtain a statistical measure of the patterns of seasonal variations in the time series, seasonal indices are worked out. Seasonal indices are a set of numbers showing relative prices during different months of a year, the average for the year being 100.

3.8.3 Estimation of Cyclical Variations

Cyclical fluctuations are the oscillatory movements in a time series with period of oscillation more than one year. Cyclical variations are of longer duration than a year and do not exhibit regular periodicity. To assess the cyclical variation in a time series, residual method is commonly employed and it is done in three steps.

The effect of the trend component is eliminated from the time series data by dividing each of the original values by the corresponding trend values and expressing the same in percentage.

It can be represented as,

$$\frac{TxCxSxI}{T} = CxSxI \text{ .... } (3.11)$$

The detrended data consists of cyclical, seasonal and irregular variations. The detrended data for each month is divided by the corresponding seasonal index and the result is multiplied by 100.

That is,

$$\frac{CxSxI}{S} = CxI \text{ .... } (3.12)$$

The deseasonalized data is a combination of cyclical and irregular components. From the deseasonalized data, the irregular components are eliminated using 12 month moving average. The result obtained is the cyclical components and are multiplied by 100 to express it in percentage.

3.8.4 Estimation of Irregular Variations

The irregular indices were obtained by dividing the cyclical-irregular indices (equation 3.10) by the cyclical indices and multiply it with 100 to express in percentage.

It is given as,

$$\frac{C x I}{C} = I \text{ .... } (3.13)$$

3.9 PRICE INSTABILITY

The instability of rubber prices in both the domestic as well as international markets were studied using the coefficient of variation (CV).

$$CV = (SD/ Mean)\ 100 \text{ .... } (3.14)$$

where,

CV = Coefficient of Variation

SD = Standard Deviation

3.10 PRICE FORECASTING USING ARIMA MODEL

The acronym ARIMA stands for "Auto-Regressive Integrated Moving Average." Box and Jenkins (1970) are credited with illustrating a methodology for building autoregressive integrated moving average (ARIMA) forecasting models. Their work has had an enormous impact on the theory and practice of modern time series analysis and forecasting. ARIMA models are, in theory, the most general class of models for forecasting a time series which can be stationarized by transformations such as differencing and lagging.

Lags of the differenced series appearing in the forecasting equation are called "auto-regressive" terms, lags of the forecast errors are called "moving average" terms, and a time series which needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series. An ARIMA model is classified as an "ARIMA (p,d,q)" model, where: **p** is the number of autoregressive terms, **d** is the number of non-seasonal differences, and **q** is the number of lagged forecast errors in the prediction equation.

In the Box and Jenkins framework, a functional form of the following form has been used for estimating times series models

$$Y_t = a_0 + a_1 Y_{t-1} + \dots\dots\dots a_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \dots\dots\dots \beta_q \varepsilon_{t-q} \dots\dots\dots\dots (3.15)$$

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;

3.10.1 Model Identification
3.10.2 Model Estimation
3.10.3 Model validation

3.10.1 **Model Identification**

In the identification stage, the visual examination of the time plot of the series, the autocorrelation function (ACF) and the partial autocorrelation function (PACF) is carried out to check for the stationarity of the series. A time series is said to be stationary, when its mean, variance, and autocorrelation function are constant. If the model is found to be non stationary, stationarity could be achieved by differencing the series. Then the next step in the identification process is to find the initial values for the parameters p and q. They could be obtained by looking for significant autocorrelation and partial autocorrelation coefficients.

3.10.2 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, Mini Tab and Eviews were used for finding the estimates of relevant parameters using iterative procedures.

3.10.3 Model Validation

The third stage of the Box-Jenkins methodology involves diagnostic checking. The two most commonly used model selection criteria are the Akaik Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC).

$$AIC = T \ln (\text{sum of squared residuals}) + 2n \quad \text{.......... (3.16)}$$

$$SBC = T \ln (\text{sum of squared residuals}) + n \ln (T) \quad \text{........ (3.17)}$$

where,

n = Number of parameters estimated (p + q + possible constant term)

T = Number of usable observations

In order to get a precise comparison of the alternative models, T should be kept fixed. Ideally, the AIC and SBC will be as small as possible. As the fit of the model improve, the AIC and SBC approach $-\infty$.

Another standard practice to check the fitness of the model is to plot the residuals of the estimated model. It is important that the residuals from an estimated model be serially uncorrelated. Any evidence of serial correlation implies a systematic movement in the $\{Y_t\}$ sequence that is not accounted by the coefficients included in the model. Hence, any of the tentative models yielding non-random residuals should be eliminated from consideration. To check for correlation in the residuals construct ACF and PACF of the residuals of the estimated model. If most of the sample autocorrelation coefficients of the residuals are within the limits ± 1.96/ N (where N is the number of observations up on which the model is based), then the residuals are white noise indicating that the model is a good fit. In this study ARIMA models were tried to forecast rubber prices.

3.11 PRICE FORECASTING USING ANN MODEL

Neural network software consists of an interconnected group of artificial "neurons" that processes information using a connectionist approach to computation. The uniqueness of the analytical pattern is the flexibility in modeling that stems from an adaptive system to change the structure of the model based on external or internal information flowing through the network during its learning phase.

Artificial Neural Network (ANN) is an information processing algorithm similar to the brain cells (neurons) learning to recognize shapes and patterns. It is a mathematical structure designed to mimic the information processing functions of a network of neurons in the brain each neuron, individually, functions in a quite simple fashion. It receives signals from other cells through connection points, averages them and if the average over a short of time is greater than a certain value, the neuron produces another signal that is passed on to other cells. It is the high degree of connectivity rather than the functional complexity of the neuron itself that gives the neuron its computational processing ability. Neural networks are very sophisticated modeling techniques, capable of modeling extremely complex functions. The neural network user gathers representative data, and then invokes training algorithms to automatically learn the structure of the data. The methodology used in this study consisted of an Artificial Neural Network, trained with the well-known error back propagation learning algorithm

The application of ANN modeling in time series econometrics owes its origin to the works of Swanson and White (1997). ANN modeling in time series analysis was popularized by Zhang *et al.*, 1998.The Zaitun Time Series software (version 2.1) was used for ANN modelling in the study.

3.12 EXPORT COMPETITIVENESS

The export competitiveness of natural rubber was studied using the Nominal Protection Coefficient (NPC). Measuring price competitiveness through NPC, Porter (1990) argued that the theory of international trade must move beyond comparative advantage to competitive advantage. Thus, the price cum cost comparisons becomes the best preliminary indicators of competitiveness. NPC is a simple index which measures the divergence of domestic price from international price and determines the degree of export and import competitiveness of the commodity in question.

NPC is the ratio of the domestic price to the border price (Gulati *et al.*, 1994, Datta, 2001).

$$NPC = P_d / P_b \quad \text{.................} \quad (3.18)$$

where,

NPC = Nominal protection coefficient of the commodity under consideration

P_d = Domestic price of the commodity

P_b = Border price or reference price after taking care of transportation and marketing expenses

The coefficient can be worked out either under exportable or importable hypothesis depending upon whether the commodity under consideration is exportable or an importable item. Under exportable hypothesis, the relevant border price is the fob price, whereas under importable hypothesis the border price is the cif price in the domestic port.

In the present study, an attempt has been made to analyze the export competitiveness of Indian natural rubber under exportable hypothesis using nominal protection coefficient. NPC values for the period from 1995 to 2010 were worked out by taking the price of natural rubber grade RSS-4 at Kottayam market as the domestic price and that of Bangkok market as the border price. A value of these NPC less than unity confirms export competitiveness, while value of NPC greater than unity indicates the absence of export competitive advantage (Datta, 2001).

3.13 MARKET INTEGRATION

In the present study, cointegration test was used to estimate the degree of competitiveness among the markets. The approaches as developed by Engle and Granger (1987), Johansen (1988, 1991); Johansen and Juselius (1990) primarily assume the existence of a long run linear relation between prices, which indicates a long run equilibrium relationship.

The integration of domestic market and international market was studied using the cointegration method (Johansen, 1991). Under Johansen's cointegration test, we determine whether the given set of non-stationary series is cointegrated or not. The null hypothesis assumes that no two series are co integrated.

In a Vector Auto Regression (VAR) of order p as given below:

$$y_t = A_1 y_{t-1} + \ldots + A_p t_{t-p} + Bx_t + \varepsilon_t \ldots\ldots\ldots\ldots (3.19)$$

y_t is a k-vector of non-stationary I(1) variables, x_t is a d vector of deterministic variables, and is a vector of innovations. If there are k endogenous variables, each of which has one unit root, there can be from zero to k-1 linearly independent, cointegrating relations. The Augmented Dickey Fuller (ADF) test was done to test the stationarity of the original price data (both domestic and international), and gave statistically non significant estimates, which meant that the two series were non-stationery.

Each column of the matrix gives an estimate of a cointegrating vector. The cointegrating vector is not identified unless we impose some arbitrary normalization. The software EViews 3.1 version was used for the estimation as it adopts a normalization scheme that solves the r cointegrating relations for the first r variables in the y_t vector as a function of the remaining k- r variables.

The Granger Causality Test was carried out to determine the dependence of these markets on each other. Granger Causality Test was also performed using EViews 3.1 version.

EViews runs bivariate regressions of the form

$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l Y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l}$.......... (3.20)

$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l}$........... (3.21)

for all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis, $\beta_1 = \beta_2 = \ldots\ldots \beta_l = 0$.

Results and Discussion

4. RESULTS AND DISCUSSION

Asian countries dominate the NR production sector, occupying 93 per cent of the total area under rubber cultivation in the world (ANRPC, 2010 a). In India, the NR production plays an important role in the economic and industrial development of the country because this sector involves about one million small growers among whom more than 15000 are in North East and also NR is an important raw material in the automobile industry which is growing very fastly in India (Government of India, 2010). Therefore, violent fluctuations in price would have far reaching socio-economic consequences for this sector. Understanding the price behaviour of NR finds importance in this context. Price forecasting based on past price data will help all the stakeholders especially farmers, traders and policy makers. Against this background, the present study attempts to analyze the price behaviour of NR and to evolve a reliable price forecasting model. The results are presented under the following heads.

4.1. Area, production and productivity status

4.2. Consumption status

4.3. Export status

4.4. Import status

4.5. Price behaviour

4.5.1. Secular trend

4.5.2. Seasonal variations

4.5.3. Cyclical variations

4.5.4. Irregular variations

4.6. Price instability

4.7. Price forecasting and its validation

4.8. Export competitiveness

4.9. Market integration

4.1 AREA, PRODUCTION AND PRODUCTIVITY STATUS OF NR

The price behaviour of NR, an industrial raw material is highly correlated with its supply and demand in the market. The supply of NR mainly depends upon the area, production and productivity of the crop. In the present study, an attempt has been made to analyze the annual growth pattern of NR in world and in India with special reference to Kerala, a major contributor of NR production in India.

4.1.1 **Global Scenario**

Globally, about 81 per cent of the world NR production is contributed by the major producers in South East Asia viz., Thailand, Indonesia, Malaysia, India, China and Vietnam. Indonesia is having the largest area under rubber cultivation (34.35 lakh ha), followed by Thailand (31 lakh ha), Malaysia (10.20 lakh ha), China (9 lakh ha), and finally India is in fifth position with an area of 6.55 lakh ha during the year 2008-09.

It was observed from the figures Fig. 4.1 and Fig. 4.2 that the area under rubber cultivation increased in Indonesia, Thailand, China and Vietnam. A drastic reduction in area was noticed in Malaysia from 24 per cent during 1995 to 14 per

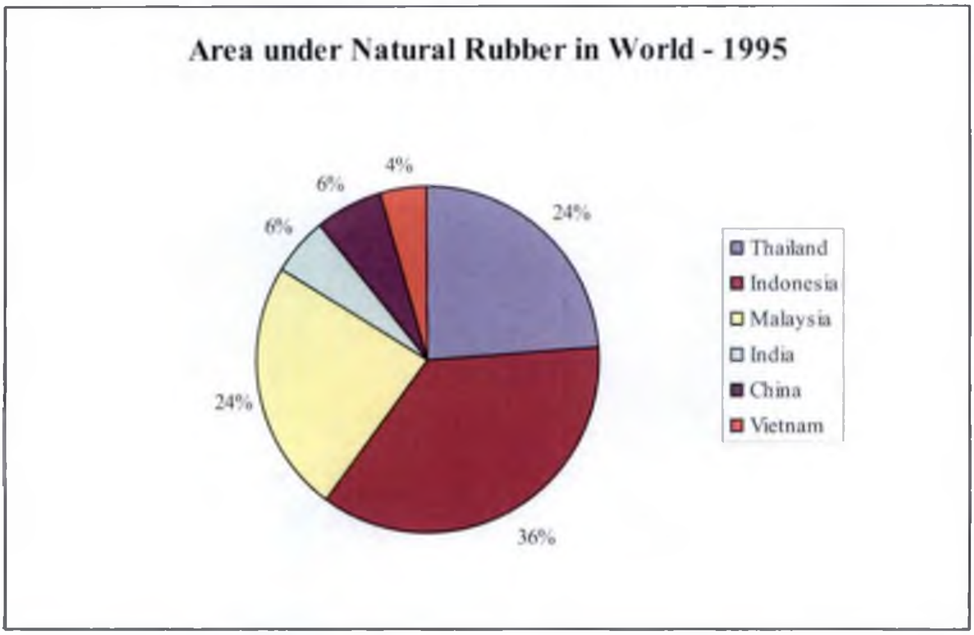

Fig. 4.1 Area under NR in major producing countries – 1995

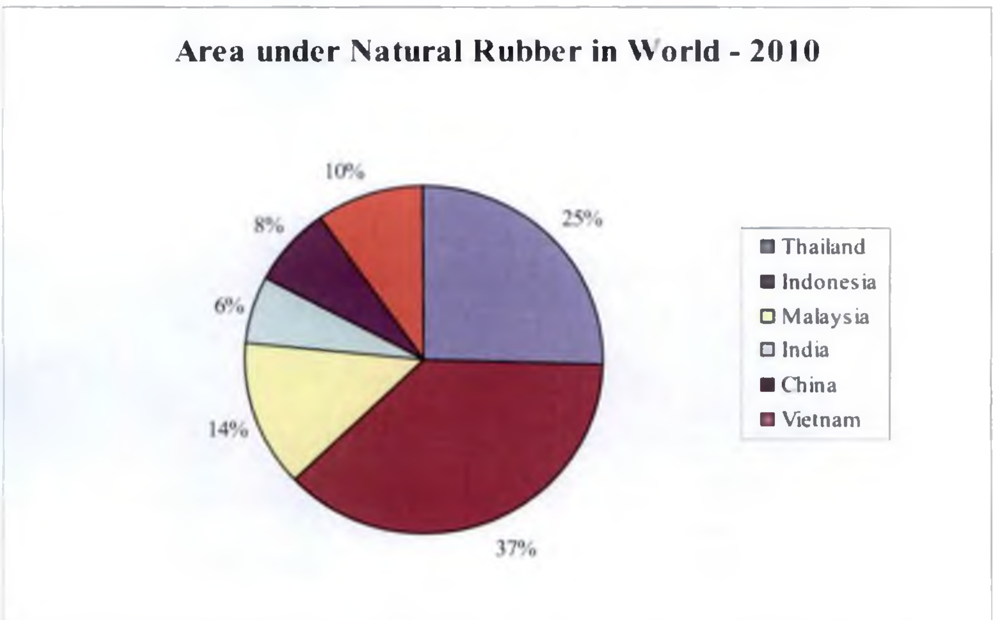

Fig. 4.2 Area under NR in major producing countries – 2010

cent during 2010 and India remains in 6 per cent of the total area under rubber during the study period. The decline in area under rubber in Malaysia was mainly due to the rapid conversion of rubber plantations in to oil palm with massive government support. Oil palm is reported to be more profitable in comparison to rubber (Athukorale *et al.*, 2009).

The total NR production in the world was 9.62 million tonnes during 2009-10. Thailand is the major producer of NR (31.64 lakh tonnes), followed by Indonesia (24.40 lakh tonnes), Malaysia (8.56 lakh tonnes), India (8.20 lakh tonnes), Vietnam (7.24 lakh tonnes) and China (6.37 lakh tonnes) during 2009. As evident from the Fig. 4.3, the NR production increased in all the major producers during the study period. But in Malaysia, a drastic reduction in NR output was noticed during 2000 and after that it also showed an upward movement.

The Fig. 4.4 shows the trends in productivity of NR in the major producing countries in the world. An increasing trend was observed in all the major producers during the period under study. It is clear from the figure that India ranks first in productivity (1771 Kg/ha), followed by Thailand (1617 Kg/ha), China (1143 Kg/ha), Vietnam (1049 Kg/ha), Indonesia (1025 Kg/ha) and finally Malaysia with 943 Kg/ha during 2010. The trends in area, production and productivity of NR in the world were studied based on the indices worked out by taking 1995 as the base year. From the Table 4.1, it is clear that 24 per cent increase in area and 30 per cent increase in productivity of NR in the world over a period of 15 years contributed to 62 per cent increase in the production of NR.

The Fig. 4.5 shows that the indices of area, production and productivity of NR in the world showed an increasing tendency during the study period, except in productivity during 2005 and in area during 2006. The reduction in area under rubber in the world during 2006 was due to the decline in area under rubber cultivation in Malaysia. The production and productivity of NR declined in 2009 due to the adverse weather conditions in the major producing countries.

Table 4.1 Area, Production and Productivity of NR in World with Indices

Year	Area(Ha)	Indices	Production (Tonnes)	Indices	Productivity (Kg/ha)	Indices
1995	7211919	100.00	6326517	100.00	877	100.00
1996	7237095	100.35	6535677	103.31	903	102.96
1997	7348371	101.89	6642776	105.00	904	103.08
1998	7460540	103.45	6644476	105.03	891	101.60
1999	7522515	104.31	6736299	106.48	895	102.05
2000	7563460	104.87	7040376	111.28	931	106.16
2001	7765881	107.68	7330965	115.88	944	107.64
2002	7847340	108.81	7590006	119.97	967	110.26
2003	8057128	111.72	8187288	129.41	1016	115.85
2004	8132629	112.77	9153461	144.68	1126	128.39
2005	8809577	122.15	9380923	148.28	1065	121.44
2006	8386039	116.28	10192231	161.10	1215	138.54
2007	8548865	118.54	10353291	163.65	1211	138.08
2008	8956353	124.19	10569081	167.06	1180	134.55
2009	8993483	124.70	10280887	162.50	1143	130.33

Source: FAO, 2010

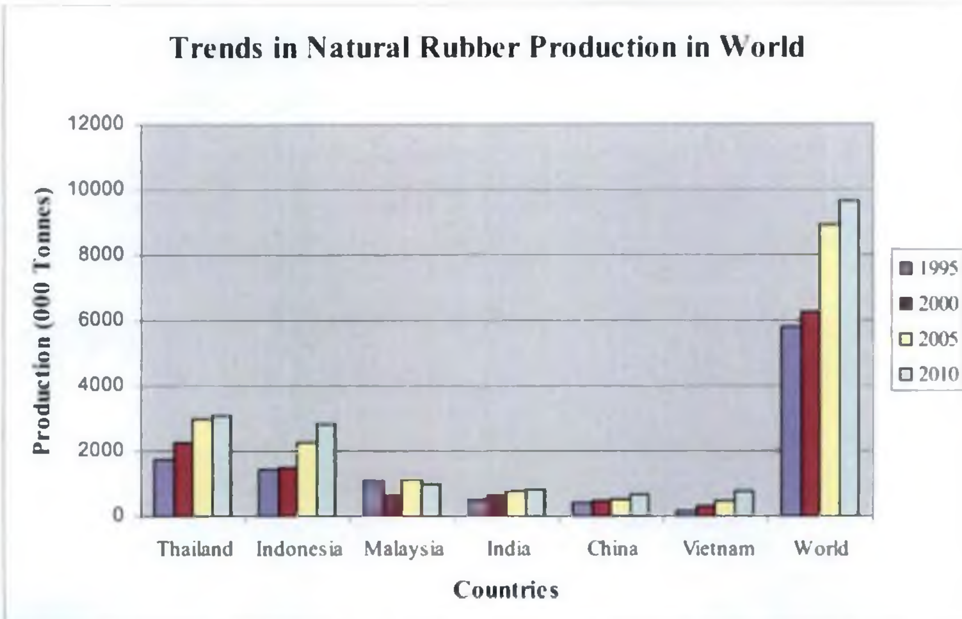

Fig. 4.3 Trends in NR production in world

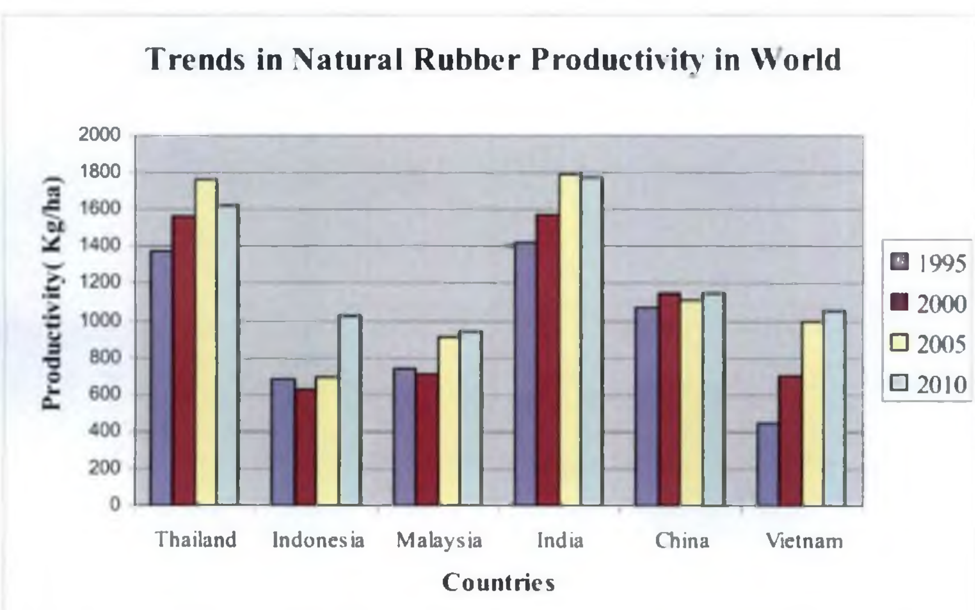

Fig. 4.4 Trends in productivity of NR in world

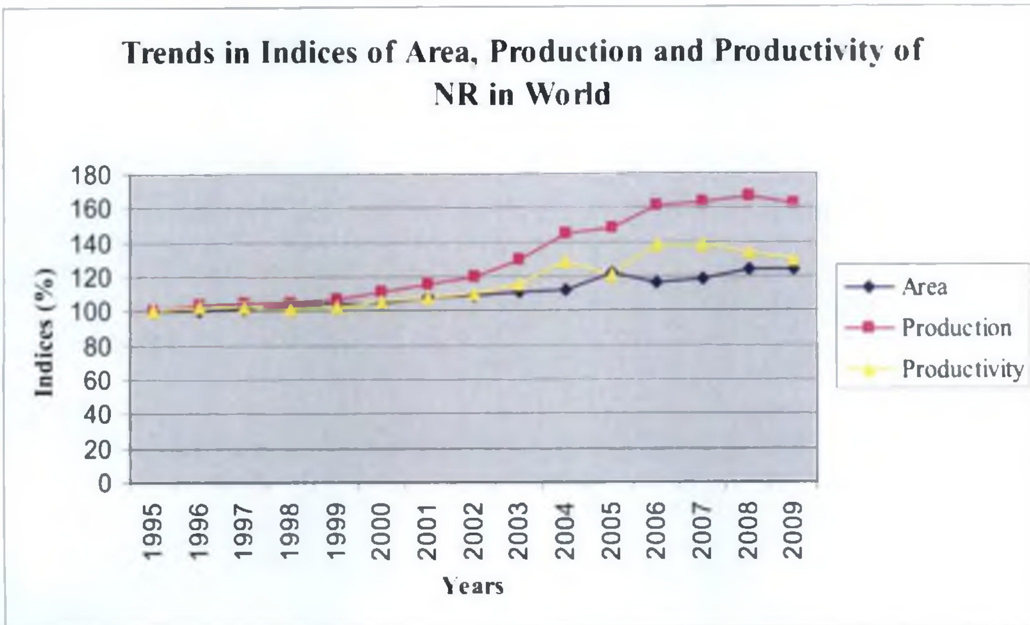

Fig. 4.5 Trends in indices of area, production and productivity of NR in world

4.1.2 **Indian Scenario**

India is the fourth largest producer of NR in the world contributing 6 per cent of the total area under rubber cultivation in the world (Fig. 4.2). India ranks first in productivity, second in consumption and fifth in area under NR in the world. In India, rubber is traditionally grown in Kerala and Kanyakumari district of Tamil Nadu and the non-traditional areas include North Eastern states like Tripura, Assam, Meghalaya, Manipur, Arunachal Pradesh and Missoram, Karnataka, Goa, Maharashtra, Orissa and Andaman and Nicobar Islands.

India had plantations in 6.62 lakh ha and produced 8.31 lakh tonnes of NR during 2009-10 (Table 4.2). In India, Kerala alone accounts for 76.53 per cent of the total area and contributes to about 89.67 per cent of the total NR production in the country. The state wise total area and production of NR in India during 2009-10 is provided in the appendix (APPENDIX I).

The area under rubber cultivation in Tripura during 2009-10 was 55415 ha with production of 25086 tonnes, which is the second largest producer of NR in India. It is clear from the figures 4.6 and 4.7 that the area under rubber in the North eastern region were showing an increasing trend from 9 per cent during 2001-02 to 15 per cent during 2009-10.

Rubber has been identified as a priority crop for rehabilitation project in Tripura because of its suitability to the terrain and the acceptability amongst the people. Government of Tripura and Rubber Board jointly work on block plantation projects and around 2750 tribal families were settled through block planting in around 3100 hectares (Government of India, 2007).

In India, 26 per cent increase in area and 25 per cent increase in productivity of NR resulted in 64 per cent rise in NR output over a period of 15 years from 1995-96 to 2009-10 (Table 4.2). The indices of area, production and productivity of NR in India exhibited an increasing trend during the period under study, except a decline in production and productivity during 2007-08 and 2009-10. The decline in production during 2009-10 was due to the adverse weather conditions and active harvesting of rubber trees during 2008. A steady increase in area under rubber cultivation was noticed in India during the period under study (Fig. 4.8).

4.1.3 Kerala Scenario

In India, Kerala alone accounts for 76 per cent of the total area under rubber cultivation. The coverage under the crop in 2009-10 was 5.25 lakh ha and the production was 7.45 lakh tonnes and the productivity was 1419 Kg/ha (Government of Kerala, 2010). Over a period of 13 years from 1995-96 to 2007-08, the area under rubber and its productivity increased to an extent of 22 per cent and 30 per cent respectively and resulted in 58 per cent rise in NR production in Kerala (Table 4.3).

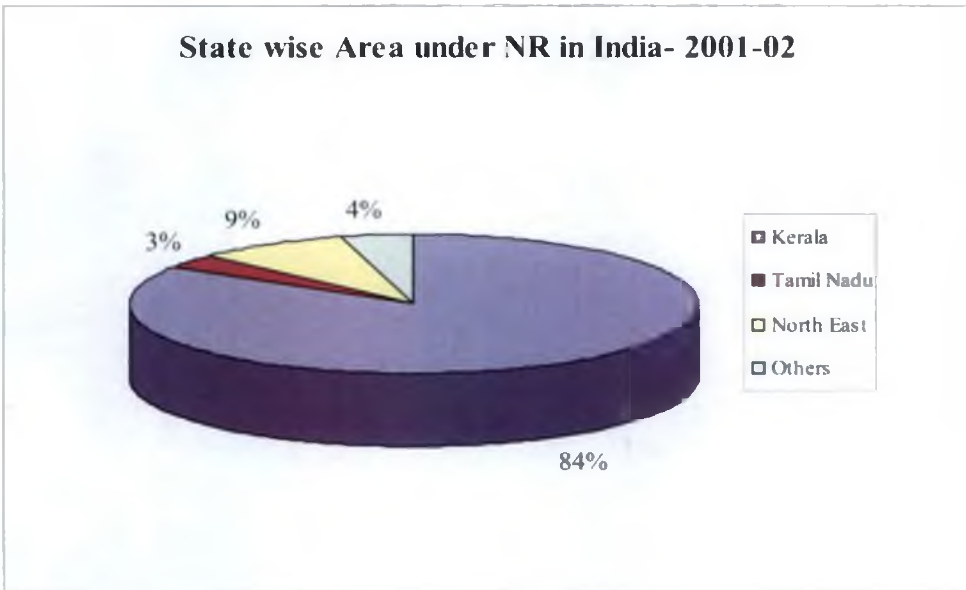

Fig. 4.6 State wise area under NR in India during 2001-02

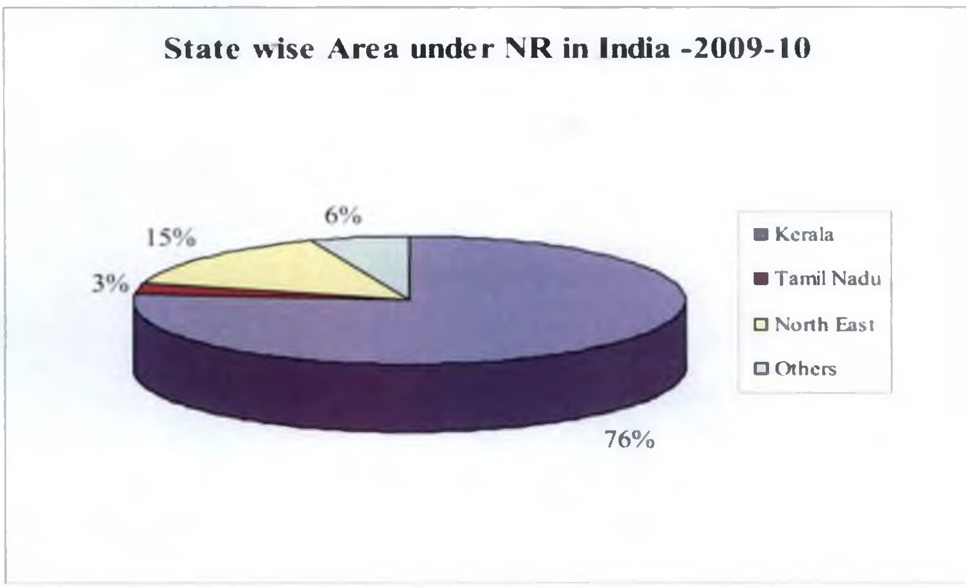

Fig. 4.7 State wise area under NR in India during 2009-10

Table 4.2 Area, Production and Productivity of NR in India with Indices

Year	Area (Ha)	Indices	Production (Tonnes)	Indices	Productivity (Kg/ha)	Indices
1995-96	524075	100.00	506910	100.00	1422	100.00
1996-97	533246	101.75	549425	108.39	1503	105.70
1997-98	544534	103.90	583830	115.17	1549	108.93
1998-99	554000	105.71	605045	119.36	1563	109.92
1999-00	558584	106.58	622265	122.76	1576	110.83
2000-01	562670	107.36	630405	124.36	1576	110.83
2001-02	566558	108.11	631400	124.56	1576	110.83
2002-03	570000	108.76	649000	128.03	1592	111.95
2003-04	573980	109.52	708000	139.67	1663	116.95
2004-05	578000	110.29	749000	147.76	1705	119.90
2005-06	581000	110.86	802625	158.34	1796	126.30
2006-07	615000	117.35	853000	168.27	1879	132.14
2007-08	615000	117.35	823000	162.36	1800	126.58
2008-09	655000	124.98	864500	170.54	1867	131.29
2009-10	662000	126.32	831400	164.01	1784	125.46

It is clear from the Fig. 4.9 that the area, production and productivity of NR in Kerala increased in a steady manner during the study period; however a slowdown in productivity is visible of late.

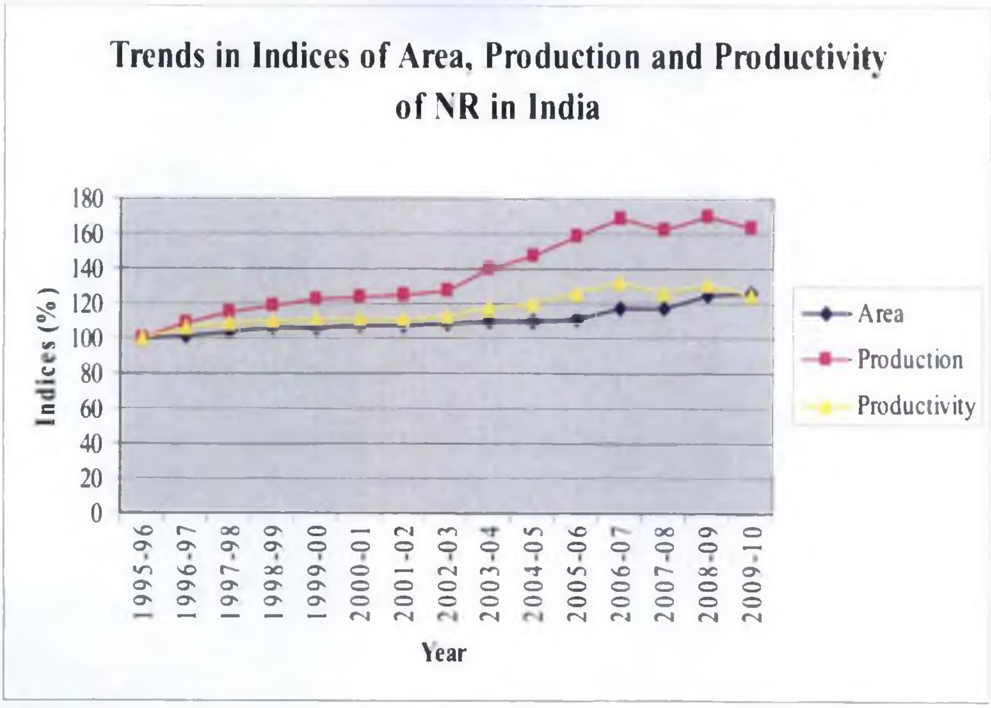

Fig. 4.8 Trends in indices of area, production and productivity of NR in India

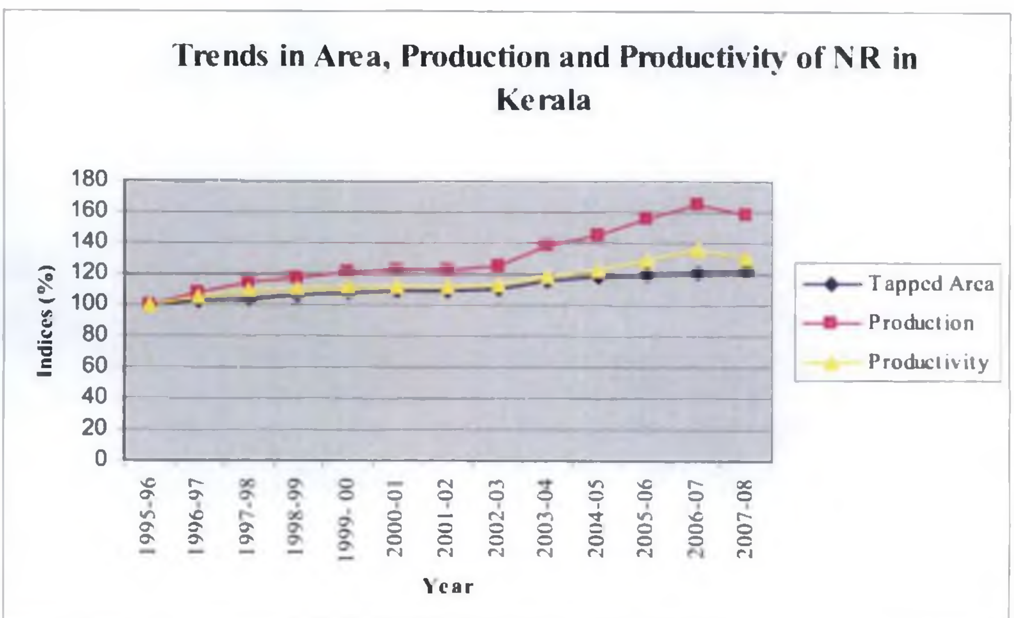

Fig. 4.9 Trends in indices of area, production and productivity of NR in Kerala

Table 4.3 Area, Production and Productivity of NR in Kerala with Indices

Year	Tapped Area (Ha)	Indices	Production (Tonnes)	Indices	Productivity (Kg/ha)	Indices
1995-96	328812	100.00	474553	100.00	1443	100.00
1996-97	335400	102.00	512756	108.05	1529	105.96
1997-98	342420	104.14	541935	114.20	1583	109.70
1998-99	349683	106.35	559099	117.82	1599	110.81
1999- 00	355342	108.07	572820	120.71	1612	111.71
2000-01	359780	109.42	579866	122.19	1612	111.71
2001-02	360006	109.49	580350	122.29	1612	111.71
2002-03	363791	110.64	594917	125.36	1635	113.31
2003-04	381970	116.17	655135	138.05	1715	118.85
2004-05	391397	119.03	690768	145.56	1765	122.31
2005-06	396385	120.55	739225	155.77	1865	129.24
2006-07	399635	121.54	783275	165.06	1960	135.83
2007-08	401420	122.08	753135	158.70	1876	130.01

4.1.4 Growth Rates in Area, Production and Productivity of NR

An attempt has been made to study the proportion and extent of changes that have taken place in area, production and productivity of NR over a period of 15 years from 1995-96 to 2009-10, but in Kerala the study was limited to 13 years. Compound Growth Rate (CGR) was used as a tool in measuring the growth and the results are given in Table 4.4 and 4.5. The CGR worked out for area, production and productivity of NR in the world are given in Table 4.4.

Globally, the NR production grew annually by 4.32 per cent which was contributed more by the growth in productivity (2.58 %) than the growth in area (1.69 %). The highest growth rate in production was observed in Vietnam (11.10

%), which was equally contributed by the growth in area (5.67 %) and productivity (6.58 %). This has enabled Vietnam to emerge as a net exporter of NR in the world. The lowest growth rate in production was observed in Malaysia (1.20 %) which was contributed by the growth in productivity (2.82 %) alone. A negative annual growth rate of 1.58 per cent was in area for Malaysia. There was rapid conversion of rubber plantations in to oil palm with massive government support during the last decade. The NR production in India grew annually by 3.82 per cent and was equally contributed by the growth in area (1.47 %) and productivity (1.79 %). The growth in production of NR in China (2.80%) was contributed mainly by the growth in area and the lowest growth rate in productivity was observed in China (0.52 %). The NR production in Kerala grew annually by 3.96 per cent and was contributed more by the growth in productivity (2.17 %) than in area (1.75 %) (Table 4.4).

Table 4.4 CGR of Area, Production and Productivity of NR in Major Producing Countries in the World

Countries	Area	Production	Productivity
Thailand	1.64	4.28	2.60
Indonesia	1.84	5.14	3.29
Malaysia	-1.58	1.20	2.82
China	2.27	2.80	0.52
Vietnam	5.67	11.10	6.58
World	**1.69**	**4.32**	**2.58**

Table 4.5 CGR of Area, Production and Productivity of NR in India and Kerala

Region	Area	Production	Productivity
India	1.47	3.82	1.79
Kerala	1.75	3.96	2.17

4.2 CONSUMPTION STATUS OF NR

In the world, China the fastest growing economy is the top consumer of NR and contributed 37 per cent of the total NR consumption in 2009. India has emerged as the second largest consumer of NR by overtaking the United States with a share of 10 per cent in world consumption (Fig. 4.10). The maximum consumption of rubber in India is in automobile industry and the Indian automobile industry witnessed a significant change during the last decade. The consumption of NR in India during 2009-10 was 9.30 lakh tonnes which was greater than the production during the same period.

The Fig. 4.11 shows that the production and consumption of NR in India showed an increasing trend during the period under study. The NR consumption registered an increase of 77 per cent compared to the 64 per cent increase in production of NR over 1995-96 which is taken as the base year (Table 4.6). The NR consumption in India grew annually by 4.08 per cent during the study period, while the annual growth rate of production was 3.82 per cent. Thus, it becomes clear that the domestic consumption of NR in India is growing at a pace faster than the growth in production.

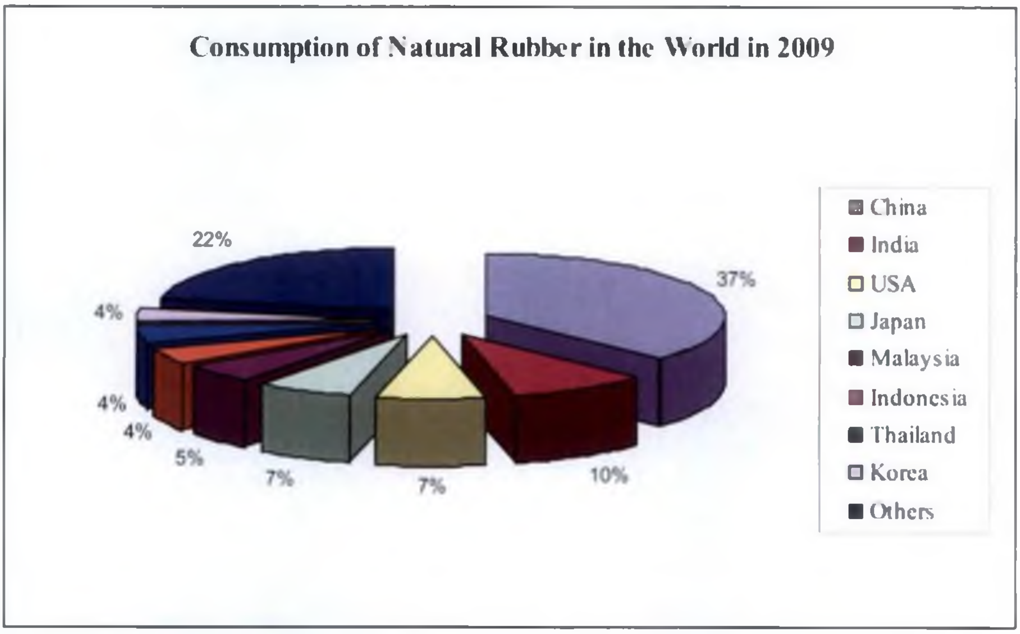

Fig. 4.10 Consumption of NR in the world during 2009

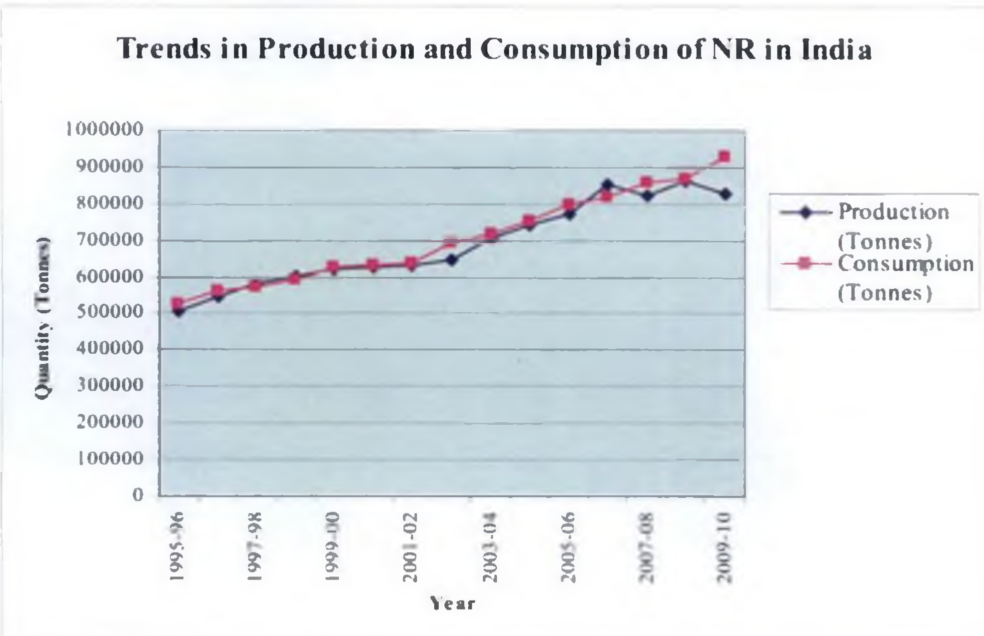

Fig. 4.11 Trends in production and consumption of NR in India

Table 4.6 Consumption of NR in India with Indices

Year	Consumption (Tonnes)	Indices
1995-96	525465	100.00
1996-97	561765	106.91
1997-98	571820	108.82
1998-99	591545	112.58
1999-00	628110	119.53
2000-01	631475	120.17
2001-02	638210	121.46
2002-03	695425	132.34
2003-04	719600	136.95
2004-05	755405	143.76
2005-06	801110	152.46
2006-07	820305	156.11
2007-08	861455	163.94
2008-09	871720	165.89
2009-10	930565	177.09

4.3 EXPORT STATUS OF NR

The major producers of NR are the major exporters of NR in the world. In 2009, Thailand contributed 44 per cent of the total NR export, followed by Indonesia (32%), Vietnam (12%), Malaysia (11%), and the contribution of India was one per cent of the total export NR in the world (Fig. 4.12). As evident from the Table 4.7, the export of NR from India rose from a low level of 1130 tonnes during 1995-96 to a highest level 13356 tonnes during 2000-01. Thereafter, the quantity exported and the value earnings from NR export were increased till 2007-

08. In 2008-09, a decline in quantity exported was observed, which also resulted in the reduction of value earnings from the export of NR.

The Indian rubber industry has a crucial role in Indian economy and has a tremendous chance of growth which in turn leads to immense increase in export opportunities. Though, India doesn't have a steady exportable surplus of NR in the latex, sheet or technically specified rubber, she largely exports rubber in the form of finished goods like tyres, rubber hoses, cots and aprons, belts and pharmaceutical goods. The exports of NR in India grew annually by 36.37 per cent and showed an increasing tendency during the study period and reached the highest, 75905 tonnes during 2003-04 (Table 4.7 and Fig.4.13). India exports rubber products to over 85 countries in the world and the main export market centres of India are China, Malaysia, USA, Germany, Pakistan, Singapore, Spain, Turkey, Indonesia and Nepal.

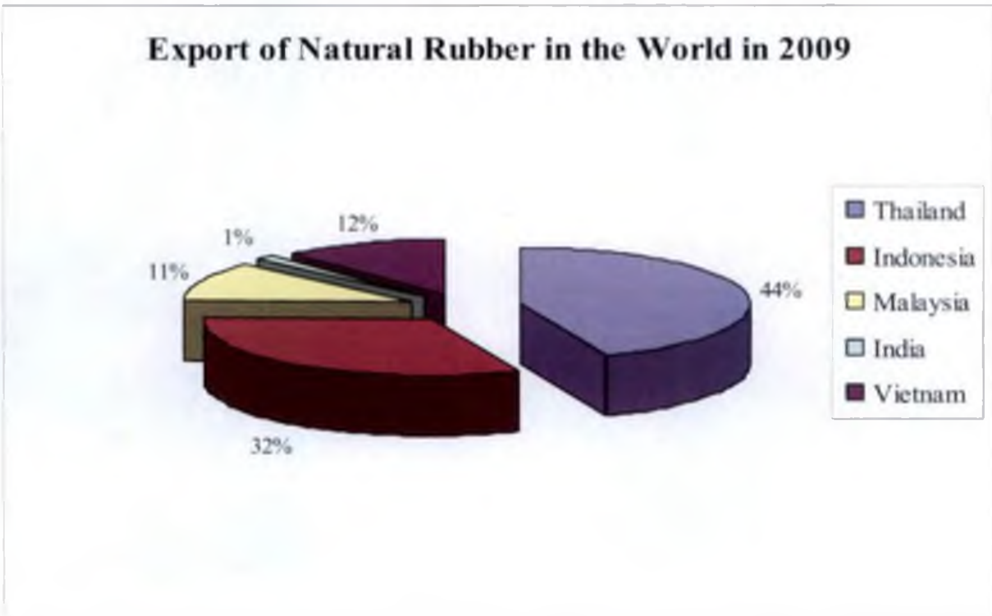

Fig. 4.12 Export of NR in the world in 2009

Table 4.7 Quantity and Value of Export of NR in India with Indices

Year	Quantity (Tonnes)	Indices	Value (1000 $)	Indices
1995-96	1130	100.00	3113	100.00
1996-97	1598	141.42	3980	127.86
1997-98	1415	125.22	2377	76.35
1998-99	1840	162.83	2482	79.74
1999-00	5989	530.00	9069	291.33
2000-01	13356	1181.95	18467	593.22
2001-02	6995	619.03	7497	240.84
2002-03	55311	4894.78	60156	1932.42
2003-04	75905	6717.26	100866	3240.17
2004-05	46169	4085.75	61738	1983.24
2005-06	73830	6533.63	136172	4374.31
2006-07	56545	5003.98	137287	4410.10
2007-08	60353	5340.97	153859	4942.46
2008-09	46926	4152.74	129212	4150.71

4.4 IMPORT STATUS OF NR

India contributed nine per cent of the total global production and 10 per cent of the total consumption of NR in the world during 2009-10. The one per cent gap in the domestic production and consumption of NR in India was met mainly by imports of NR from the major producing countries in the world. It is showing an increasing tendency due to the rapid developments in the automobile sector and the import of NR by India during 2009-10 was 170679 tonnes.

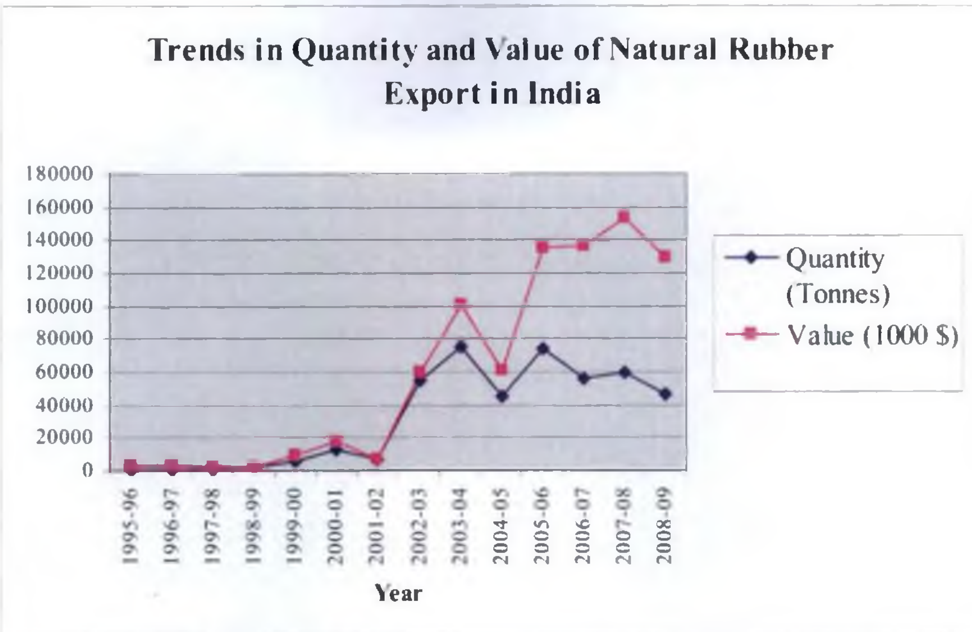

Fig. 4.13 Trends in quantity and value of export of NR in India

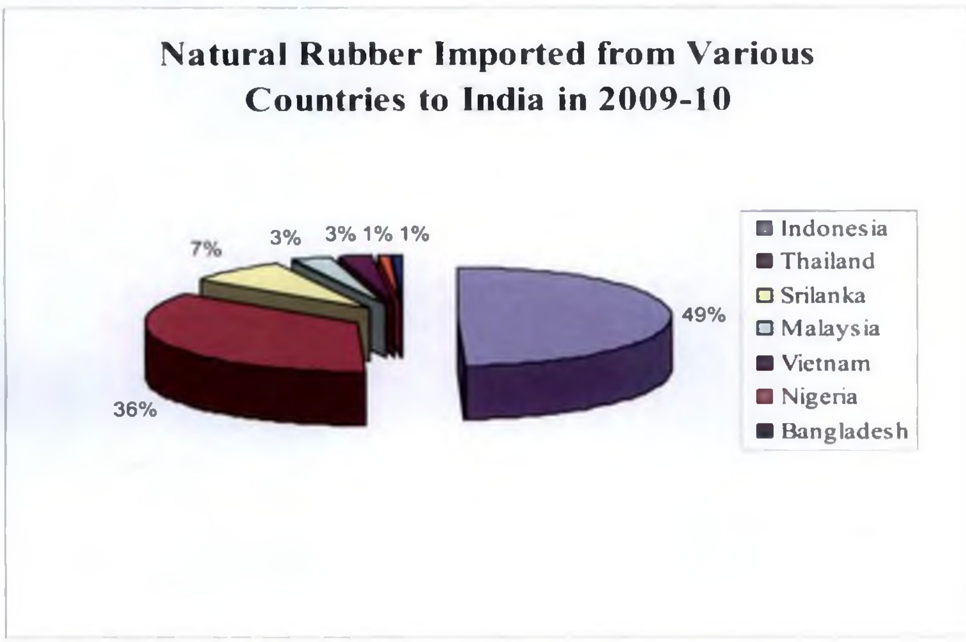

Fig. 4.14 NR imported from various countries to India during 2009-10

India recorded 57 per cent increase in the import of NR over the base year 1995-96. The highest quantity of NR was imported during 2006-07 (88040 tonnes) and the least quantity (8970 tonnes) during 2001-02 (Table 4.8). The compound growth rate of NR import during the period from 1995-96 to 2008-09 was worked out to 12.37 per cent per annum. As evident from the Fig.4.15, the quantity and value of import of NR in India showed a mixed trend during the period under study. There was a drastic decline in import of NR was observed in 1996-97 from 100 per cent during 1995-96 to 38 per cent due to the increase in production of NR during 1996-97 (Table 4.2). Thereafter, a further decline in import was noticed and reached the lowest level of 17 per cent during 2000-01 and after that a mixed trend was observed with alternate ups and downs.

According to ANRPC, China, India and Malaysia together account for 47 per cent of the global demand for NR. The major importers of NR in the world are China, India, USA and Japan. The growth in demand for NR in the automobile industry leads to tremendous increase of its import to India. India imported NR mainly from Indonesia (49%), followed by Thailand (36%), Sri Lanka (7%), Malaysia (3%) and Vietnam (3%) during 2009-10 (Fig. 4.14).

It may be noted that changes in trade policies are also instrumental in having a higher import of NR. As a result of the removal of quantitative restrictions on NR import with effect from 1st April 2001, 49769 tonnes of NR was imported during 2001-02. During 2002-03, the import declined to 26217 tonnes because of the unattractive price margin. A rise in import was observed during 2003-04 due to the removal of the ban on import under Advance Licence Scheme.

Another important development in government policy which favour the import of NR in India was that the government restored the facility for duty free import of NR in July 2003 and further from 8th January 2004 onwards, reduced the customs duty on NR from 25 per cent to 20 per cent and cancelled the Special

Additional Duty (SAD) of 4 per cent. Further, the port restriction on import of NR imposed on 6th August 2004. All the above factors contributed to the record rise in import of NR during 2004-05 to 72835 tonnes.

Table 4.8 Quantity and Value of Import of NR in India with Indices

Year	Quantity (Tonnes)	Indices	Value (1000 $)	Indices
1995-96	51635	100.00	141185	100.00
1996-97	19770	38.29	46338	32.82
1997-98	32070	62.11	53365	37.80
1998-99	29534	57.20	35881	25.41
1999-00	20213	39.15	21785	15.43
2000-01	8970	17.37	10803	7.65
2001-02	49769	96.39	59639	42.24
2002-03	26217	50.77	36343	25.74
2003-04	43154	83.58	69139	48.97
2004-05	72835	141.06	149316	105.76
2005-06	45285	87.70	105201	74.51
2006-07	88040	170.50	227823	161.36
2007-08	86394	167.32	232918	164.97
2008-09	81545	157.93	232486	164.67

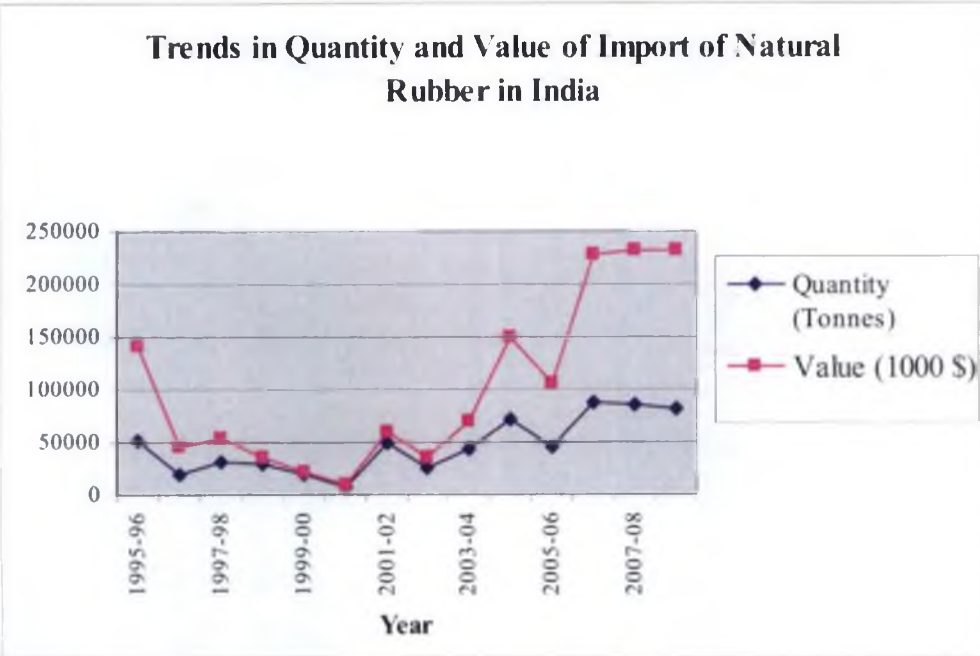

Fig. 4.15 Trends in quantity and value of import of NR in India

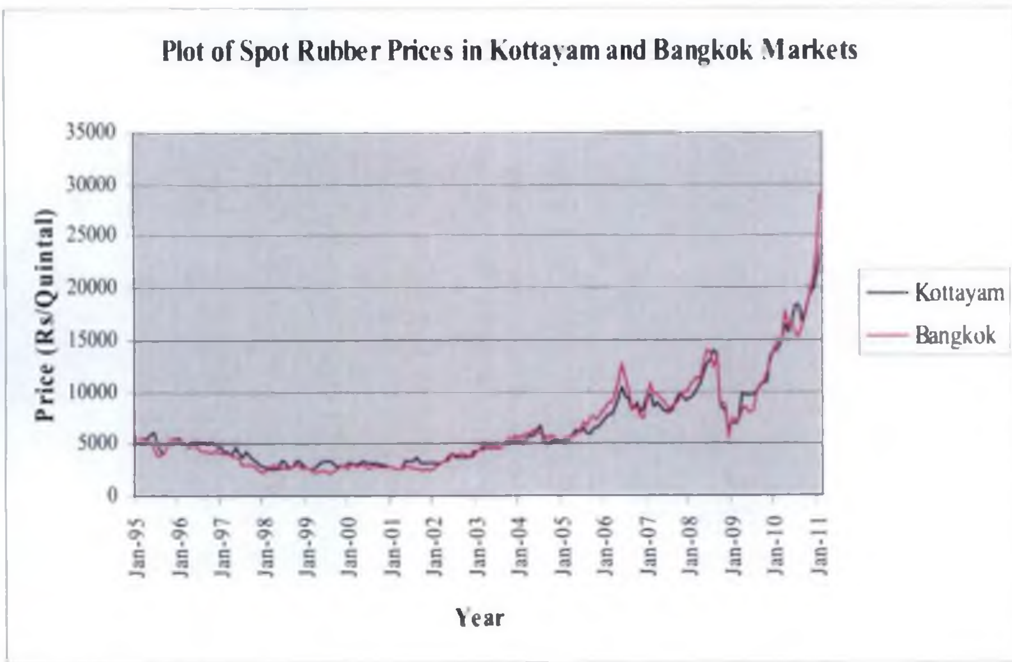

Fig. 4.16 Plot of spot prices of NR in Kottayam and Bangkok markets

A sudden decline in import of NR was observed during 2005-06 due to the increased domestic production. During 2006-07, a large quantity of NR was imported by the automobile industry due to the wide difference between domestic and international prices. In 2007-08, the import of NR remained almost steady at 86394 tonnes, with the demand from the automobile industry remain strong and the rise in domestic spot prices made the international prices more attractive.

4.5 PRICE BEHAVIOUR OF NR

Prices perform a number of functions in an economic system. In a competitive economy, the pricing mechanism provide the signals to the producers in deciding what and how much is to be produced with the available resources for maximisation of income. The wide price fluctuations affect the incomes and living standards of farmers, rural labourers and the non-farming population (Acharya and Agarwal, 1991). The unpredictable changes in the market arising from the disequilibrium of demand and supply bear serious implications on the net income of the producers of the perennial crops compared to annual crops.

The studies on the price behaviour of perennial crops assume added significance because it involves higher investment, long gestation period and an extended span of economic life and will also provide valuable information to formulate effective price policy to safeguard the interest of farmers. In this background, the present study was conducted to analyze the price behaviour of NR, RSS-4 grade in the domestic market at Kottayam and International market at Bangkok during the period from 1995 to 2011.

The monthly modal price data of NR grade RSS-4 were collected from the Rubber Board, Kottayam pertaining to the two reference markets from January 1995 to February 2011, by covering a period of 16 years. The data were subjected to the technique of classical decomposition of time series analysis and decomposed in to its four components viz., secular trend, seasonal variations, cyclical variations and irregular variations. The following section contains the description of the four components of time series under appropriate headings.

4.5.1 **Trend Analysis of Prices of NR**

A detailed trend analysis was carried out separately for domestic as well as international markets by applying the method of least squares. The various functional forms viz., linear, quadratic, compound, growth, logarithmic, cubic, sigmoid, exponential, power, inverse and logistic models were tried to explain the trend in the price of NR. The model form, adjusted R^2 values, Standard Error (SE) and parameters of the fitted models for both the international and domestic markets are given in APPENDIX II and III respectively. The higher R^2 values were obtained only for quadratic and cubic models fitted to both the markets. The plots of these two models obtained for Bangkok and Kottayam markets are provided in APPENDIX IV and V respectively.

Hence, exponential smoothing methods viz., single exponential and double exponential smoothing were tried to explain the underlying trend in the data. It was observed that single exponential smoothing itself has enough capacity to explain the underlying trend in prices of RSS-4 in both international and domestic markets with a MAPE value of 7 per cent and 6 per cent respectively.

The Fig.4.16 shows the plot of spot price of RSS-4 in both the international as well as domestic markets and it was observed that the rubber prices in both the markets moved in the same direction. As evident from Fig. 4.17 and 4.18, both the domestic and international prices followed the same trend with simultaneous movement in the upward and downward directions. The analysis showed that the RSS-4 prices in the Bangkok as well as the Kottayam markets were stagnant from January 1995 to April 2001; thereafter the prices showed an increasing trend.

The increasing trend in rubber prices is mainly attributed to the increase in demand for NR in large scale for the automobile sector that was witnessing an expansion during this phase in China, Korea and India. The global supply of NR was also tight due to the changing weather conditions and the active replanting activities in most of the major rubber producing countries in the world. The factors other than demand and supply, which affect rubber prices, include weakening of US dollar, volatility in Yen, increasing crude oil prices and futures market (ANRPC, 2010 b). Currently the NR industry is passing through a situation of tight supply due to progressive decline in production and a substantial increase in demand as the industrial economies are recovering fast from global recession. Hence, it is expected that secular trend in rubber prices may continue to move upwards in the medium perspective as the crude oil prices are also remaining buoyant.

4.5.2 Seasonal Variations in Rubber Prices

The seasonality in the production of crops which results in seasonality in market arrivals mismatching with round the year consumption leads to seasonal variations in the price of agricultural commodities. The degree of seasonal fluctuations in prices is related to the degree of perishability of the product and availability of storage and other market infrastructure facilities. The present study therefore makes an attempt to measure the seasonal variations in the price of NR in the international as well as the domestic market. The seasonal price indices were worked out separately for both the markets.

The Table 4.9 shows the seasonal indices for the two markets. As evident from the Fig.4.19, there was some similarity in the seasonal variations exhibited by the rubber prices in the two markets. In the international market, the highest price index was observed in June (103.98) and the lowest was obtained during the month of July (95.30). A drastic reduction in price was noticed in July from the

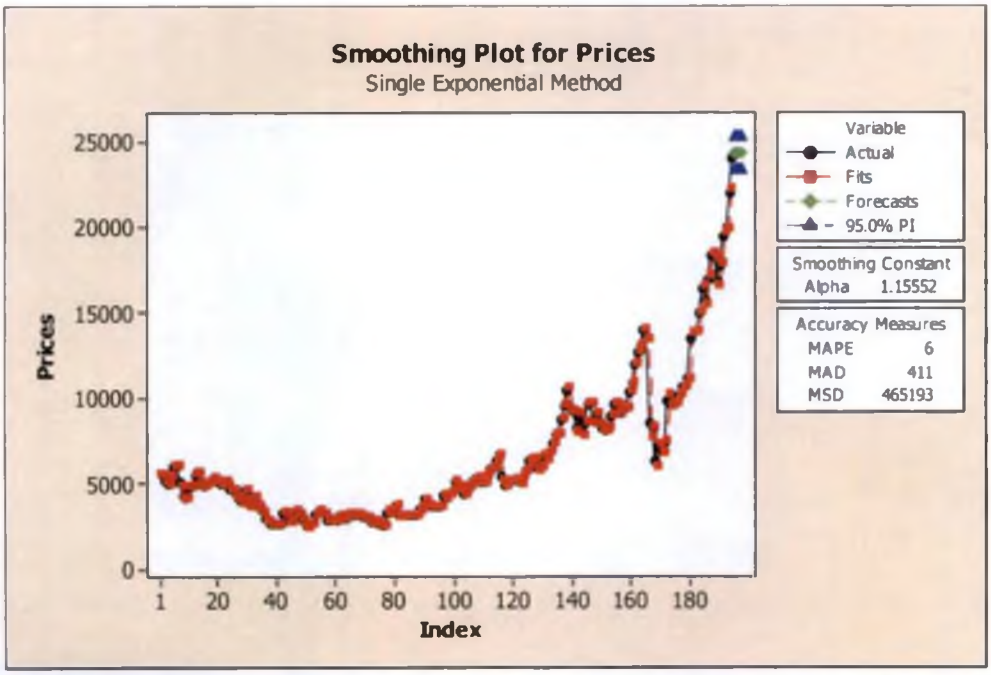

Fig. 4.17 Trend line fitted to RSS-4 prices in Kottayam market using SES method

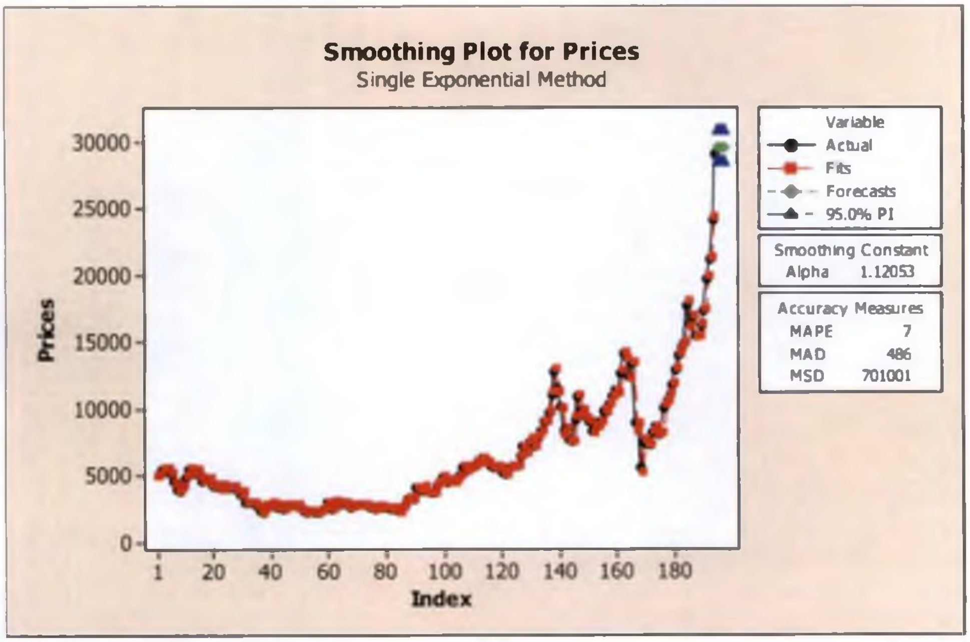

Fig. 4.18 Trend line fitted to RSS-4 prices in Bangkok market using SES method

peak price in June in the Bangkok market. In the Kottayam market, on the other hand buoyant phase was observed during May to July with the peak price during May (107.52) and trough phase from September to February with the lowest price in the month of February (94.56).

The intra year price fluctuation is mainly due to the seasonality in production, weather conditions and also the changes in the demand and supply of the commodity. As far as the annual production pattern in rubber is considered, the maximum yield is getting during the months of November, December and January and the lean production period occurs in February, March and April which coincides with the low market arrivals because of the wintering and tapping rest given to the rubber trees. In the major rubber producing countries in the world viz., Thailand, Indonesia and Malaysia, the wintering season is from February to April and the production is less during that period which will cause the price to increase in the months of April, May and June.

In the Kottayam market the buoyant phase in rubber prices is in months of May, June and July because of low production of NR in Kerala due to the onset of South West monsoon, but from August onwards the production increases and the prices are declining and it reaches the minimum during February. Hence, there exist an inverse relationship between rubber prices and market arrivals. The study by Ipe (1988) to analyze the seasonal variations in rubber prices showed that the seasonal price index was the highest in July and the lowest in December. There is advancement in peak price to May in the present study. This may be due to the impact of climate change on rubber production, whereby South West monsoon pattern has changed drastically during the last five years.

Table 4.9 Seasonal Indices of Rubber Prices in Bangkok and Kottayam Market

Month	Bangkok Market	Kottayam Market
January	100.19	96.66
February	101.37	94.56
March	102.22	97.41
April	103.43	101.38
May	102.76	107.52
June	103.98	104.53
July	95.30	106.27
August	96.47	101.12
September	98.34	98.44
October	99.08	99.20
November	99.68	96.78
December	97.18	96.23

4.5.3 Cyclical Variations in Rubber Prices

The indices for the cyclical variations in RSS-4 prices were worked out separately for the international and domestic markets and depicted in Fig. 4.20. As evident from the figure, no price cycles could be identified in the rubber prices in the international as well as domestic markets.

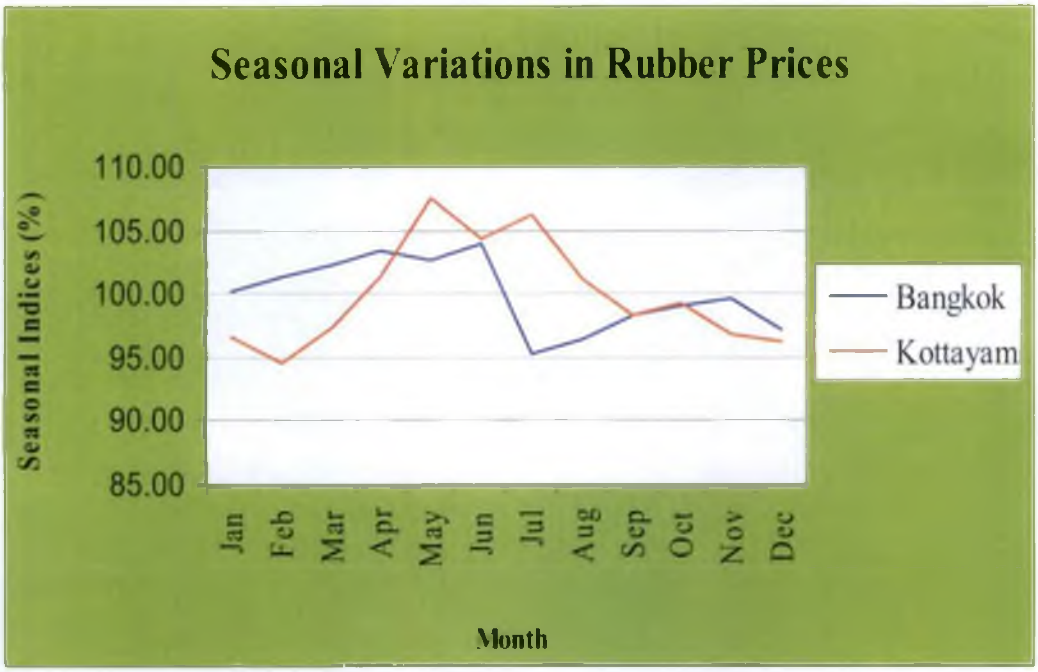

Fig. 4.19 Seasonal variations in RSS-4 prices in Kottayam and Bangkok markets

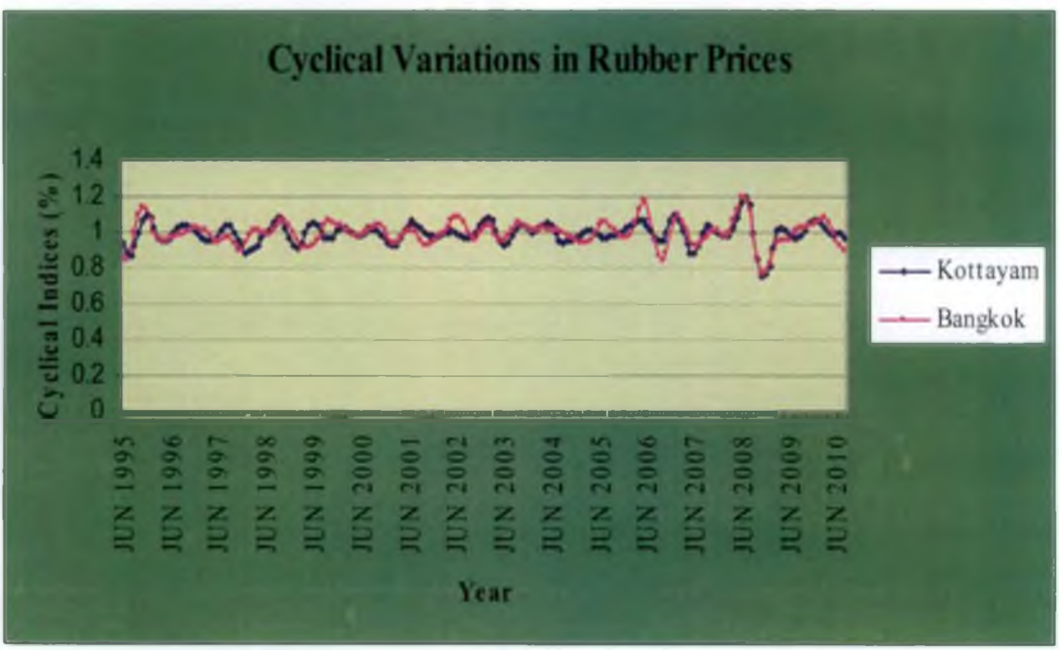

Fig. 4.20 Cyclical variations in RSS-4 prices in Kottayam and Bangkok markets

4.5.4 **Irregular Variations in Rubber Prices**

The indices of irregular variations were worked out separately for international and domestic markets using the residual method by eliminating the trend, seasonal and cyclical components from the original data. The indices are presented graphically in Fig.4.21. It may be noted that there were considerable irregular variations in the rubber prices in both the markets. The irregular variations in the international and domestic markets exhibited the same pattern. Such associations of domestic and international markets are possible in the current era when high market interventions have been witnessed, and reported earlier by Anjaly *et al.* 2010 and Jayasree *et al.* 2010. The irregular variations in rubber prices are indicative of the demand and supply shocks due to the incidence of adverse weather conditions in the major producing countries, which fuels intensive speculative activities.

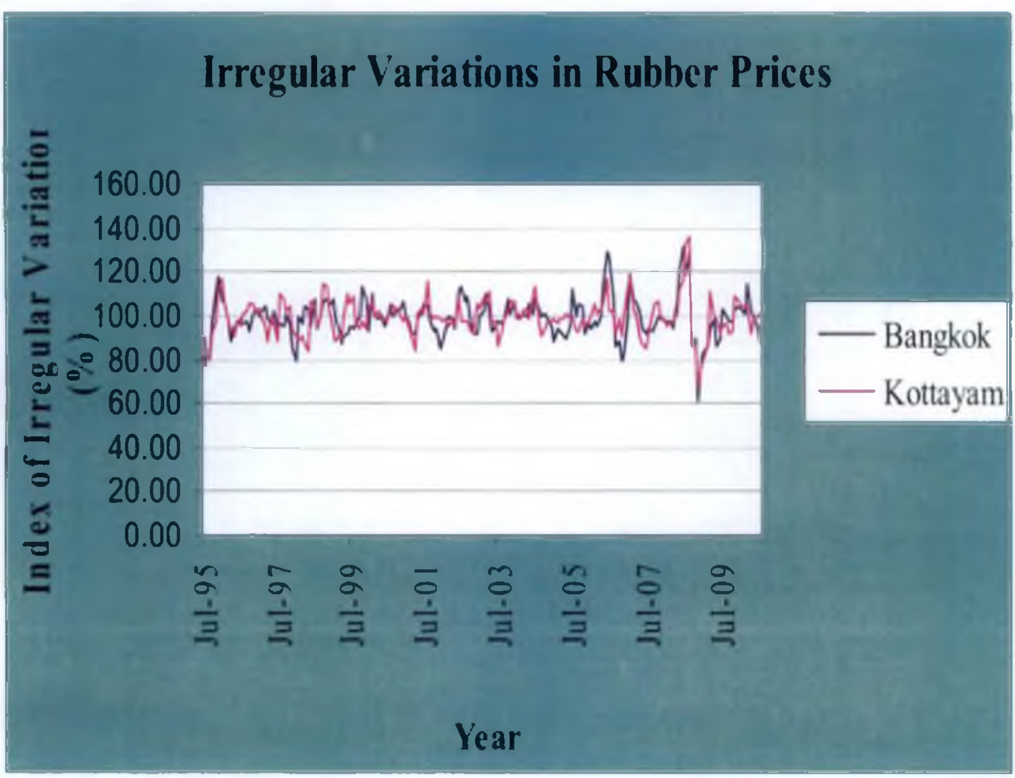

Fig. 4.21 Irregular variations in RSS-4 prices in Kottayam and Bangkok markets

4.6 PRICE INSTABILITY IN NR PRICES

The instability in rubber prices was studied using the coefficient of variation (CV). The CV values obtained for the domestic as well as international markets were 63.71 per cent and 68.76 per cent respectively, which meant that the rubber prices in both the markets were highly unstable.

4.7 PRICE FORECASTING AND VALIDATION OF NR

Forecasts of agricultural commodity prices are intended to be useful for farmers, governments and agribusiness industries. Since NR is an industrial raw material with huge demand potential, forecasting the price of NR will have greater impact on the industrial sector as well as the farmers can also make advantage out of the likely market prices in the immediate future. Hence, in this study, an attempt has been made to evolve a reliable price forecasting model for NR grade RSS-4 in the Kottayam as well as Bangkok markets using various methods viz., moving average, single exponential smoothing, double exponential smoothing, Box-Jenkins ARIMA model and also by ANN model.

4.7.1 **Price Forecasting using Moving Average Method**

The short term price forecasts were made about RSS-4 prices in the Kottayam and Bangkok markets using moving average method. It is clear from the Fig. 4.22 and Fig. 4.23 that the trend lines fitted with moving average method on the time series data of RSS-4 prices in Kottayam and Bangkok markets were not able to capture the actual trend in the data. There were many outlier values in the data which were not considered in this method and the accuracy of the models were 89 per cent and 87 per cent for Kottayam and Bangkok markets respectively. The Table 4.10 shows the forecasted price of RSS-4 in the Kottayam and Bangkok markets for the months of March'11, April'11 and May'11.

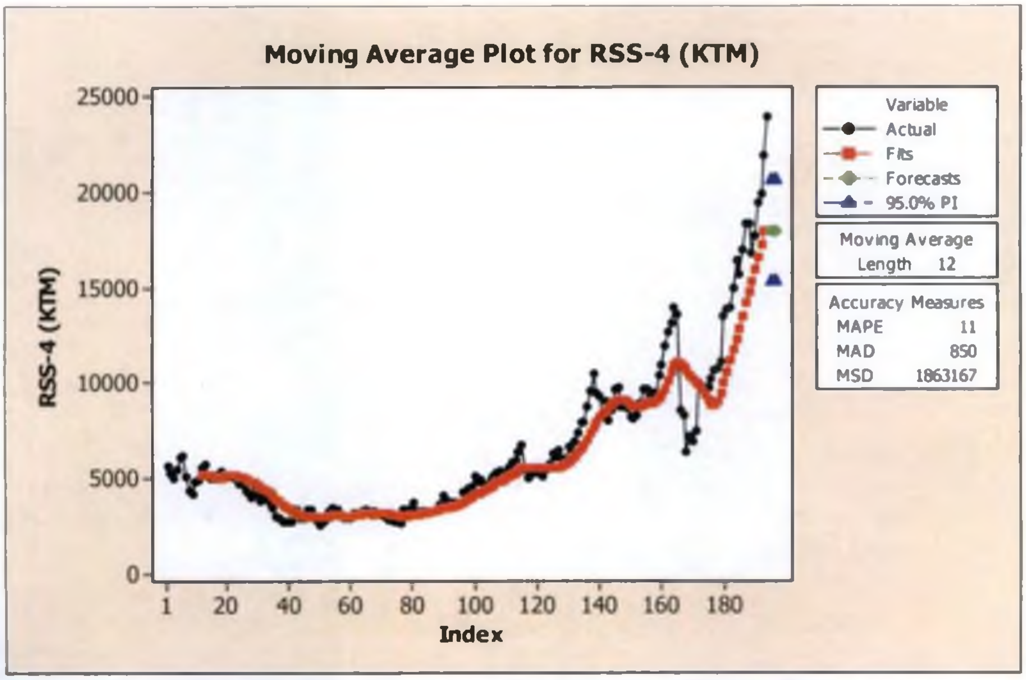

Fig. 4.22 Moving average plot of RSS-4 prices in Kottayam market

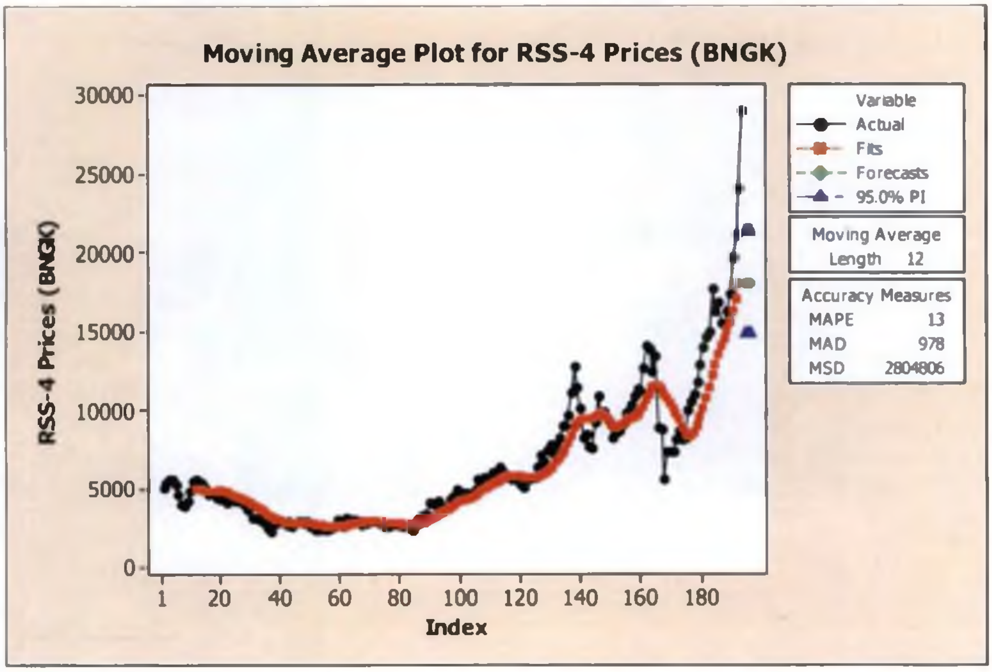

Fig. 4.23 Moving average plot of RSS-4 prices in Bangkok market

Table 4.10 Forecasted Price (Rs/Kg) of RSS-4 in Kottayam and Bangkok Markets using Moving Average Method

Months	Kottayam Market	Bangkok Market
March' 11	180	181
April' 11	180	181
May' 11	180	181

4.7.2 Price Forecasting using Exponential Smoothing Methods

In this study, the exponential smoothing methods viz., single and double exponential smoothing methods were tried to forecast the price of RSS-4 in the Kottayam and Bangkok markets. It was observed from the figures (Fig. 4.17, Fig. 4.18, Fig. 4.24 and Fig. 4.25) that the trend lines fitted with single and double exponential smoothing methods were good enough to capture the actual trend in the data and also the fitted models were having above 90 per cent accuracy. The accuracy measures obtained for these two models fitted to Kottayam and Bangkok markets are given in Table 4.11.

It is clear from the tables (Table 4.10 and Table 4.12) that the predicted prices were same for the three months using moving average and single exponential smoothing methods in both the domestic as well as international markets. As the predicted values do not reflect the fluctuating price of NR, moving average as well as single exponential smoothing methods were not considered as an appropriate model for forecasting NR prices.

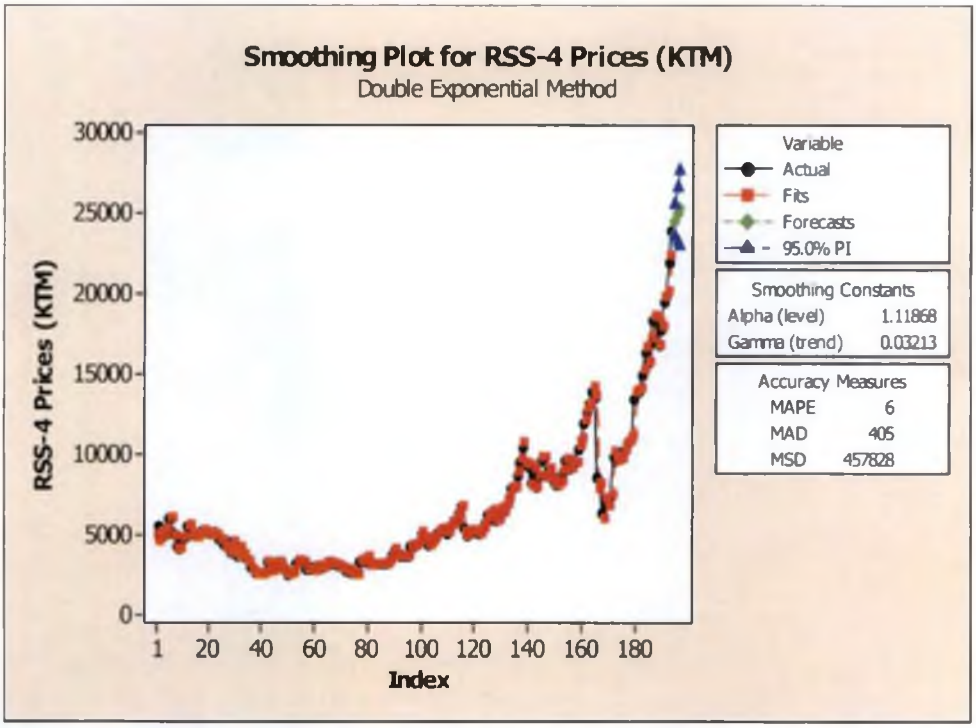

Fig.4.24 Smoothing plot of RSS-4 prices in Kottayam market using DES method

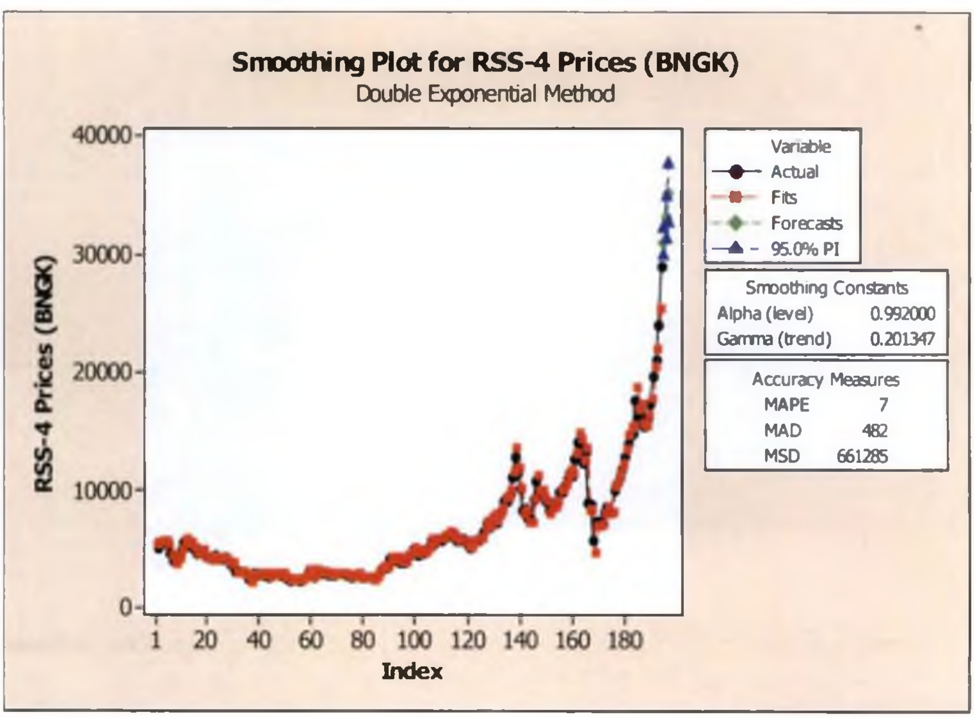

Fig.4.25 Smoothing plot of RSS-4 prices in Bangkok market using DES method

Table 4.11 Accuracy Measures of Exponential Smoothing Methods

Accuracy Measures	Kottayam Market		Bangkok Market	
	SES	DES	SES	DES
MAPE	6	6	7	7
MAD	411	405	486	482
MSD	465193	457828	701001	661285

Table 4.12 Forecasted Price of RSS-4 in Kottayam and Bangkok Markets using Exponential Smoothing Methods

Months	Kottayam Market		Bangkok Market	
	SES	DES	SES	DES
March' 11	243	246	296	311
April' 11	243	250	296	332
May' 11	243	254	296	353

4.7.3 Price Forecasting using ARIMA Models

Box-Jenkins ARIMA models were tried as an improvement over the previous models as a reliable price forecasting model in the short term. Various ARIMA models were tried separately for both the data with and without outlier values. However, none of them were found to be good fit for rubber prices in Kottayam market. Hence, ANN model was tried to predict the price of RSS-4 in Kottayam market.

Whereas in Bangkok market, ARIMA (0, 1, 0) (1, 0, 1) was identified as the best model for the data without outlier values. The accuracy of the model based on MAPE values, Normalized BIC and ACF and PACF plots of residuals were also satisfactory (Table 4.13, Fig. 4.27). The plot of actual and predicted price of RSS-4 in the Bangkok market also indicates the fitness of the model (Fig. 4.26). The predicted price of RSS-4 in Bangkok market using ARIMA (0, 1, 0) (1, 0, 1) is given in Table 4.14.

Table 4.13 Accuracy Measures of ARIMA (0, 1, 0) (1, 0, 1) model for Bangkok Market

Accuracy Measures	ARIMA (0,1,0) (1,0,1)
MAPE	6.01
Normalized BIC	13.18

Table 4.14 Forecasted Price of RSS-4 in Bangkok Market using ARIMA (0, 1, 0) (1, 0, 1)

Months	Forecasted Price (Rs/Kg)
March'11	292
April'11	297
May'11	301

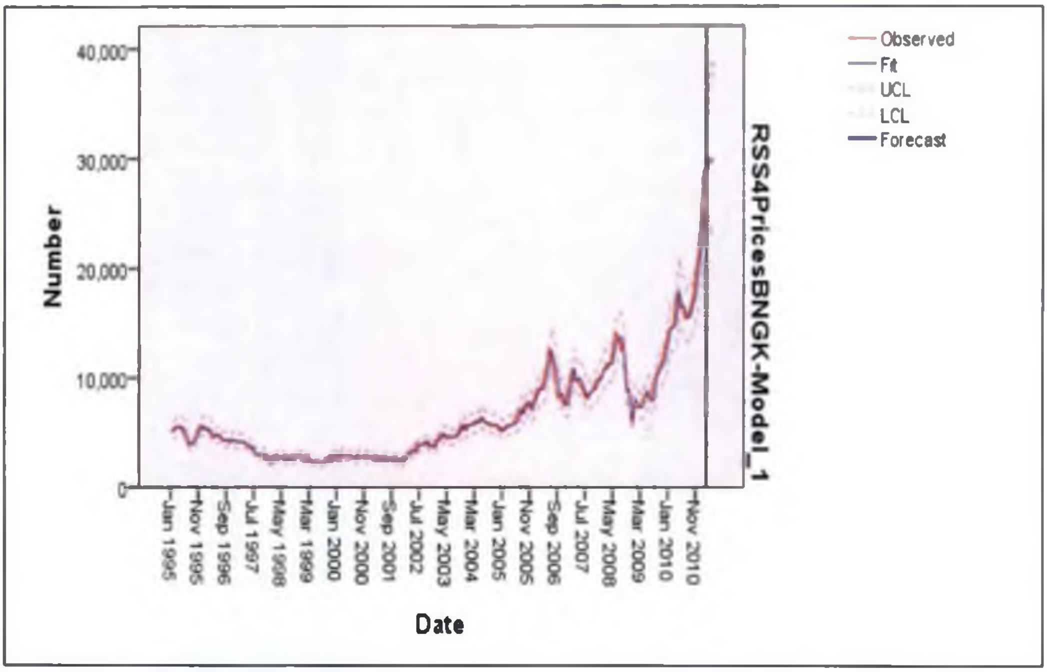

Fig. 4.26 Plot of actual and predicted price of RSS-4 in Bangkok market using ARIMA (0, 1, 0) (1, 0, 1) model

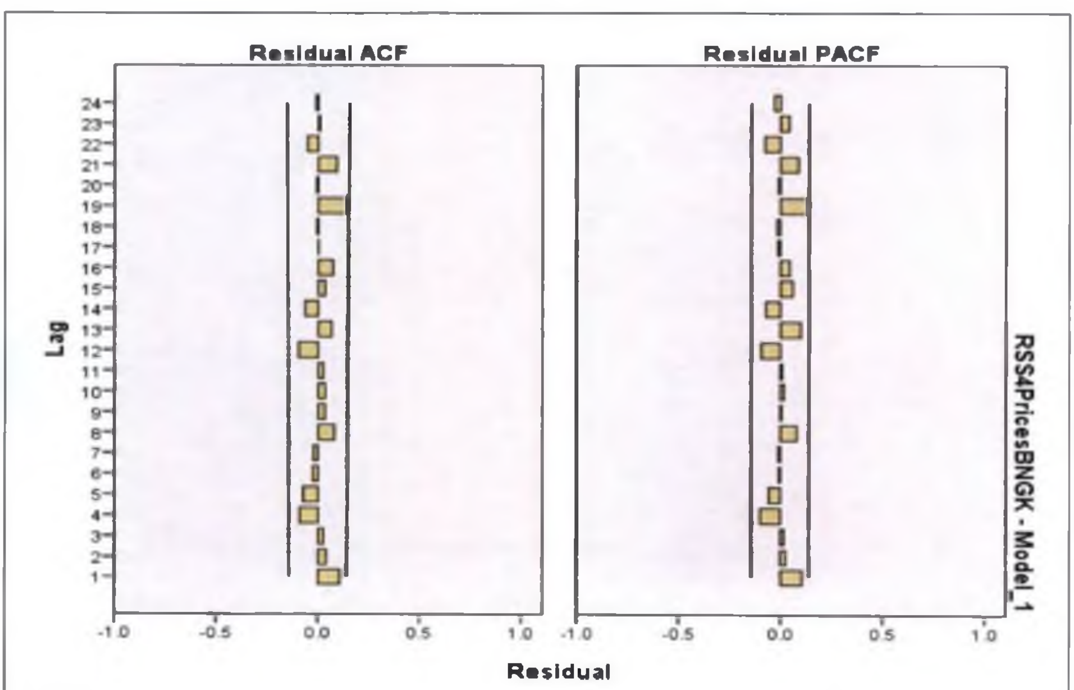

Fig. 4.27 ACF and PACF plots of ARIMA (0, 1, 0) (1, 0, 1) model fitted to RSS-4 prices in Bangkok market

4.7.4 **Price Forecasting using ANN Model**

The price of RSS-4 in Kottayam market forecasted using this model is given in the Table 4.15 along with error parameters. It is clear from the Fig. 4.28 that the actual and predicted price of RSS-4 in Kottayam market using ANN model was moving together with no variation in the mean. The Fig. 4.29 shows the stationarity of the residuals indicating the fitness of the model in predicting the price of RSS-4 in Kottayam market.

Table 4.15 Forecasted Price of RSS-4 in Kottayam Market using ANN Model

Month	**Forecasted Price (Rs/Kg)**
March'11	225.00
April'11	219.00
May'11	223.00

Error parameters: MAE – 439.91, MSE – 452458.08, Error – 0.0564

ANN model was also tried to predict the price of RSS-4 in Bangkok market. The actual and predicted price graph and the plot of residuals obtained by ANN model are given in Fig. 4.30 and Fig. 4.31 respectively. It is clear the Fig.4.30 that the actual and predicted prices are moving close to each other and the Fig. 4.31 indicates the stationarity of the series. The rubber price predicted using ANN model is provided in Table 4.16 along with the error parameters. Based on the statistical accuracy measures, it was inferred that ANN is a preferred model for predicting the price of RSS-4 in Bangkok market.

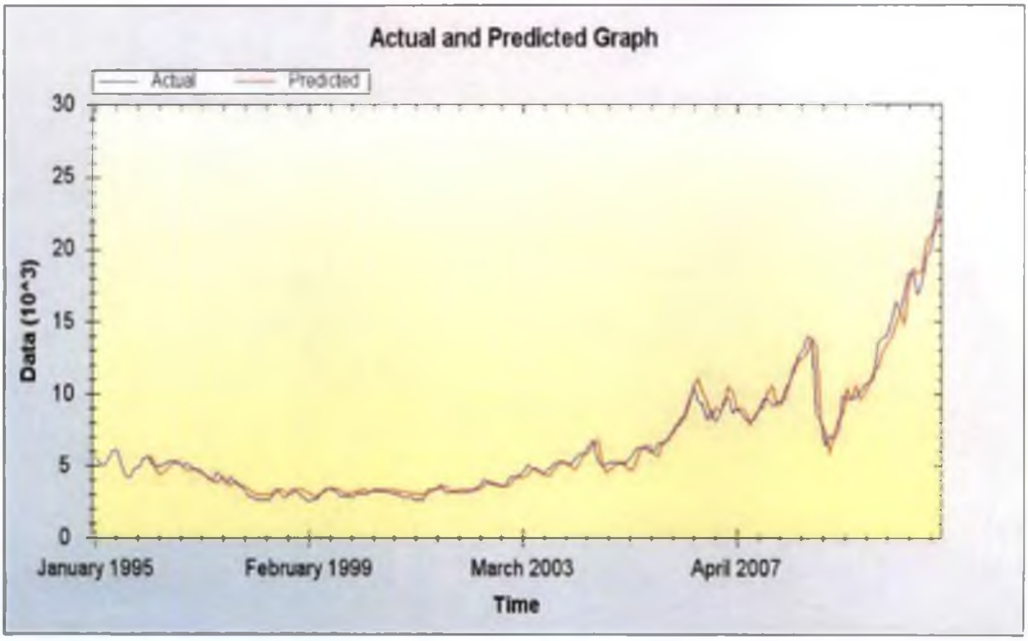

Fig. 4.28 Plot of actual and predicted price of RSS-4 in Kottayam market using ANN model

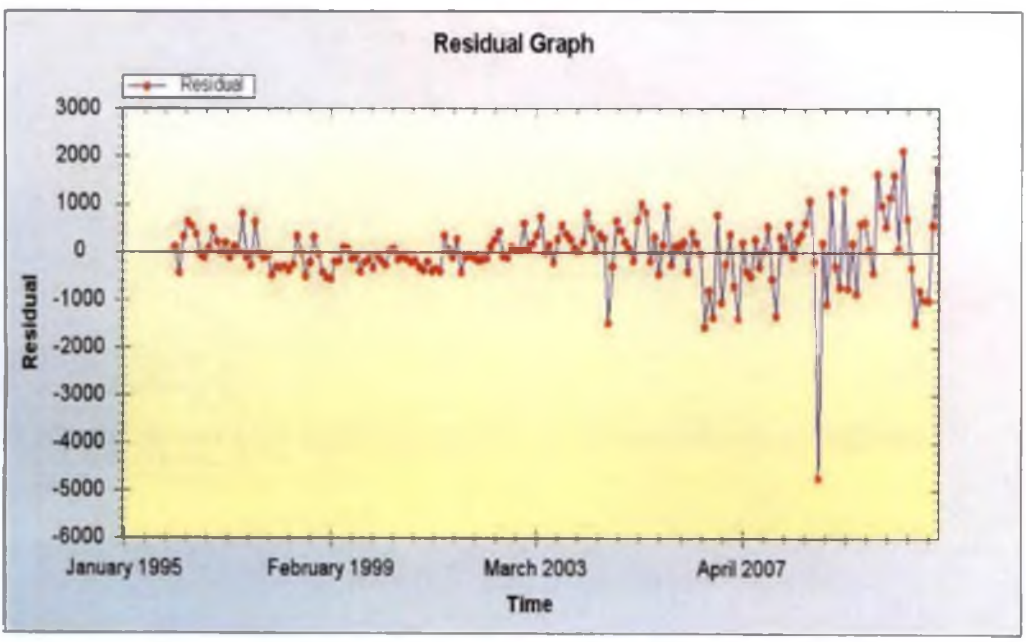

Fig. 4.29 Plot of residuals of RSS-4 prices in Kottayam market using ANN model

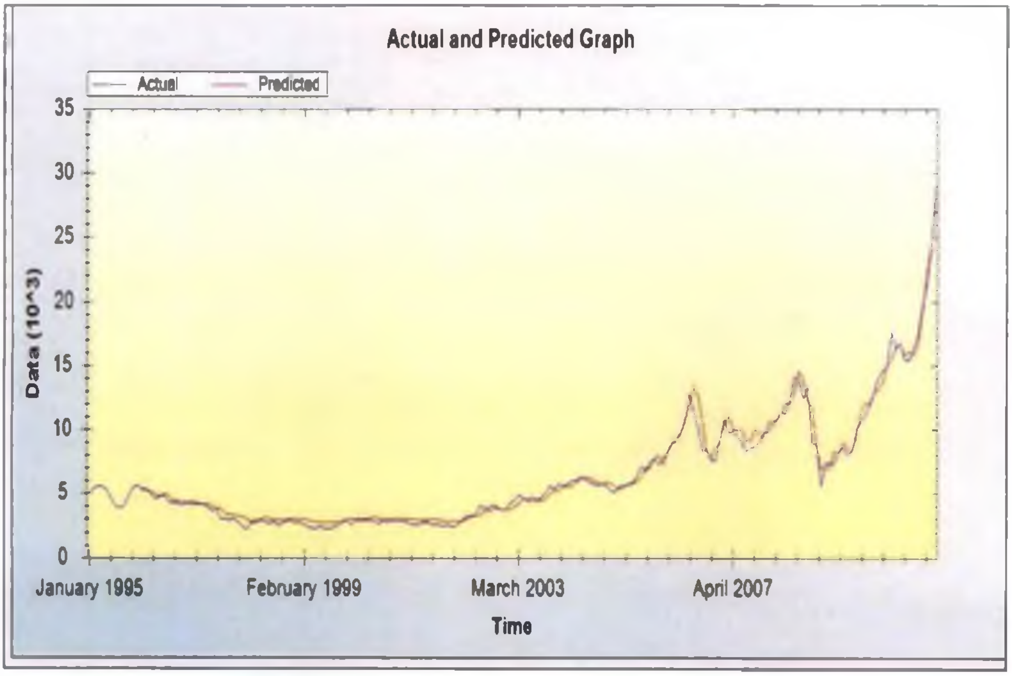

Fig.4.30 Plot of actual and predicted price of RSS-4 in Bangkok market using ANN model

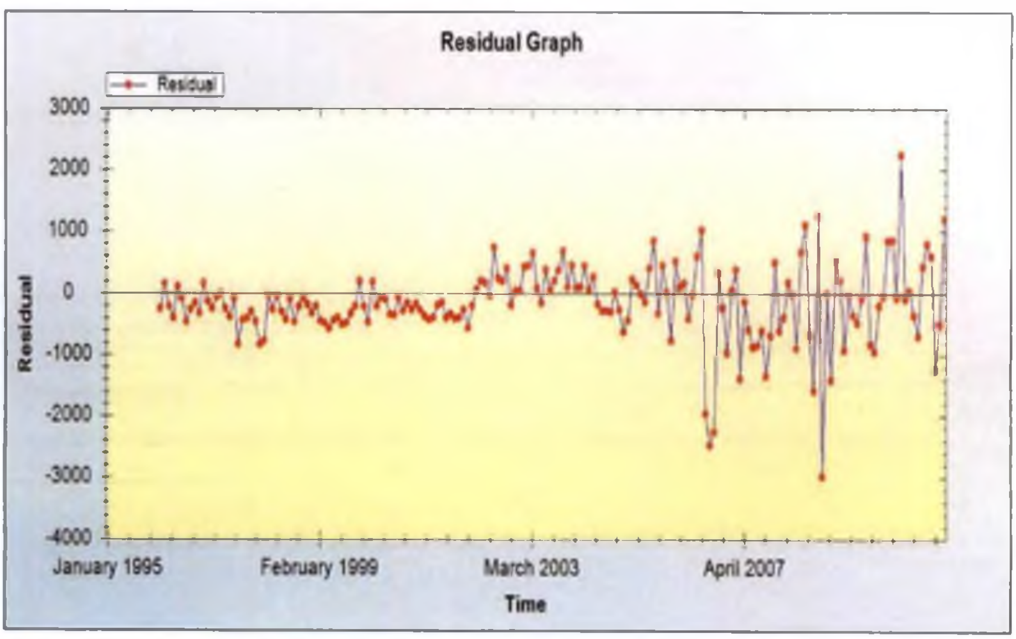

Fig. 4.31 Plot of residuals of RSS-4 prices in Bangkok market using ANN model

Table 4.16 Forecasted Price of RSS-4 in Bangkok Market using ANN Model

Month	Forecasted Price (Rs/Kg)
March'11	297
April'11	302
May'11	303

Error parameters: MAE – 440.77, MSE – 400754.09, Error – 0.1571

In the present study, various price forecasting models viz., moving average, single exponential smoothing, double exponential smoothing, ARIMA models and ANN were tried to develop a reliable price forecasting model for RSS-4 prices in Kottayam and Bangkok markets. Among these models, double exponential smoothing and ANN were found to be the best models for predicting the price of RSS-4 in Kottayam market based on the accuracy measures like MAPE, mean absolute error (MAE) and the plots also gave satisfactory results. The forecasted price of RSS-4 in Kottayam market by double exponential smoothing were Rs.246/Kg, Rs.250/Kg and Rs.254/Kg for the months of March'11, April'11 and May'11 respectively and the same by ANN model was Rs.225/Kg, Rs.219/Kg and Rs.223/Kg for the same period. Out of these two models, the error parameters obtained for double exponential smoothing were MAPE (6), MAD (405) and MSD (457828) and the same for ANN were MAE (439.91), MSE (452458.03) and Error (0.0564) (Table 4.11 and 4.13). Since the error parameters were low for the ANN model compared to double exponential smoothing, ANN was identified as the best model for predicting the price of RSS-4 in Kottayam market.

While in Bangkok market, double exponential smoothing, ARIMA (0,1,0) (1,0,1) and ANN model were found to be good fits for RSS-4 prices based on the accuracy measures such as MAPE values, Normalized BIC, MAE and MSE.

Among these models, ARIMA (0,1,0) (1,0,1) was selected as the best model for predicting rubber prices in Bangkok market as this model got low MAPE values compared to other models. The RSS-4 prices in Bangkok market predicted by ARIMA (0, 1, 0) (1, 0, 1) model for the months March, April and May of 2011 were Rs.292/Kg, Rs.297/Kg and Rs.301/Kg respectively. Thus, it is clear from the foregoing discussion that ANN model was suited better for predicting the price in the domestic market, while ARIMA (0,1,0) (1,0,1) model was suitable for price prediction in the international market.

4.7.4 Validation of Price Forecasts

The validation of price forecast is done to confirm the reliability of the selected model for predicting the prices. It is carried out by comparing the predicted price with the actual modal price that prevailed in the market during a month under consideration. The predicted price of RSS-4 in the domestic market was validated using the actual market price that prevailed in the Kottayam market during the period from March'11 to May'11 (APPENDIX VI, VII and VIII). An allowance of plus or minus 10 per cent is allowed in such exercises. It is clear from the Table 4.17 that only the price predicted by ANN model was found to be close to the modal price. A slight variation was observed in April, but with in the 10 per cent variation level.

The validation of the predicted price of RSS-4 in Bangkok market was also done by the same method used in Kottayam market. The rubber price predicted using different models viz., moving average, single exponential smoothing, double exponential smoothing, ARIMA models and ANN were compared with the actual modal price that prevailed in the Bangkok market for the period from March'11 to May'11 (APPENDIX IX, X and XI).

It is clear from the Table 4.18 that ARIMA (0,1,0) (1,0,1) model fitted by omitting the outlier values came closer to the real market prices, but more divergence between the predicted price and the actual market prices are visible from April'11 onwards. The rubber prices in domestic as well as international markets were very high till the first week of March 2011. The earthquake and tsunami of March 11 in Japan resulted in a sudden decline in rubber prices to a magnitude of Rs. 40/Kg because Japan alone accounts for seven per cent of the global demand for NR in its automobile industries (ANRPC, 2011 b).

Table 4.17 Validation of Predicted Price of RSS-4 at Kottayam Market

Months	Predicted Price (Rs/Kg)				Modal Price (Rs/Kg)
	Moving Average	SES Model	DES Model	ANN Model	
March'11	180	243	246	225	227
April'11	180	243	250	219	240
May'11	180	243	254	223	222

Table 4.18 Validation of Predicted Price of RSS-4 at Bangkok Market

Months	Predicted Price (Rs/Kg)						Modal Price (Rs/Kg)
	Moving Average	SES	DES	ARIMA (0,1,2) (1,0,1)	ARIMA (0,1,0) (1,0,1)	ANN Model	
March'11	181	296	311	297	292	297	274
April'11	181	296	332	313	297	302	262
May'11	181	296	353	318	301	303	230

Thereafter, rubber prices recovered from the tsunami impact due to the tight supply of NR resulting from the seasonal wintering of rubber trees (ANRPC, 2010 b) and also due to the floods and mudslides in Southern Thailand which devastated the rubber plantations (ANRPC, 2011 a; TRA, 2011). According to a report from ANRPC, the import demand from China also increased from the last week of March after a two months decline. Thus, the tight supply situation and high import demand from China resulted in rise in rubber prices during April'11, but not to the same extent as in the first week of March.

The global market had showed signs of correction from the last week of April largely on concerns about the global economy, Japanese Yen appreciation and a marginal drop in crude oil prices. The NR market across the globe was also in a correction mode and the rubber prices in both the domestic as well as international markets were softening in May due to the fresh developments in production and supply of NR (Joseph, 2011).

The supply of NR in the global market increased as the farmers started tapping in all the major producing countries from the first week of May and they started to clear off their old stocks in view of improving price situation. This selling pressure pulled down the prices further. In view of softening of prices, the tyre manufacturing companies decided to postpone their large scale purchases. The tyre companies' purchases which accounts for 62 per cent of the total rubber consumption registered a 25 per cent decline in May (Valy, 2011). There are also trade reports saying that the major consumer China is still off the markets as rubber inventories in its bonded warehouses are very high.

Thus, the increased global supply of NR coupled with reduced demand from the industrial consumers resulted in lower NR prices in the international market during April and May. However, international prices are higher than the domestic prices.

Therefore, it can be concluded from the foregoing analyses and discussion that while ANN model could capture the price trends in the domestic market, whereas no model could capture the complexities in the international market satisfactorily.

4.8 EXPORT COMPETITIVENESS OF NR

Table 4.19 Domestic and International Price of NR with NPCs

Year	Domestic Price (P_d)	International Price (P_b)	NPC
1995	5059	4968	1.02
1996	5122	4648	1.10
1997	3988	3444	1.16
1998	3013	2743	1.10
1999	2997	2529	1.18
2000	3125	2861	1.09
2001	3109	2619	1.19
2002	3621	3571	1.01
2003	4814	4877	0.99
2004	5571	5821	0.96
2005	6068	6539	0.93
2006	8783	9477	0.93
2007	9006	9347	0.96
2008	10775	11140	0.97
2009	9756	9294	1.05
2010	16983	16643	1.02
Mean	**6362**	**6283**	**1.01**

Trade competitiveness basically depends upon the level of domestic prices relative to international prices. If domestic price of a commodity is lower than the net export prices, the commodity is export competitive, otherwise it is not. In the present study the export competitiveness of Indian NR was measured using Nominal Protection Coefficient (NPC). NPC under exportable hypothesis was worked out by taking the price of NR grade RSS-4 at Kottayam market as domestic price and that of Bangkok market as the border price. The average f. o. b price for 16 years from 1995 to 2010 was obtained at Rs. 62.83/Kg and that of domestic price was Rs. 63.62/Kg. An examination of the year wise NPC values under exportable hypothesis indicated that the NR was not export competitive for a period from 1995 to 2003 and also during 2009 and 2010 due to the ruling nature of domestic price (Table 4.10). Such results were reported earlier by Pradeep (2003) with respect to prices at Kuala Lumpur markets. The Indian NR was found to be export competitive only during a short period from 2004 to 2008 because the international price was higher than the domestic price during that period. It is concluded that the Indian NR was not by and largely export competitive during the study period. The mean NPC value for the period worked out to 1.01, which is more than unity.

4.9 MARKET INTEGRATION OF NR

Johansen's cointegration method is the most widely used tool to study market integration. The necessary condition for doing the cointegration analysis is to determine, whether the two price series are stationary or not. The Augmented Dickey Fuller (ADF) test was done separately for domestic as well as international markets to test the stationarity of the two price series. The ADF statistic obtained for both the markets are furnished in table 4.20 along with MacKinnon critical values. The test gave statistically significant estimates at 1 per cent level of significance, which meant that that the two series were stationary.

The cointegration test was conducted to examine whether the two markets were integrated or not. The results of the cointegration test are given in Table 4.21. It is evident from the Table 4.21 that the null hypothesis of independence of the markets was rejected at 1 per cent level of significance, which indicates that the two markets were integrated.

The pair wise Granger Causality test was carried out to know the direction of influence of one market on the other. Two null hypothesises were tested under this test and gave statistically significant result for the second null hypothesis at one per cent level of significance (Table 4.22). It indicates that there was influence of Bangkok market on the rubber prices in Kottayam market and not vice versa. This is understandable as Kottayam is a localised market, having relevance to the state of Kerala, whereas Bangkok is an international market which acts as a reference market for NR.

Table 4.20 ADF Statistic Obtained for Kottayam and Bangkok Markets

Market	ADF Statistic
Kottayam	2.240712**
Bangkok	2.387172**

MacKinnnon critical values: 1 % level- -3.4662, 5 % level- -2.8768, 10 % level- -2.5748

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

Table 4.21 Johansen's Co integration Test

Market	Eigen value	Likelihood Ratio	5 % critical value	1 % critical value	Hypothesized No. of CE(s)
Bangkok	0.116457	29.03474	15.41	20.04	None**
Kottayam	0.029368	5.633623	3.76	6.65	At most 1*

** denotes rejection of the null hypothesis at 1 % level of significance
CE denotes the Cointegrating Equation

Table 4.22 Pair wise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
KTM does not Granger Cause BNGK	2.57710	0.11008
BNGK does not Granger Cause KTM	8.78343	0.00343**

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

The Likelihood Ratio test indicated that at most one cointegrating equation was significant at 5 per cent level with linear deterministic trend and at 1 to 4 lag intervals. The cointegrating equation obtained was

KTM Price = 719.9633 – 1.103096 BNGK Price.
(0.03750)

Summary and Conclusion

5. SUMMARY AND CONCLUSION

NR a product of vital and commercial importance is recovered from the latex of the rubber tree, *Hevea braziliensis*. Like any other agricultural commodities, rubber prices are also subjected to significant fluctuations. The temporal and spatial variations in the price of agricultural commodities provide a better insight to design and implement appropriate policies for reducing price fluctuations. The volatility in rubber prices is an important risk to producers, traders, consumers and others involved in the production and marketing of NR. Therefore, accurate price forecasts are necessary to facilitate efficient decision making as there are considerable time lag between making output decisions and actual output of the commodity in the market. Hence, in this study the price behaviour of NR in India was studied and various price forecasting models were tried to develop a reliable price forecasting model for rubber prices in Kottayam and Bangkok markets.

The study was conducted during 2010-11 based on the secondary data collected from the Marketing Department of Rubber Board, Kottayam. The main items of observation were the month wise modal price data of RSS-4 in Kottayam and Bangkok markets for the period from January 1995 to February 2011. The details regarding area, production and productivity of NR in India and Kerala were collected from the Rubber Board and the same for world were obtained from the official website of FAO, Rome. The consumption, export and import details of NR in India were collected from the Rubber Statistical News, published by the Rubber Board.

The annual growth pattern in area, production and productivity of NR in world, India and Kerala were studied using the index numbers. The area under rubber cultivation increased in Indonesia, Thailand, China and Vietnam. A drastic reduction in area was noticed in Malaysia, which was mainly due to the rapid conversion of rubber plantations in to oil palm with massive government support.

The area, production and productivity of NR in the world, India and Kerala showed an increasing tendency during the study period. In order to study the proportion and extent of changes in area, production and productivity of NR, compound growth rates were worked out separately for world, India and Kerala. The highest growth rate in area, production and productivity were observed in Vietnam and it is emerging as a net exporter of NR in the world. The compound growth rates of area, production and productivity of NR in India were below the global growth rates and that of Kerala was above the national level.

Consumption status of NR in India was also studied using index numbers. India has emerged as the second largest consumer of NR by overtaking the United States with a share of 10 per cent in world consumption. The maximum consumption of rubber in India is in automobile industry and the Indian automobile industry witnessed a significant increase during the last decade. The production and consumption of NR in India showed an increasing trend during the period under study and the domestic consumption of NR in India was growing at a pace faster than the growth in production.

The exports of NR from India grew annually by 36 per cent and showed an increasing tendency during the study period. India is not having a steady exportable surplus of NR latex, sheet or technically specified rubber. The exports were by and large made in the form of finished rubber goods. India recorded 57 per cent increase in the import of NR over the base year 1995-96. The compound growth rate of NR import during the period from 1995-96 to 2008-09 was worked out to 12 per cent. The growth in demand for NR in the ever expanding automobile industry led to tremendous increase in its import to India, and the changes in trade policies also aided in having a higher import of NR.

The price behaviour of NR was studied using the techniques of classical decomposition of time series analysis. The monthly modal price data on RSS-4 in Kottayam and Bangkok markets were subjected to the techniques of classical decomposition of time series and decomposed in to its four components viz., secular trend, seasonal, cyclical and irregular variations. A trend analysis was carried out separately for domestic as well as international market by applying the method of least squares, but no satisfactory fit was obtained based on adjusted R^2 values and standard errors. Hence, trend lines were fitted with exponential smoothing methods.

Single exponential smoothing fitted to the data explained the underlying trend in rubber prices in both international and domestic markets. The analysis showed that the RSS-4 prices in the Bangkok as well as the Kottayam markets were stagnant from January 1995 to April 2001, after which the prices started increasing. The period from May 2005 marked an increasing trend for NR in the international as well as domestic market.

The seasonal variations in the price of NR in the international as well as the domestic markets were studied using seasonal price indices worked out separately for both the markets. In the international market, the peak price was observed in June and the trough price was obtained during the month of July. In the Kottayam market, on the other hand buoyant phase was observed during May to July with the peak price during May and trough phase from September to February with the lowest price in the month of February. The rubber prices in the international as well as domestic markets were not subjected to pronounced price cycles. There were considerable irregular variations in the rubber prices in both the markets. The irregular variations in the international and domestic markets exhibited the same pattern. The irregular variations in rubber prices could be attributed to the demand and supply shocks due to the incidence of adverse weather conditions in the major producing countries and due to speculative activities.

Various price forecasting models viz., moving average, single exponential smoothing, double exponential smoothing, ARIMA, and ANN models were tried to develop a reliable price forecasting model for RSS-4 prices in Kottayam and Bangkok market. The double exponential smoothing and ANN models were found to be statistically more appropriate to predict rubber prices in Kottayam market. The validation exercise clearly indicated that the price forecast made by the ANN model was more reliable for predicting the price of RSS-4 in Kottayam market. However, no model could capture the underlying dynamics of rubber prices in the international market at Bangkok.

The export competitiveness of Indian NR was measured using NPC under exportable hypothesis. The mean NPC value for a period of 16 years worked out to 1.01, which indicated that Indian NR was not export competitive during the study period.

The market integration studies using the co integration technique showed that the two markets were integrated. The pair wise Granger Causality test indicated that there was unidirectional influence of Bangkok market on the prices of NR in Kottayam market and not vice versa.

Based on the foregoing analyses and discussion, the following policy measures are being suggested:

1. There is growing deficit between domestic production and consumption of NR in the country because of the increased demand for NR in the automobile industry. About 90 per cent of the NR output in India is from the traditional rubber cultivating areas such as Kerala and Tamil Nadu. As the availability of land is limited in the traditional areas, the government should take initiatives to intensify rubber cultivation in non-traditional areas in the North Eastern states to bridge the gap between production and consumption of NR in India. This in turn, will bring down price instability in NR.

2. Even though, India ranks first in productivity of NR in the world, Indian NR production is not globally competitive. Vietnam and China are emerging as new competitors of NR in the global market. Abundance of

cheap labour will provide them added advantage. Hence, efforts should be taken to evolve new technologies for enhancing the productivity of NR in India and thereby increase the income of rubber farmers in the country per unit cultivated area.

3. The rubber prices are subjected to significant seasonal variations because of the seasonality in production of NR. The peak supply of NR is limited to few months in a year, whereas there is year round consumption of NR by the automobile industry. Hence, efforts should be made to develop improved tapping techniques to extend the tapping days, which in turn would ensure year round availability of NR.

4. A univariate price forecasting model was used to predict rubber prices in this study due to data limitations. As a crucial industrial raw material, the price of NR mainly depends up on the factors such as global demand and supply, domestic demand and supply, crude oil prices, changes in the foreign exchange rates etc. In order to develop a multivariate price forecasting model, a strong data base of the above factors is needed. Hence, efforts should be taken to develop and maintain a strong data base for key indicators of the economy.

5. Lack of accurate and relevant market information has been identified as a major factor influencing the efficient performance of any agricultural marketing in India. Asymmetry to market information has been a major factor hindering the market transparency in most Indian states. While large corporate buyers and industrial users rely upon sophisticated IT enabled market information and intelligence systems, small traders, processors, consumers and most farmers rely on word-of-mouth accounts of commodity prices and changing market conditions. The poor quality of market information dissemination makes it imperative to have a time tested, regional and farmer centric agricultural market intelligence system for rubber farmers to reduce the price risk.

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Appendices

APPENDIX I

State wise Total Area and Production of NR in India during 2009-10

State	Area (ha)	Production (Tonnes)
Kerala	525408	745510
Tamil Nadu	19545	24695
Tripura	55415	25080
Assam	28102	7071
Meghalaya	9196	4545
Nagaland	4141	1000
Manipur	2723	630
Mizoram	908	136
Arunnachal Pradesh	1200	138
Karnataka	34777	21331
Andaman & Nicobar Islands	878	311
Goa	1017	351
Maharashtra	858	70
Orissa	657	177
West Bengal	587	319
Andra Pradesh	1103	36

APPENDIX II

Models Fitted to Rubber Prices in Bangkok Market along with Adjusted R^2 Values and Standard Errors (SE)

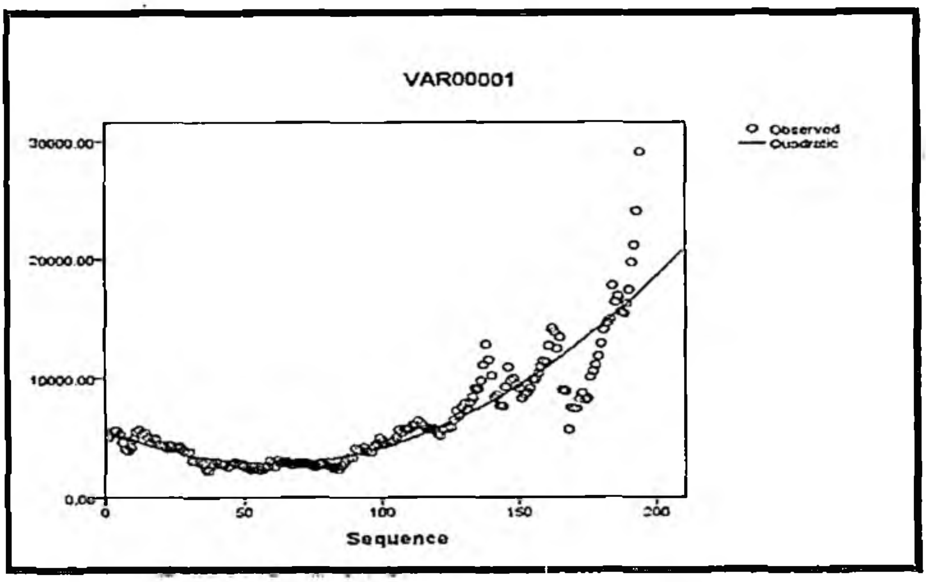
Sl. No.	Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
1	**Linear**	0.581	2889.79	571.76	60.75		
2	**Quadratic**	0.830	1839.10	5616.48	-93.69	0.792	
3	**Compound**	0.623	0.367	2362.88	1.008		
4	**Growth**	0.623	0.367	7.768	0.008		
5	**Logarithmic**	0.240	3892.27	-3424.15	2314.07		
6	**Cubic**	0.830	1841.70	5371.79	-78.82	0.602	0.001
7	**Sigmoid**	0.001	0.598	8.605	-0.545		
8	**Exponential**	0.623	0.367	2362.88	0.008		
9	**Inverse**	0.008	4447.13	6672.72	-5917.65		
10	**Power**	0.236	0.523	1438.06	0.308		
11	**Logistic**	0.623	0.367	0.000	0.992		

APPENDIX III

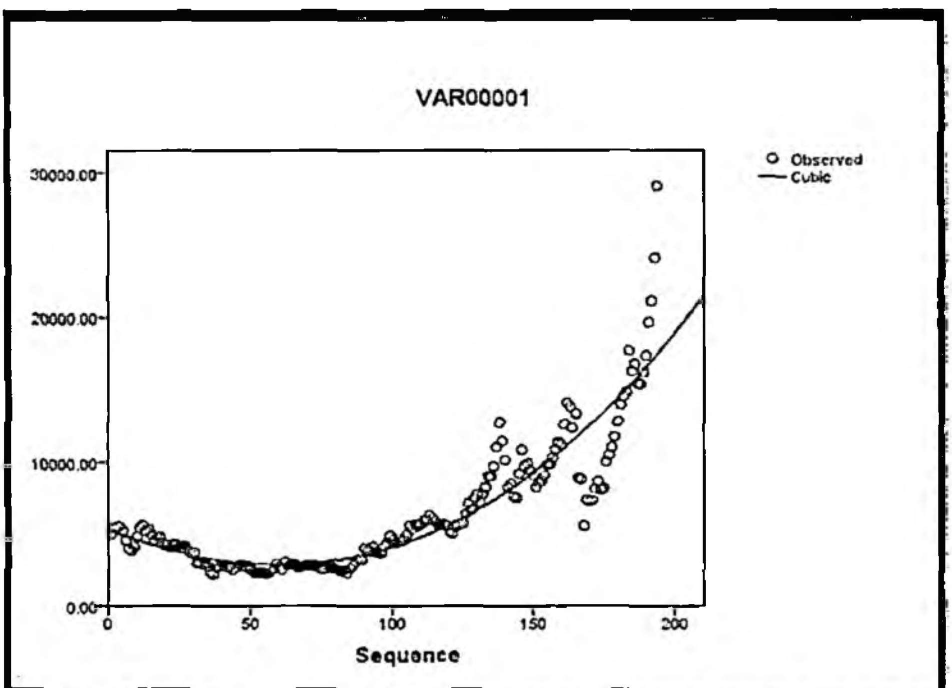
Models Fitted to Rubber Prices in Kottayam Market along with Adjusted R^2 Values and Standard Errors (SE)

Sl. No.	Model	Adjusted R^2	SE	B_0	B_1	B_2	B_3
1	**Linear**	0.570	2722.38	1061.85	55.98		
2	**Quadratic**	0.874	1472.31	6240.71	-102.56	0.813	
3	**Compound**	0.604	0.340	2681.42	1.008		
4	**Growth**	0.604	0.340	7.894	0.007		
5	**Logarithmic**	0.224	3658.53	-2397.83	2080.51		
6	**Cubic**	0.877	1453.82	5549.52	-60.56	0.276	0.002
7	**Sigmoid**	0.000	0.540	8.638	-0.448		
8	**Exponential**	0.604	0.340	2681.42	0.007		
9	**Inverse**	0.006	4140.42	6673.18	-5094.80		
10	**Power**	0.217	0.478	1778.56	0.266		
11	**Logistic**	0.604	0.340	0.000	0.993		

APPENDIX IV

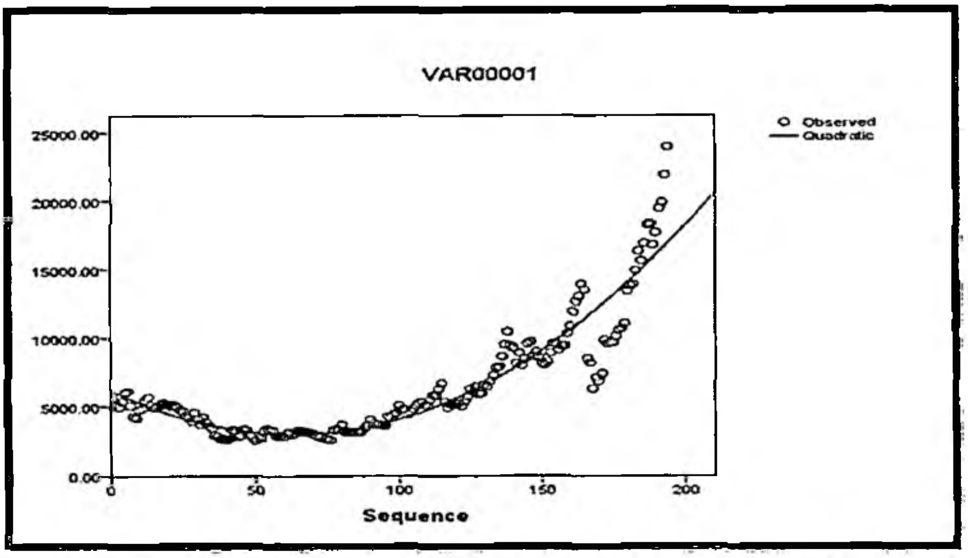


Trend line fitted to rubber prices in Bangkok market using Quadratic model

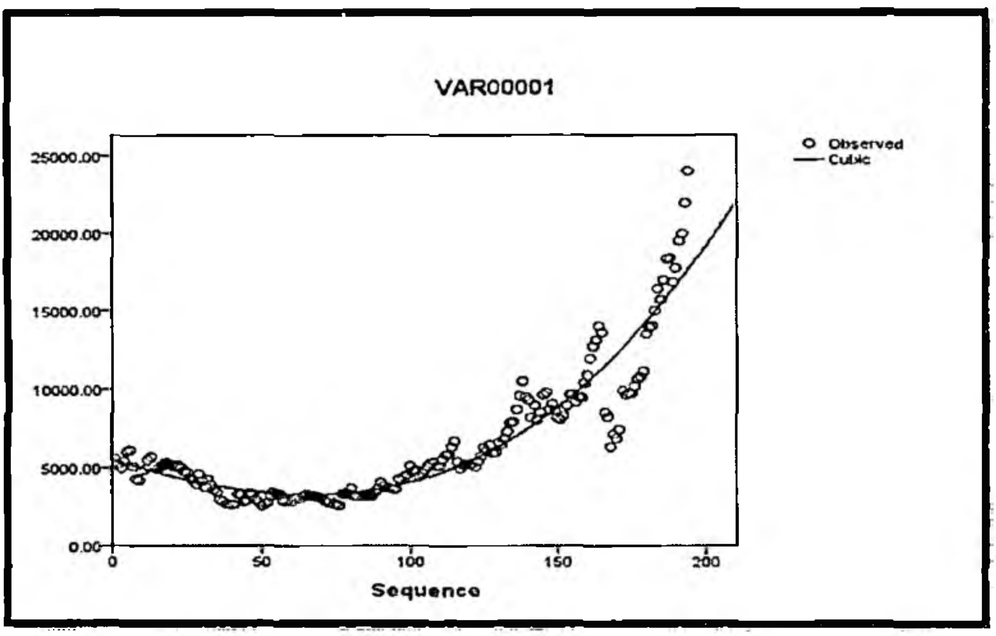


Trend line fitted to rubber prices in Bangkok market using Cubic model

APPENDIX V



Trend line fitted to rubber prices in Kottayam market using Quadratic model



Trend line fitted to rubber prices in Kottayam market using Cubic model

APPENDIX VI

Validation of RSS-4 Price Forecast in Kottayam Market in the Month of March 2011

Date	Day	Price (Rs/Kg)
01-03-2011	Tuesday	224
02-03-2011	Wednesday	226
03-03-2011	Thursday	230
04-03-2011	Friday	230
05-03-2011	Saturday	230
06-03-2011	Sunday	NT
07-03-2011	Monday	227
08-03-2011	Tuesday	222
09-03-2011	Wednesday	216
10-03-2011	Thursday	218
11-03-2011	Friday	212
12-03-2011	Saturday	201
13-03-2011	Sunday	NT
14-03-2011	Monday	185
15-03-2011	Tuesday	187
16-03-2011	Wednesday	201
17-03-2011	Thursday	215
18-03-2011	Friday	221
19-03-2011	Saturday	222
20-03-2011	Sunday	NT
21-03-2011	Monday	223
22-03-2011	Tuesday	228
23-03-2011	Wednesday	228
24-03-2011	Thursday	228
25-03-2011	Friday	227
26-03-2011	Saturday	227
27-03-2011	Sunday	NT
28-03-2011	Monday	227
29-03-2011	Tuesday	227
30-03-2011	Wednesday	229
31-03-2011	Thursday	231
Modal Price		**227**
Predicted Price using ANN Model		**225**

NT – No Transaction

APPENDIX VII

Validation of RSS-4 Price Forecast in Kottayam Market in the Month of April 2011

Date	Day	Price (Rs/Kg)
01-04-2011	Friday	232
02-04-2011	Saturday	233
03-04-2011	Sunday	NT
04-04-2011	Monday	240
05-04-2011	Tuesday	243
06-04-2011	Wednesday	241
07-04-2011	Thursday	240
08-04-2011	Friday	239
09-04-2011	Saturday	240
10-04-2011	Sunday	NT
11-04-2011	Monday	240
12-04-2011	Tuesday	240
13-04-2011	Wednesday	NR
14-04-2011	Thursday	240
15-04-2011	Friday	NT
16-04-2011	Saturday	240
17-04-2011	Sunday	NT
18-04-2011	Monday	239
19-04-2011	Tuesday	236
20-04-2011	Wednesday	239
21-04-2011	Thursday	239
22-04-2011	Friday	NT
23-04-2011	Saturday	240
24-04-2011	Sunday	NT
25-04-2011	Monday	240
26-04-2011	Tuesday	240
27-04-2011	Wednesday	239
28-04-2011	Thursday	238
29-04-2011	Friday	NR
30-04-2011	Saturday	236
Modal Price		**240**
Predicted Price using ANN Model		**219**

NT – No Transaction, NR – Not Recorded

APPENDIX VIII

Validation of RSS-4 Price Forecast in Kottayam Market in the Month of May 2011

Date	Day	Price (Rs/Kg)
01-05-2011	Sunday	NT
02-05-2011	Monday	235
03-05-2011	Tuesday	234
04-05-2011	Wednesday	233
05-05-2011	Thursday	230
06-05-2011	Friday	227
07-05-2011	Saturday	228
08-05-2011	Sunday	NT
09-05-2011	Monday	230
10-05-2011	Tuesday	232
11-05-2011	Wednesday	232
12-05-2011	Thursday	229
13-05-2011	Friday	229
14-05-2011	Saturday	230
15-05-2011	Sunday	NT
16-05-2011	Monday	228
17-05-2011	Tuesday	227
18-05-2011	Wednesday	225
19-05-2011	Thursday	225
20-05-2011	Friday	222
21-05-2011	Saturday	222
22-05-2011	Sunday	NT
23-05-2011	Monday	220
24-05-2011	Tuesday	219
25-05-2011	Wednesday	218
26-05-2011	Thursday	217
27-05-2011	Friday	216
28-05-2011	Saturday	215
29-05-2011	Sunday	NT
30-05-2011	Monday	218
31-05-2011	Tuesday	222
Modal Price		**222**
Predicted Price Using ANN Model		**223**

NT - No Transaction

APPENDIX IX

Validation of RSS-4 Price Forecast in Bangkok Market in the Month of March 2011

Date	Day	Price (Rs/Kg)
01-03-2011	Tuesday	275
02-03-2011	Wednesday	274
03-03-2011	Thursday	274
04-03-2011	Friday	270
05-03-2011	Saturday	NT
06-03-2011	Sunday	NT
07-03-2011	Monday	267
08-03-2011	Tuesday	263
09-03-2011	Wednesday	248
10-03-2011	Thursday	245
11-03-2011	Friday	241
12-03-2011	Saturday	NT
13-03-2011	Sunday	NT
14-03-2011	Monday	223
15-03-2011	Tuesday	201
16-03-2011	Wednesday	204
17-03-2011	Thursday	208
18-03-2011	Friday	227
19-03-2011	Saturday	NT
20-03-2011	Sunday	NT
21-03-2011	Monday	241
22-03-2011	Tuesday	251
23-03-2011	Wednesday	253
24-03-2011	Thursday	260
25-03-2011	Friday	259
26-03-2011	Saturday	NT
27-03-2011	Sunday	NT
28-03-2011	Monday	255
29-03-2011	Tuesday	253
30-03-2011	Wednesday	254
31-03-2011	Thursday	256
Modal Price		**274**
Predicted Price using ARIMA Model		**292**

NT – No Transaction

APPENDIX X

Validation of RSS-4 Price Forecast in Bangkok Market in the Month of April 2011

Date	Day	Price (Rs/Kg)
01-04-2011	Friday	255
02-04-2011	Saturday	NT
03-04-2011	Sunday	NT
04-04-2011	Monday	258
05-04-2011	Tuesday	267
06-04-2011	Wednesday	NR
07-04-2011	Thursday	268
08-04-2011	Friday	270
09-04-2011	Saturday	NT
10-04-2011	Sunday	NT
11-04-2011	Monday	271
12-04-2011	Tuesday	272
13-04-2011	Wednesday	NR
14-04-2011	Thursday	NR
15-04-2011	Friday	NR
16-04-2011	Saturday	NT
17-04-2011	Sunday	NT
18-04-2011	Monday	262
19-04-2011	Tuesday	257
20-04-2011	Wednesday	263
21-04-2011	Thursday	262
22-04-2011	Friday	262
23-04-2011	Saturday	NT
24-04-2011	Sunday	NT
25-04-2011	Monday	258
26-04-2011	Tuesday	254
27-04-2011	Wednesday	251
28-04-2011	Thursday	250
29-04-2011	Friday	249
30-04-2011	Saturday	NT
Modal Price		**262**
Predicted Price using ARIMA Model		**297**

NT – No Transaction, NR – Not Recorded

APPENDIX XI

Validation of RSS-4 Price Forecast in Bangkok Market in the Month of May 2011

Date	Day	Price (Rs/Kg)
01-05-2011	Sunday	NT
02-05-2011	Monday	245
03-05-2011	Tuesday	243
04-05-2011	Wednesday	243
05-05-2011	Thursday	NR
06-05-2011	Friday	236
07-05-2011	Saturday	NT
08-05-2011	Sunday	NT
09-05-2011	Monday	229
10-05-2011	Tuesday	228
11-05-2011	Wednesday	230
12-05-2011	Thursday	230
13-05-2011	Friday	NR
14-05-2011	Saturday	NT
15-05-2011	Sunday	NT
16-05-2011	Monday	NR
17-05-2011	Tuesday	NR
18-05-2011	Wednesday	230
19-05-2011	Thursday	231
20-05-2011	Friday	230
21-05-2011	Saturday	NT
22-05-2011	Sunday	NT
23-05-2011	Monday	229
24-05-2011	Tuesday	230
25-05-2011	Wednesday	231
26-05-2011	Thursday	233
27-05-2011	Friday	233
28-05-2011	Saturday	NT
29-05-2011	Sunday	NT
30-05-2011	Monday	233
31-05-2011	Tuesday	235
Modal Price		**230**
Predicted Price using ARIMA Model		**301**

NT – No Transaction, NR – Not Recorded

PRICE BEHAVIOUR OF NATURAL RUBBER IN INDIA

By

REEJA VARGHESE
(2009 - 11 - 112)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Agriculture

Faculty of Agriculture
Kerala Agricultural University, Thrissur

Department of Agricultural Economics

COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2011

ABSTRACT

Natural rubber, a product of vital commercial importance is recovered from the latex of the rubber tree, *Hevea braziliensis*. The present study entitled "Price behaviour of natural rubber in India" was conducted during 2010-11 based on the secondary data. The changes in area, production and productivity status of natural rubber in the world, India and Kerala were studied using the index numbers and compound growth rates. The compound growth rates in area, production and productivity of natural rubber in India were below the global growth rates, while that of Kerala was above the national level.

India is emerging as the second largest consumer of natural rubber in the world. Consumption status of natural rubber in India showed that there is a growing deficit between domestic production and consumption of natural rubber in India. India was not a regular exporter of natural rubber, and therefore considerable fluctuations were observed in the export status depending on the domestic production level. The deficit in demand was met by imports. The import of natural rubber by Indian automobile industries grew annually by 12 per cent during the study period.

The secular, seasonal, cyclical and irregular variations in rubber prices were studied using the techniques of classical decomposition of time series analysis. The trend in rubber prices in the domestic market at Kottayam and international market at Bangkok were captured by the single exponential smoothing model satisfactorily. The analysis showed that the RSS-4 prices in the Bangkok as well as the Kottayam markets were stagnant from January 1995 to April 2001, after which the prices showed an upward trend.

The rubber prices were subjected to considerable seasonal variations due to the seasonality in production. In the international market, the peak price was observed in June and the trough price during the month of July, whereas in

Kottayam market, the peak price was observed during May and the lowest price in the month of February. The rubber prices in the international as well as domestic markets were not subjected to pronounced price cycles. There were considerable irregular variations in rubber prices in both the markets. The rubber prices exhibited considerable instability in both the markets.

Out of the different price forecasting models used to develop a reliable price forecasting model, the artificial neural network (ANN) model was found to be more reliable for predicting the price of RSS-4 in Kottayam market. However, no model could capture the underlying dynamics of rubber prices in the international market at Bangkok satisfactorily.

The export competitiveness of Indian natural rubber was measured using nominal protection coefficient (NPC) under exportable hypothesis. It was found that Indian natural rubber was not export competitive during the study period. The market integration studies showed that Kottayam and Bangkok markets were integrated and there was a unidirectional influence of Bangkok market on the prices of natural rubber in Kottayam market, while the influence of Kottayam market on Bangkok market could not be established.

The policy interventions suggested based on the study include efforts to increase the area under natural rubber in the non traditional rubber growing areas like North Eastern states, evolving technologies for enhancing the productivity of natural rubber in India to increase the income of farmers per unit cultivated area, improved tapping techniques to extend the tapping days, and to develop a multivariate price forecasting model. A reliable, regional market intelligence system for the natural rubber growers in the country to provide timely and reliable market information and intelligence is also suggested.