STATISTICAL INVESTIGATION OF PRICE BEHAVIOUR IN CHILLI

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1. INTRODUCTION

Chilli (*Capsicum annum* L.) is one of the most important commercial spice crop of India Chilli is used in number of activities such as vegetables, spice, condiments, suace, pickles. Chilli occupies an important place in India dietary it is indispensable item in the kitchen as it is consumed daily as condiment in one or the other form. It is rich in vitamins, especially in vitamins A and C, The dried chilli fruits constitute a major share among the spices consumed per head.

The nature of supply and demand for agricultural products generally results in instability of prices and income within agricultural sectors as well as in other sectors of economy. The variation in chilli prices is of two kinds , first is related to the trend of the price level ,which shows fluctuations over time, and other comprises of the fluctuation over space . These two kinds of prices variation plays a significant role in cropping pattern of the farmers as well as instability of income in the chilli growing farmers.

1.1 World Scenario

International trade in chilli was dominated by India. The total export of chilli from India is on an average only 4 per cent of the total production. This is mainly because of the high domestic consumption. The total chilli production in India 21.48 lakh tonnes (Hanamashetti *et al.*, 2009) Chilli growing countries were India, China, Ethiopia, Myanmar, Mexico, Vietnam, Peru, Pakistan, Ghana and Bangladesh and these countries accounting for more than 85 percent of the world production in 2007. The lion's share is taken by India with 36 per cent share in global production, followed by China (11 %), Bangladesh (8 %), Peru (8 %) and Pakistan (6 %). China has emerged as a principal exporter of chilli and is serious competitor in international market. China has successfully penetrated the large Malaysian Market, mainly at the expense of Indonesia. The United States of America has also been purchasing larger quantities of chilli from China. Japan is producing special type of chilli like Bird's Eye, Santaka and Hontaka types of chilli. These chilli have a market, but export from Japan is decreasing mainly on account of local demand.

The bulk of imports of paprika chilli in western countries are consumed in food processing industry, where it is used as a colorant and for flavouring. In countries like United States of America, United Kingdom, Germany and Sweden, considerable quantities of these spices are used in the extraction of oleoresins extracts.

1.2 India's Scenario

India is the largest producer and consumer of chilli among other major producers in the World. India contributes about 25 per cent to total World's production and remained in first position in terms of international trade by exporting 20 per cent from its total production. India had produced about 10.64 lakh tonnes with an area of 6.5 lakh hectares under chilli during 2005-06. In India, chilli is grown in almost all state. Andhra Pradesh is having largest area of chilli in India and contributes about 26 per cent to the total area, followed by Maharashtra (15 %), Karnataka (11 %), Orissa (11 %), Madhya Pradesh (7 %) and 'other States' contributes nearly 22 per cent to the total area under chilli.

1.3 Karnataka's scenario

Karnataka stands fourth place in area wise about covering 9.11% and in terms of production stands second position by producing 11.51% to the total production basket next to the Andra Pradesh (62.5%) (Hanamashetti et al. 2009) In India Karnataka is an important chilli growing state among major chilli growing states. Generally chilli is grown in all most all districts of the state. But it is highly concentrated in the districts like Dharwad, Haveri, Koppal, Bellary, Raichur, Gulbarga and Belagam (North Karnataka).

There are various purposes for which present analysis of time series is performed. The objectives may include prediction of future values based on knowledge of the past, control of process producing the series, to obtain an understanding of mechanism generating series.

Study of trends helps to compare markets for their long-term behavior. An understanding of periodically of cycles helps those concerned with development; use of these commodities specifically in the area of short -term and long term forecasting. The latest technique of box-jenkins model is used to analyse non-stationary and seasonal data. It helps in identifying stochastic process and arrivals accurately

By keeping these things in mind the following specific objectives are set.

1. To study the long term and short term trend movements in chilli
2. To predict the price and arrivals of chilli
3. To study the approximation of growth rate in chilli

2. REVIEW OF LITRATURE

In this chapter an attempt has been made critically, review the literature of the past research work relevant to the present study and those are classified as follows.

2.1 Behaviour of price and arrivals

2.2 Fitting ARIMA and Exponential Smoothing technique

2.3. Growth rate

2.1 Behaviour of price and arrivals

Gill and Johl (1970) analyzed the seasonal patterns in the gram prices at Sirsa market for fifteen years between 1952 and 1966. The index for the arrivals was the highest in the month of May at 270.05 and price index was at its lowest in May at 92.59. Violent seasonal fluctuations led them to conclude that production was over dependent on nature, storage facilities were lacking and the zonal movement policies were poorly conceived.

Gurumallappa (1972) studied the relationship between the arrivals and prices of groundnut in Raichur and found that prices were high when the arrivals were also high and the average monthly whole sale prices generally ruled low in the harvest season

George and Govindan (1975) opined that the supply and price of many agricultural commodities follow somewhat regular cycles. The monthly wholesale price data of potatoes in Ahmadabad market for nine years 1974 to 1996 were subjected to Harmonic analysis. It revealed the presence of a time trend, a 12 month cycle and a three year cycle. Estimators were obtained by the method of least squares. The elasticities for short run, seasonal and long run were worked out. A method was suggested by them to compute the adjustment lags the time and its impacts on arrivals corresponding to seasonal cycles were also studied.

Govardhan (1978) analysed the marketing of dry chillies in Karnataka. His study showed an inverse relationship between the price and arrivals. Seventy two to eighty percent of the total produce arrived at the markets between November and April. In this period, prices were at relatively low levels.

Mundinamani *et al.* (1991) used the monthly time series data on market arrivals and prices of groundnuts for the period 1960-61 to 1983-84 collected from the regulated markets of Gadag and Hubli to estimate indices, trend equations and coefficients of variation. The pattern of market arrivals of groundnut indicates a seasonal character. The prices of groundnuts were found to be a function of market arrivals only in the short- run. The seasonal pattern of market arrivals and the resulting short-run instability in groundnut prices could be eliminated by using a package of measures. In the long-run, prices are influenced not only by market arrivals but also by other factors such as the general rise in prices and the steady rise in demand for groundnut products.

Kasar *et al.* (1996) studied behaviour of price and arrivals of red chillies in Maharashtra seasonal indices of arrivals of red wet chillies begin in October and end in April, where as that of red dry chillies start in May and end in September. The arrivals of red wet chillies were maximum during December to march when the corresponding prices were relatively low. The arrivals of red wet chillies were low during October, November and April during these months prices were relatively at higher level. By and large, it appears that when the seasonal index of arrivals of red wet chillies was more during December to March, the seasonal index of prices was at a low level. On the other hand, when the seasonal index of arrivals of red dry chillies was low (May to September) the price index of chillies was at a very high level.

Keith *et al.* (1997) examined seasonal potato price indices for two major wholesale potato markets of Delhi and Kolkata. It was cleared that potato prices typically double between the end of harvest in March and the onset of summer in July and August. The most rapid increase in potato prices occurs in April and May. There was a slight dip in price in the Delhi market in midsummer which may reflect the arrival of a summer crop. Prices then continue to rise until peaking in September or October when existing stocks are lowest and just prior to the arrivals on the market of early potatoes in months of November and December.

Ravikumar *et al.* (2001) concluded that in general, arrivals showed mixed trend, whereas, prices showed an increasing trend for the selected commodities in Anakapalle regulated market of Andhra Pradesh. There exists an inverse relationship between seasonal indices of arrivals and prices of selected commodities. Therefore, the policy implication lies in encouraging the farmers to dispose their produce at the opportune time to get good remunerative prices. It requires providing finance to farmers and better storage facilities either at village level or at market level so as to spread the arrivals reasonably in the lean months of the year.

Rajeshekar (2005) studied the cyclic trend in arrivals and prices of vegetables for Mysore and K.R.Market. K.R.Market cycle was smoothening with maximum cycle effects in case of 156 months. The slump was observed with 35 months indicating that the high arrivals observed in every 30 months. The cyclical components were observed only in weekly prices for K.R.Market.

Mithlesh (2006) studied the trend in dairy industry in India during pre WTO and post WTO period. In the pre WTO period (1985-86 to 1994-95), the import value of whole milk powder recorded increasing trend which was non significant but in case of post WTO period trend was decreasing non-significantly except in 1999 to 2001.

Punitha (2007) studied the seasonal indices and trend in arrivals and prices of maize and ground nut in Davengere market and Hubli market. In case of maize, Davangere market showed increasing trend in arrivals but Hubli market showed stagnant trend and both the markets showed an increasing trend in prices. In Davangere market significant and positive relationship between arrivals and prices was observed for maize. Whereas, in Hubli market non-significant and negative relationship was observed.

Yogisha (2007) computed trend in arrivals and prices of potato in Chikkaballapur, Chintamani, kolar and Srinivaspur during 1994-95 to 2004-05. The results shows that in the initial years potato arrivals was increasing and in the mid period it started decreasing while in the later period the arrivals again increased in all markets except Srinivaspur. In case of price trend pattern, decreasing trend in prices of potato in later period except Bangalore and Chintamani may be because of increased arrivals of potato to these markets.

2.2 Fitting ARIMA and Exponential Smoothing.

2.2.1 Box-Jenkins Model and its Application.

A class of ARIMA (Auto Regressive Integrated Moving Average) model is called Box-Jenkins model. Box and Jenkins popularized its use during late sixties. The application of these models for predicting prices of agricultural commodities is very few. Some studies which have used this modular, reviewed below.

Leuthold *et al.* (1970) forecasted daily log prices and daily quantities supplied by using several alternative techniques. A distinction between econometric and the Box Jenkins models was made. It was stated that the former identified and measured both economic and non-economic variables affecting price and quantity, while the latter identified the stochastic components. The models were tested using Theils 'U' coefficient and the authors concluded that the econometric models yielded slightly superior forecasts. Finally, it was concluded that although better forecasts would be obtained by econometric models yet stochastic models were less prone to error and were less expensive.

Schmity and Walts (1970) forecasted wheat yield changes in four largest wheat exporting countries US, Canada, Australia and Argentina using Box Jenkins models. These forecasts were compared with those obtained by exponential smoothing. Using Theils 'U' inequality coefficient and concluded that forecasts with parametric modelling gave better results for the US but not for the others.

Chatfield and Protharo (1973) observed that the Box Jenkins procedure was not suitable for the sale forecasts with a multiplicative seasonal component. In this analysis, monthly data on sales of a company was used. The adequacy of the model was tested using Box-Pierce Test.

Govindan (1974) used Box Jenkins model to analyze wholesale price indices of rice, wheat, jowar and gram. The short term forecasts were found to give good results while the same was not true of long term forecasts. Janus quotients of the forecasts showed that the model gave good results.

Newbold and Granger (1974) compared the forecast performance of the Box-Jenkins, Holt-winters and step-wise regression models. The study indicated that each method had its own advantage over the others. It was opined that the Box-Jenkins gave better forecast in the short–run, but the method required time and skill to compute. The results indicated that for time series with less than 30 observations, step wise regression was better. For data between 30 to 50 observations, a combination of Holt-winters and step wise regression was found suitable. For series of 50 and above the Box-Jenkins performed well. For data with strong seasonal and long fluctuations, the Holt-winters model was suggested.

Protharo and Wallis (1976) examined the extent to which variations in a series could be explained first by a dynamic econometric model and then by ARIMA model. Econometric model clearly indicated that they provided a closer estimate of behaviour of the series during the sample periods.

Chatfield (1977) observed that the Box Jenkins approach being a valuable addition in the forecast tool bag which gave a deeper understanding of time series behaviour. Even though it was found to be more expensive yet the accuracy justified the cost.

Makridakis and Hibbon (1979) averred that accuracy of forecasts are negatively associated with the error term. Several tests to arrive at the accuracy of forecasts like mean square error (MSE), Theils 'U' coefficient and mean absolute percentage error (MAPE) were suggested.

Chengappa (1980) applied the Box Jenkins model to forecast poor sale and export auction prices of coffee. Monthly data were used and due to the distinct seasonal variation in prices, the ARIMA seasonal model was applied. The poor sale price forecasts were found to be accurate when compared to forecast of export prices. This was attributed to a possible lack of stationarity of the data. Hence adoption of differencing procedure or a transformation to make the data stationary was found necessary for a better estimate of export prices.

Achoth (1985) analyzed the supply, price and trade of Indian tea by fitting ARIMA models to data on prices and production. The moving average models were found to be most suitable. Among the price series a particular month's price was not related to the price of the immediate previous month but significantly related to the price of same month in previous years. However, the production in a particular month was related both to production of the previous month as well as to the production of same month in previous years. The forecasts yielded reasonably good results as judged from the tests of their efficiency. The forecasts of prices were superior when compared to the forecasts of quantities, which was attributed to the highly structured pattern of price behaviour.

Devaiah *et al.* (1988) attempted forecasting the prices of cocoons at Ramnagaram market by using ARIMA models. The forecasts were made for 13 months from April 1987 to April 1988. The forecasted values were observed to be close to he actual prices.

Lanciotti (1990) presented a paper on analysis of time series data of monthly prices for a group of diary products with the aim of obtaining reliable forecasts. The method of analysis employed is ARIMA as put forward by Box-Jenkins. The time series data covers both wholesale and retail prices for butter, Gorgonzola, Provolone, Grana Padano and Pasmigiano Reggiano. To estimate the reliability of the forecast obtained, a comparison is made with those resulting from naïve models do not require any estimates. Indicators on the accuracy of the forecasts show that except for Grana Padana, Le ARIMA forecasts are better.

Yin-Runsheng and Mins-Rs (1999) indicated timber price forecasts were Auto Regression Integrated Moving Average (ARIMA) models employing the standard Box-Jenkins modeling strategy by using quarterly price series Timber Mart South. The results showed that most of the selected pipe 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 forecast, are fairly accurate. It is suggested that forecasting future prices could aid timber producers and consumers alike in timing harvests reducing uncertaining and enhancing efficiency.

Mastny (2001) used ARIMA models, also called Box and Jenkins models after their developers, is a group of models allowing the analysis of the time series with various features. The article demonstrates the possible usage of the Box-Jenkins methodology for the analysis of time series for agricultural commodities. The paper contains a basic mathematical explanation of ARIMA models together with a practical illustration of a price development forecast for a selected agricultural commodity.

Gangadharappa (2005) fitted ARIMA model to study the variation in arrivals and prices of potato in Bangalore, Belgaum, kolar, Hassan and Hubli markets of Karnataka during 1996-97 to 2003-04. Box-Jenkins method was applied for precise forecasting of arrivals and prices of potato for the monthly data to all the selected markets. Of all the ten series, he found only two series, which yielded Box –Pierce 'Q' statistic which was significant and AIC was minimum.

Punitha (2007) attempted to fit ARIMA model to forecast the values of arrivals and prices of maize and ground nut for Davengere market and Hubli market. The forecasted values of groundnut arrivals and prices showed an increasing trend in Davangere market, but in Hubli market prices showed decreasing trend. The forecasted values of arrivals and prices of maize showed an increasing trend in both the markets.

Satya *et al.* (2007) made an attempt to forecast milk production using statistical time series modeling techniques such as double exponential smoothing and Auto- Regressive Moving Average (ARIMA) for the study period of twenty five years (1980-81 to 2004-05). On validation of the forecast from these models, ARIMA model performed better than the other one.

Bharathi (2009) examined the price behaviour of mulberry silk cocoon in Ramnagar and Siddlaghatta market. Box-Jenkins ARIMA model was used to forecast the monthly arrivals and prices of mulberry silk cocoons in Ramanagara and Siddlagatta markets.

Chandrakala (2009) analysed spatial and temporal behavior of arrivals and prices of groundnut in Karnataka. ARIMA model was employed to forecast the arrivals and prices of groundnut in selected markets. Among five markets (Challakere, Chitradurga, Bellary, Yadagir and Davangere markets) the Bellary market yielded the best results.

2.2.2 Exponential Smoothing Method.

Belov *et al*. (1985) examined on promising chopper mechanisms for forage harvesters. Design features of the chopping mechanisms of forage harvesters are briefly evaluated and future manufacturing trends are analysed by means of time series analysis and exponential smoothing. Harvesters having cylinder choppers and blowers constituted more than 50 percent of the existing population and it were predicted that this trend would continue. The proportion of harvesters having disc chopper-forwarders would reach 10-12 per cent in the coming 5 years.

Deluyker *et al*. (1987) analysed on modeling daily milk yield in Holstein cows using time series analysis. Time series analysis of milk yields of cows milked 3 times daily was carried out on 513 partial or complete lactation yield records. It was found that the exponential smoothing function was most appropriate for the modelling of individual milking and daily yield data. Model parameters were influenced by parity, stage of lactation, occurrence of missed milkings and treatment for diseases. An examination of the residual variances showed that the model to forecast daily total yield performed as well as the model to forecast individual-milking yield.

Sisak (1989) worked on the principle of adaptive models of time series with regard to short term forecasting and the possibilities for application to cost planning. An adaptive model for the exponential smoothing of time series data is used to determine short term forecasts in the development of production costs for a farm forestry enterprise in Czechoslovakia. The results obtained are compared to those derived from an extrapolation of regression estimates. It is argued that the exponential smoothing technique can be more easily used in the computer programs for farm management and provide better quality forecasts for farm planning/budgeting than the regression model forecasts.

Manurung (1991) analysed on forecasting of oil palm hectarage and the need for seed in the second long term development plan. Forecasts of oil palm hectarage in Indonesia over the period of the second long term development plan (1994-2018) are made using the double exponential smoothing method. The average forecast growth rate is 3.24 percent per year. Three seed sources in Indonesia will be able to supply the projected number of seeds needed to support this development in oil palm area.

Sheldon (1993) worked on forecasting tourism: expenditures versus arrivals. This examines issues relating to the measurement and forecasting of international tourist expenditures and arrivals. It shows that the two series fluctuate differently, and examines the accuracy of six different forecasting techniques (time series and econometric causal models) to forecast tourism expenditures. The results show that the accuracy of the forecasts differs depending on the country being forecast, but that the no-change model and Brown's double exponential smoothing are, overall, the two most accurate methods for forecasting international tourism expenditures

Mohan (1995) worked on forecasting weekly reference crop evapotranspiration series. The time variant characteristics of evapotranspiration (ET) necessitate the need for forecasting ET. In this, two techniques, namely a seasonal ARIMA model and winter’s exponential smoothing model, have been investigated for their applicability for forecasting weekly reference crop ET. A seasonal ARIMA model with one autoregressive and one moving average process and with a seasonality of 52 weeks was found to be an appropriate stochastic model. The ARIMA and Winter's models were compared with a simple ET model to assess their performance in forecasting. The forecast errors produced by these models were very small and the models showed promise of great use in real-time irrigation management.

Lim (2001) worked on forecasting tourist arrivals. Various exponential smoothing models were estimated over the period 1975-99 to forecast quarterly tourist arrivals to Australia from Hong Kong, Malaysia, and Singapore. The root mean squared error criterion is used as a measure of forecast accuracy. Prior to obtaining the one-quarter-ahead forecasts for the period 1998-2000, the individual arrival series are tested for unit roots to distinguish between stationary and non-stationary time series arrivals. The Holt-Winters Additive and Multiplicative Seasonal models outperform the Single, Double, and the Holt-Winters Non-Seasonal Exponential Smoothing models in forecasting. It is also found that forecasting the first differences of tourist arrivals performs worse than forecasting its various levels.

Rancheva (2002) attempted to study trends of average yield changes of cereals in Bulgaria. This estimates the main trend in the productivity/yields of cereals in Bulgaria, using exponential smoothing methods. Time series data for the period 1940-95 are used in the analysis.

Vasanthakumar (2002) worked on statistical evaluation of price variation in tropical Timbers. Exponential smoothing model is preferred to the multiplicative time series model for forecasting purpose. The single parameter exponential smoothing model was used to predict the prices of teak, rosewood and yellow teak.

Kumar *et al*., (2005) analysed on Price forecasting of different classes of teak by the application of exponential smoothing model. A single-parameter exponential smoothing model was used to forecast prices of different classes of teak in the Dandeli timber depot in Karnataka, India. Price data for the period May 1987-May 2001 were used, and both ex-post and ex-ante forecasts were made. The results of the ex-post forecasts reveal that the predicted prices are close to the actual prices.

Gajendra Singh (2006) examined assessment of food security situation for disaster risk management: an analysis for the Gujarat State. This study analyzes and forecasts the food security situation in the state of Gujarat, India. The study is based on the premises that the gap between food supply and food requirement is a better indicator of the food security level than the usually adopted supply-demand gap. The study considers the exponential smoothing and moving averages for making projections of food grains. The estimates of food grain production and requirement indicate that the overall cereals and pulses requirement would continue to be in deficit in both periods.

Huertas *et al*. (2007) attempted to study forecasting international tourist demand using Holt-Winters exponential smoothing model. This examined forecasts of international tourism arrivals to Spain. A survey was conducted on residents from 10 other major origin countries with respect to their future visits to Spain. The Holt-Winters exponential smoothing model was used to forecast the residents' demand for tourism in Spain by 2007-08.

2.3. Growth rates

Singh *et al*. (1997) while assessing the regional variations in agricultural performance in India, estimated the compound growth rates of area, production and yield of pulses by fitting log linear function of the form, $\log Y = a + b^t$. The data were analyzed by considering three time period viz., Period I (1960-61 to 1967-68), Period II (1968-69 to 1980-81), Period III (1981-82 to 1992-93). In almost all the states selected for analysis, the growth rate of pulses, significant growth rates were observed with respect to area.

Legesse (2000) found that during eighties wheat area showed a declining growth rate (i.e.) 3.94 per cent per annum but production and productivity showed a negative growth rate. During nineties the Karnataka state recorded a significant positive growth rate of 3.47 per cent in area while in production the state recorded a mild growth, productivity showed a negative growth rate.

Asfaw (2000) in his study on agricultural performance in Sub-Saharan African countries reported that during 1961-73 periods both area and yield contributed to increase total food grain production. Countries during 1974-84, all the countries had negative growth in area and production. During the third period (1985-98) all the countries experienced expansion in area and production under food grains. This is attributed to Structural Adjustment Policy (SAP) initiatives.

Desai (2001) analyzed the growth rates of mango exports to five major importing countries viz., UAE, UK, Netherland, Hong Kong and Japan for the period 1990 to 1998. Remaining countries importing mango from India were grouped together as others. Fresh mango exports to Japan registered a growth rate of 33.87 percent followed by others (12.97%), Nether lands (7.50%) and UK (5.76%). The total growth in export of fresh mango was 9.01 per annum.

Kaur *et al*. (2002) computed compound growth rate to examine the trends in area, production and productivity of pulses. The study revealed that growth rates in production and productivity of total pulses in India were found to be significant and positive.

Lakhana (2003) in his study on production, price behaviour and export of groundnut in India with special reference to Gujarat state, for pre- Technology Mission of Oilseeds (TMO) (1970-71 to 1985-86), post-TMO (Technology Mission of Oilseeds) (1986-87 to 2001-02) and for the entire period (1970-71 to 2001-02) of selected markets (i.e. Rajkot, Junagadh, Kalawad and Amrelin). The post-TMO period had witnessed positive growth rates in area, yield and production. Growths rates of area for Junagadh and Rajkot districts as well as for the state of Gujarat as a whole were positive and significant. However, growth rates of yield were negative throughout the study area during pre-TMO. During post-TMO, growth rates of all variables were found to be positive.

Shwetha (2003) computed compound growth rate for production and export of shrimp, squid and ribbon fish for the period from 1990 to 2000. The result of the study revealed that there was a significant positive growth in case of total production and exports of shrimp, squid and ribbon fish.

Nisha (2004) studied the growth rate of groundnut in India from 1980-1988 and 1991-1994. The results revealed that, in the pre-liberalization period, there is a negative growth rate both in quantity and value. But in the post liberalization period (after 1991), the quantity of exports showed an increasing trend whereas the value of exports showed a declining trend.

Varghese (2004) worked out the trend in area, production and productivity of cardamom in Kerala for a period from 1970-71 to 2002-03 using semi-logarithmic growth equation. The area under cardamom registered a negative growth rate (-1.216%) which was significant. The output growth at an average annual trend growth rate of 4.14 percent while yield registered an average annual growth rate of 5.51 per cent.

Lathika and Kumar (2005) analyzed the growth trends in area, production and productivity of coconut for different coconut producing States/union territories in India for two sub-periods; phase I (1951 to 1995) and phase II (1996 to 2002). Area showed positive growth in both phases for selected States except for the Andaman and Nicobar islands where the growth was negative (-9.69) in II phase. Production also showed a positive growth in all the States in both the phases and Andhra Pradesh had highest growth in II phase (16.69 %). The growth rate of productivity showed negative growth in Kerala and Orissa in the I phase, Karnataka in the II phase.

Amarender reddy (2005) conducted study on growth and instability of chickpea production in India. Study revealed that the average production of chickpea increased by7 per cent from 4.8mt in 1970-85 to 5.2mt in 1986-2003 in India. Coefficient of variation increased from 14 per cent to 17 per cent during the same period. Most of the states fall n low growth-high risk category in chickpea production. Only Madhya Pradesh, Andhra Pradesh and Orissa fall under desirable state of high growth- low risk category. Madhya Pradesh, Maharashtra and Karnataka contributed to increase in production.

Varuna (2005) studied the compound growth rate in black pepper in India during 1980-81 to 2002-03. The results showed that the area under black pepper increased at the rate of 3.63 per cent per annum. The production and productivity increased at 5.20 % and 1.52 % per annum respectively, which showed positive and significant growth.

Dudhat (2006) computed the compound growth rates for quality seeds for the study of 1980-81 to 2000-01 in Gujarat. The growth rates under quality seeds found positive in both 1981-91 (2.81%) and 1992-01 (2.26%) period but it was statistically non- significant, whereas in overall period (1981-01), the growth rate was positive and statistically significant. Almost the same pattern of growth rates was observed in production but in case of yield, the negative growth rates was observed in all the periods under study and it was found statistically significant in 1981-91 (-3.83%).

Tumar (2006), studied the growth and instability in area, production and productivity of garlic in Gujarat and its export from India. The study was confined to major garlic growing district of Gujarat. The data for the period 1985-86 to2001-02 and analysis by using exponential production function and instability index. The result reveal that area and production has increased in the state but with high instability.

Khan (2007) studied growth rates in Arecanut prices before Market Intervention Scheme (MIS) (1994-95 to 2001-02) and MIS (2002-03 to 2004-05) periods. . In the period before MIS the growth rate was positive for both white chali variety and edi variety 4.87 per cent and 1.49 per cent respectively. Whereas for saraku and bette varieties it was negative -0.49 per cent and -0.67 per cent respectively. During the MIS period the growth rate was positive for all varieties 0.36, 3.64, 4.06 and 6.24 per cent respectively for white chali, saraku, bette and edi varieties. The growth rate for the entire period was negative for saraku and bette varieties with -0.54 and -0.58 per cent, respectively.

Vinaya (2007) used compound growth rates to find the growth in area, yield and production of rice. The results revealed that in Karnataka, area under rice increased from 1.12 million hectares during 1985-86 to 1.14 million hectares in 2004-05. The area increased at a compound growth rate of 1.01 percent per annum. For the same period, production increased from 2.38 million tonnes to 2.51 million tonnes at an annual compound growth rate of 2.21 percent, where as yield increased at the rate of 1.27 percent.

Seema *et al.* (2008) conducted study on assessment of agricultural production growth and instability during new Economic regime in Rajasthan. The study revealed that maize, barley, arhar groundnut, rapeseed, mustard, mango, papaya and guava were found to have positive growth in production due to positive growth in yield. The crops found with low inter year instability in yield were maize, barley, groundnut, rapeseed, mustard, linseed and mango.

Hosamani *et al.* (2009), the study observed that there was stability in Production and export of chilli during post-liberalization than the pre-liberalization period. The cardinal factors driving the significant increase in production are use of high yield, favourable weather conditions and changing consumption pattern. The change in economic environment and favourable weather conditions are found to be important factors increase the production to meet the domestic as well as external demand there is a potential to increase the export as currently. India Is exporting still less than 20% of its production for studying of these they used statistical tools like Exponential Growth function, compound growth rates etc.

3. METHODOLOGY

The aim of this chapter is to provide a brief description of the materials which provide the necessary data base for the study under the following headings and to highlight the importance of statistical tools employed.

3.1 Description of the selected markets

3.2 Nature and sources of data

3.3 Analytical tools and techniques

3.1.1 Description of the selected area

North Karnataka is a relatively arid expanse of plateau, lying between 300 and 700 meters elevation, in southern India and within the Karnataka province. It includes the districts of Belgaum Bijapur, Bagalkot, Bidar, Bellary, Gulberga, Raichur, Gadag, dharwad,Haveri, and Uttar kannada Districts. It is drained by the Krishna River and its tributaries the Bhima, Ghataprabha, Malaprabha, and Tungabhadra. It mostly lies with the Deccan thorn scrub forests ecoregion, which extends north into eastern Maharastra. Chilli was grown in almost all districts of North Karnataka but highly concentrated in Dharawd, Haveri, and Gadag districts, now days area was extending in districts like Bellary, Raichur, Gulberga because of various irrigation projects. Chilli was planted on an average 1,25,000 ha with an average yearly production of about 500 to 600 tonnes.

3.1.2 Description of the selected markets.

In Karnataka, there are many chilli markets, out of these markets Byadagi and Hubli markets are predominant in Northern Karnataka, which have been selected for the present research study.

3.1.2.1 Hubli market

The Hubli agriculture produce market committee was established in the year 1943 under the Bombay agricultural produce market act, 1939 in Dharwad district. The jurisdiction of market committee extends over the Taluks of Hubli Khalagatagi, Shiggaon and part of Savanur Taluk. Hubli market has one sub market at khalagatigi and other at the Shiggaon. In Hubli Agricultural produce market committee open auction, open agreement and tender system are in practice. The infrastructural facilities such as post and telegraph, banking facilities, guest house etc., have been provided in Hubli market yard for the convenience of people who participate in the marketing activities.

3.1.2.2 Byadagi market

Byadagi is a Taluk headquarter in Haveri district, here chilli plays an important role in the agricultural economy of Byadagi Taluk . Chilli crop occupies an area of about 4,227 hectares of land in Byadagi Taluk. Byadagi is an important trading centre particularly for dry chillies. Byadagi market was brought under regulation in the year 1948 under the provisions of the Bombay agricultural produce market act 1939. The jurisdiction of the market committee covers the whole of Byadagi Taluk. Since its inception, this market is known for trading in dry chilies and second largest market for chilli in india after Guntur (Andra Pradesh) and on an average yearly transaction of about nearly 300 to 350 tonnes. And annual turnover of the market is about 300 crores.

3.2 Nature and source of data

The required data on area, production, and productivity was collected from Directorate of economics and statistics Bangalore for the period 1997-98 to 2008-09.The monthly price and arrivals of chilli was collected from Byadagi and Hubli markets for the period 1993-94 to 2008-09.

3.3 Analytical tools and techniques

In this section, brief description of statistical tools employed has been presented.

3.3.1 Time series analysis

Time series analysis was done to study the variations in arrivals and prices of chilli in monthly prices and arrivals of chilli for the period of 10 years.

A time series is a complex mixture of four components namely, Trend (T), Seasonal (S), Cyclical (C) and Irregular (I). These four types of movements are frequently found either separately or in combination in a time series. The relationship among these components is assumed to be additive or multiplicative, but the multiplicative model is the most commonly used, which can be represented as

$$O_t = T \times C \times S \times I$$

Where,

O_t - Original observation at time 't'

T - Secular trend

S - Seasonal variations

C - Cyclical movements

I - Irregular fluctuations

Secular trend (T)

Over a long period of time, time series is very likely to show a tendency to increase or decrease over time. The factors responsible for such changes in time series are the growth of population, change in the taste of people, technological advances in the field etc.

There are different types of trends, some of them are linear and some are non-linear in their form. For shorter period of time, in most of the situations the straight line provides the best description of trend and for longer period of time, the non-linear form generally provides a good description of the trend. Often, it may be possible to describe such movements with a structured mathematical model. In the absence of such a definite format, approximately a polynomial or a free hand could describe the movements.

Seasonal variation (S): The variation within a year is called as seasonal variation. The main causes of seasonal variations are customs, climates etc. Such seasonal components can be analyzed through harmonic analysis.

Cyclical movements (C): Cyclical movements are fluctuations which differ from periodic movements. Cyclical movements have longer duration than a year and have periodically of several years as in business cycles.

Irregular variations (I): Here the effects could be completely unpredictable, changing in a random manner. A given observation is affected by episodic and accidental factors. These are also known as causal series and are affected by the unknown causes. These unknown causes act in an unpredictable manner.

3.3.1.1 Estimation of seasonal indices of monthly data

The multiplicative model permits the estimation of each of the four components.

As a first step to estimate the seasonal index, a 12 month centered moving average was calculated as follows.

$$M_1 = \frac{Y_1 + 2Y_2 + 2Y_3 + \ldots\ldots\ldots\ldots + 2Y_{12} + Y_{13}}{12}$$

$$M_2 = \frac{Y_2 + 2Y_3 + 2Y_4 + \ldots\ldots\ldots\ldots + 2Y_{13} + Y_{14}}{12}$$

$$M_3 = \frac{Y_3 + 2Y_4 + 2Y_5 + \ldots\ldots\ldots\ldots + 2Y_{14} + Y_{15}}{12}$$

etc., which is a sequential manner for each points of time 't'.

In this fashion, a 12 month centered moving average removes a large part of fluctuation due to the seasonal effects so that what remains is mainly attributable to other sources *viz.*, long term effects $T_{t,}$ cyclical effect C_t and the irregular variation I_t which is due to random causes is also minimized by the process of smoothing out effect. Thus, this affords a means of not only estimating TC effect but also estimating seasonal components.

In the next step of computing the seasonal index, the original series is divided by the centered moving average. This gives the first estimate of seasonal components $S_{t.}$

$$S_t = \frac{Y_t}{(TC)_t}$$

$$= \frac{(T_{t.}C_{t.}S_{t.}I_t)}{(T_{t.}C_t)}$$

It is always expressed in terms of percentages (Column 4 of Table 3.1). In this process, we do not have moving average for the first six and last six months. These seasonal components are next arranged month-wise for each year (Table 3.2)

The last row in the Table 3.2 give estimates of seasonal index for the 12 months adjusted for their total to 1200 or averaged to 100.

The last row in the Table 3.2 gives the first estimates of seasonal variations. In order to obtain a better estimate *i.e.,* stabilized seasonal indices we need to employ an interactive process as under.

The original observation (Y_t) is divided by corresponding (S_t) value and then obtain the residual $(TCI)_t$ corresponding to time point t.

$$(TCI)_t = \frac{Y_t}{S_t} = \frac{(TCSI)_t}{S_t}$$

The residual series $(TCI)_t$ thus obtained is subjected to the same process of determining 12 month centered averages as done earlier to obtain better estimates for trend cycle effect *viz.*, (TC)t. These revised estimates are next employed as above to generate a revised set of seasonal indices by dividing each observation (Yt) by the corresponding (TC)t value. This will lead to revise estimates of seasonal indices (St) as second interactive ones. This interactive process is separately employed until stabilized seasonal indices are obtained i.e., two successive seasonal indices do not differ by more than five per cent i.e.

$$\left(TCI\right)_t = \frac{S_i + S_j}{S_i} \times 100 \le 5, i = j = 1,2,....12$$

3.3.1.2 Estimation of cyclical indices

The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Y_t) by corresponding (S) for time't'

Symbolically

$$T.C.I = \frac{T.C.S.I}{S}$$

These depersonalized data contain trend, cyclical and irregular components. This trend cycle components are plotted against time for examining cyclical behaviour. If there is any existence of cycle, periodicity of cycle is noted. Again moving average of length equal to periodicity of cycle is computed for eliminating cyclical behaviour.

These moving averages are arranged cycle wise. These are adjusted for cyclical indices, as in the case of seasonal indices. Then trend cycle values (TC) are divided by adjusted components CI.

The examination of both the graphs of trend cycle component as well as trend component will give a clear idea of the presence of cycle.

If there is similarity in these two graphs, it is an indication of non-existence of the cycle. However, the non-similarity in the two graphs is an indication of the presence of the cycle. If ultimately a cycle is reflected, then the cyclical effect is removed from T-C components. If no cycle is detected, then the trend cycle values are treated as pure trend values. The Friedman's two way analysis of variance was employed to know the significant difference among months within a cycle and also between cycles. A significant difference indicates the presence of changing cyclical behaviour and non-significant difference indicates the consistency of cyclical pattern.

3.3.1.3 Analysis of long-term movements

The residuals ($T_t = Y_t/S_tC_t$) after eliminating seasonal effects and cyclical effects (if any) from original observations (Y_t) are used to determine the trend. If there is no cyclical pattern, then trend cycle components are treated as trend values.

When definite mathematical model cannot be identified to fit the trend data, the orthogonal polynomial model are used to determine the long term behaviour. These models are fitted by the principles of Least Squares. The polynomial model tried is shown below.

1st degree (straight line) : $Y_t = a + bx + u$

2nd degree polynomial : $Y_t = a + bx + cx^2 + u$

3rd degree polynomial : $Y_t = a + bx + cx^2 + dx^3 + u$

4th degree polynomial : $Y_t = a + bx + cx^2 + dx^3 + ex^4 + u$

5th degree polynomial : $Y_t = a + bx + cx^2 + dx^3 + ex^4 + fx^5 + u$

6th degree polynomial : $Y_t = a + bx + cx^2 + dx^3 + ex^4 + fx^5 + gx^6 + u$

Where,

Y_t = Trend values at time t

u = Disturbance term

a, b, c, d, e, f, g = Coefficient to be estimated

Table 3.1: Computation of centered 12 month moving average

Year / Month	Observations(Y)	Centred 12 month moving average	Percent 12 month moving average
1994			
April	Y_1	-	-
May	Y_2	-	-
June	Y_3	-	-
July	Y_4	-	-
August	Y_5	-	-
September	Y_6	-	-
October	Y_7	M_1	S_1
December	Y_8	M_2	S_2
1999			
January	Y_9	M_3	S_3
February	Y_{10}	M_4	S_4
March	Y_{11}	M_5	S_5
April	Y_{12}	M_6	S_6
May	Y_{13}	M_7	S_7
June	Y_{14}	M_8	S_8
July	Y_{15}	M_9	S_9
August	Y_{16}	M_{10}	S_{10}
September	Y_{17}	M_{11}	S_{11}
October	Y_{18}	M_{12}	S_{12}
November	Y_{19}	M_{13}	S_{13}
December	Y_{20}	M_{14}	S_{14}
2000			
January	Y_{21}	M_{15}	S_{15}
2009			
	Y	M	S

Table 3.2: Average of percentage centered 12 month moving average and computation of seasonal index for observation

Year	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1994	*	*	*	*	*	*	S	S	S	S	S	S
1999	S	S	S	S	S	S	S	S	S	S	S	S
**	*	*	*	*	*	*	*	*	*	*	*	*
**	*	*	*	*	*	*	*	*	*	*	*	*
2009	S	S	S	S	S	S	S	S	S	S	S	S
Mean	*	*	*	*	*	*	*	*	*	*	*	1200
Adj. Seasonal Index	*	*	*	*	*	*	*	*	*	*	*	100

Table 3.3: Tabular format of obtaining cyclical component

Months Cycle	1	2	3	31	32	60	Total
I	*	*	*…………...*	C	C…………..C	C	
II	C	C	C…………..C	C	C…………..C	C	
III	C	C	C…………..C	C	C…………..C	C	
IV	C	C	C…………..C	C	C…………..C	C	
V	C	C	C…………..C	C	C…………..C	C	
Mean	-	-		-		-	(Row total 6000)
Cyclical index (adjusted)	-	-		-		-	

The suitable model for data is judged based on R^2 (coefficient of determination) value.

3.3.2 Box-Jenkins models

The Box-Jenkins procedure is concerned with fitting a mixed Auto Regressive Integrated Moving Average (ARIMA) model to a given set of data. The main objective in fitting this ARIMA model is to identify the stochastic process of the time series and predict the future values accurately. These methods have also been useful in many types of situation which involve the building of models for discrete time series and dynamic systems. But, this method was not good for lead times or for seasonal series with a large random component (Granger and Newbold, 1970).

Originally ARIMA models have been studied extensively by George Box and Gwilym Jenkins during 1968 and their names have frequently been used synonymously with general ARIMA process applied to time series analysis, forecasting and control. However, the optimal forecast of future values of a time-series are determined by the stochastic model for that series. A stochastic process is either stationary or non-stationary. The first thing to note is that most time series are non-stationary and the ARIMA model refer only to a stationary time series. Therefore, it is necessary to have a distinction between the original non-stationarity time series and its stationarity counterpart.

3.3.2.1 Stationarity and non-stationarity

The term stationarity meaning that the process generating the data is in equilibrium around a constant value and that the variance around the mean remains constant over time. The data must be roughly horizontal along time axis.

If mean changes over time (with some trend cycle pattern) and variance is not reasonably constant then series is non-stationary in both mean and variance.

If a time series is not stationary, then it can be made more nearly stationary by taking the first difference of the series. Conversely a stationary process may be summed or integrated to give a non-stationary process.

Let X_t be a random variable and x_t (where, t=1, 2, . . . n) be the observations on X_t with density function f (x_t). If the observations are independent, then

$$f(X_1, X_2, ..., X_n) = f_1(x_1) f_2(x_2)....f_n(x_n)$$

This implies that joint distribution is independent of historical time.

The assumption of stationarity reduces the number of parameters in the joint probability density function of a random variable x_t in the series.

Since the ARIMA models refer only to a stationary time series, the first stage of Box-Jenkins model is reducing non-stationary series x_t to a stationary series Y_t by taking first differences as follows.

$$\begin{aligned} Y_t &= \Delta X_t \\ &= X_t - X_{t-1} \\ &= X_t - BX_t \\ &= (1-B)X_t \end{aligned} \tag{3.2}$$

Where,

B = Backward shift operator

The backward shift operator is convenient for describing the process of differencing. To define B, such that

$$B_i X_t = X_{t-1}, \qquad \text{i= 1, 2, . . . n}$$

Suppose the first difference of the series doesn't become stationary then second order differencing is done as follows

$$Y_t = \Delta(\Delta X_t) \quad 3.3$$

$$= \Delta(X_t - X_{t-1})$$

$$= (X_t - X_{t-1}) - (X_{t-1} - X_{t-2})$$

$$= X_t - 2X_{t-1} + X_{t-2}$$

$$= X_t - 2BX_t + B^2 X_t$$

$$= (1 - 2B + B^2)X_t$$

$$= (1 - B^2)X_t$$

In general, if it takes a d^{th} order difference to achieve stationarity we will write.

d^{th} order difference $= (1-B)^d X_t$ 3.4

The general ARIMA (o, d, o) model will be

$$(1-B)^2 X_t = e_t \quad 3.5$$

Where e_t is error term distributed normally with

$E(e_t) = 0, V(e_t) = e_t^2$ and

$Cov(e_i, e_j) = \theta$ For all t ($i \neq j$)

In order to test the stationarity, compute the auto-correlation functions (ACF) of difference series (Y_t) up to 24 lags. If the ACF for first and higher differences (after 2-3 lags) drop abruptly to zero then it indicates the series is stationary.

3.3.2.2 Stationary time series model

3.3.2.2.1 Auto regressive process (p, o, o)

If the observation Y_t depends on previous observation and error term e_t is called auto regressive process (AR process)

$$Y_t = \mu + \varnothing_t Y_{t-1} + \varnothing_2 Y_{t-2} + \ldots\ldots + \varnothing_p Y_{t-p} + e_t$$

$$= \varnothing_p(B)(Y_t - \mu) + e_t \quad 3.6$$

Note the term μ in equation (3.5) is not quite the same as the "Mean" of the Y series. Rather, the development is as follows.

$$(Y_t - \mu) = \phi_p(Y_t - \mu) + e_t$$

$$= \phi_1(Y_{t-1} - \mu) + \phi_2(Y_{t-2} - \mu) + \ldots. + \phi_p(Y_{t-p} - \mu) + e_t \quad 3.7$$

$$= \phi_1(Y_{t-1} - \phi_1\mu) + \phi_2(Y_{t-2} - \mu) + \ldots + \phi_p(Y_{t-p} - \mu) + e_t$$

$$Y_t = (\mu - \phi_1\mu - \ldots - \phi\mu) + \phi_1 Y_{t-1} + \ldots + \phi_p Y_{t-p} + e_t$$

$$= \mu_1 + \phi_1 Y_{t-1} + \ldots + \phi_p Y_{t-p} + e_t$$

3.3.2.2.2 Moving average process (o, o, q)

If the observation Y_t depends on the error term e_t and also on one or more previous error terms (e_t 's) then we have moving average (MA) process.

$Y_t = \mu + e_t - \theta_1 e_{(t-1)} - \theta_2 e_{(t-2)} - \ldots \theta_q e_{(t-q)}$ 3.8

Where,

$\theta_i = i^{th}$ moving average parameter

$i = 1, 2, \ldots q$

q = Order moving average

3.3.2.2.3 Mixtures: ARIMA process

If the non-stationarity is added to a mixed ARIMA process, then the general ARIMA (p, d, q) is implied. Here the word integrated is confusing to many and refers to the differencing of the data series.

$$(1-B)^d (1-\phi_p B^p) Y_t = \mu + (1-\phi_p B^q) e_t \quad 3.9$$

Seasonality and ARIMA models

Some time series exhibit perceptible periodic pattern for instance price and arrivals of agricultural commodities usually have a seasonal pattern process then the general.

The ARIMA notation can be extended readily to handle seasonal aspects and the general shorthand rotation is ARIMA

(p.d.q.)	(P.D.Q.)
(Non-seasonal part of the model)	(Seasonal part of the model)

s = number of periods per season

The mixture of AR and MA seasonal model is

$\varnothing_p (B)\ \Delta^d \varnothing_p(B^s)\ \Delta^D x_t = \theta_q (B)\ .\ (H)_Q (B^s)\ e_t$ 3.10

If $Y_t = \Delta^d \Delta^d\ x_t$ – the model becomes an integrated model.

The main stages in setting up a Box-Jenkins forecasting model are as follows.

1. Identification
2. Estimating the parameters
3. Diagnostic checking and
4. Forecasting

3.3.2.2.4 Identification of models

A good starting point for time series analysis is a graphical plot of the data. It helps to identify the presence of trends.

Before estimating the parameter (p, q) of model, the data are not examined to decide about the model which best explains the data. This is done by examining the sample ACF (Autocorrelation function) and PACF (Partial Autocorrelation function) of differenced series Y_t.

The sample auto correlations for k time lags can be found and denoted by r_k as follows

$$\hat{\rho}(Y_t) = r_k\left(\hat{Y}_t\right) \quad 3.11$$

$$= \frac{C_k(Y_t)}{C_0(Y_t)}$$

Where,

$$C_k(Y_t) = \frac{1}{n}\sum_{t-1}^{n-k}(Y_t - \bar{Y})(Y_{t+k} - \bar{Y})$$

K = 0, 1, 2, ... n

t = 1, 2, . . . n-k

$$\bar{Y}_t = \frac{1}{n}\sum_{t=1}^{n} Y_t$$

n = Length of time period

Both ACF and PACF are used as the aid in the identification of appropriate models. There are several ways of determining the order type of process, but still there was no exact procedure for identifying the model.

3.3.2.2.5 Estimation of parameters

After tentatively identifying the suitable model, next step is to obtain Least Square Estimates of the parameters such that the error sum of squares is minimum.

$$S(\theta,\phi) = \sum_{t=1}^{n} e_t^2(\theta,\phi) \quad 3.12$$

Where

t = 1, 2, 3 . . . n

There are fundamentally two ways of getting estimates for such parameters.

a) Trial and error: Examine many different values and choose set of values that minimizes the sum of squares residual

b) Interactive method: Choose a preliminary estimate and let a computer programme refine the estimate interactively.

The latter method is used in our analysis for estimating the parameters.

3.3.2.2.6 Diagnostic checking

After having estimated the parameters of a tentatively identified ARIMA model, it is necessary to do diagnostic checking in order to verify that the model is adequate.

Examining ACF and PACF of residuals may show an adequacy or inadequacy of the model. If it shows random residuals, then it indicates that the tentatively identified model was adequate. When an inadequacy is detected, the checks should give an indication of how the model need be modified, after which further fitting and checking takes place.

One of the procedures for diagnostic checking mentioned by Box-Jenkins is called over fitting i.e. using more parameters than necessary. But the main difficulty in the correct identification is not getting enough clues from the ACF because of inappropriate level of differencing. The residuals of ACF and PACF considered random when all their ACF were within the limits.

$$CI = \pm 1.96\sqrt{1/(n-12)} \quad 3.13$$

Box and Pierce 'Q' statistic was used to check whether the auto correlations for these residuals are significantly different from zero. It can be computed as follows.

$$Q = n\sum_{k=1}^{m} r_k^2 \quad 3.14$$

Where,

m = Maximum lag considered
n = N – D
N = Total number of observations
r_k = ACF for lag k
D = Differencing

And Q is distributed approximately as a Chi-square statistic with (m-p-q) degree of freedom.

The minimum Akike Information Coefficient (AIC) criterion is used to determine both the differencing order (d, D) required to attain stationarity and the appropriate number of AR and MA parameters, it can be computed as follows.

$$AIC_{(p+q)} = \{(1+\log 2\pi) + n\log\sigma^2 + 2m\} \qquad 3.15$$

Where,

σ^2 = Estimated MSE

n = Number of observations

m = p + q + P + Q

This diagnostic checking helps us to identify the differences in the model, so that the model could be subjected to modification, if need be.

3.3.2.2.7 Forecasting

After satisfying about the adequacy of the fitted model, it can be used for forecasting. Forecasts based on the model.

$$(1-\varnothing B)\ (1-\phi B)^s\ Y_t = (1-\theta B)\ (1-(H)^s B)\ e_t \qquad 3.16$$

Were computed for upto 36 months (m) ahead. The above model (3.16) gives the forecasting equation is

$$Y_t = \varnothing Y_{t-1} + \phi Y_{t-12} - \varnothing\phi Y_{t-13} + e_t - \theta e_{t-1} - (H)\ e_{t-12} + \theta(H)\ e_{t-13} \qquad 3.17$$

Given data upto time‘t’ the optional forecast of Y (also called Ex-Ante forecast) model at the t is the conditional expectation of Y_{t+1}.

It follows, in particular, that

$$e_t = Y_t - Y_{t-1} \qquad 3.18$$

The errors e_t in model (3.18) are in fact that forecast errors for unit lead time. That for an optimal forecast these ‘one step ahead’ forecast errors ought to form an uncorrelated series is otherwise obvious. Suppose, if these forecast errors were autocorrelated, then it could be possible to forecast the next forecast error in which case it could not be optimal.

The required expectations are easily found because

$$E(Y_{t+m}) = Y_t(m), E(e_{t+m}) = 0 \qquad 3.19$$

Where,

m = 1, 2, 3 . . . . . n

$$E(Y_{t-m}) = Y_{t-m} E(e_{t-m}) = a_{t-m} = Y_{t-m} - Y_{t-m-1}$$

Where, m = 0, 1, 2 . . . n 3.20

For instance, to determine the three month ahead (1-3) forecast for series Y_t (use equation 3.17).

$$Y_{t+1} = Y_{t+3}$$

$$= \varnothing Y_{t+2} + \phi Y_{t-9} - \varnothing\phi Y_{t-10} + e_{t+13} - \theta e_{t-2} - (H)\ e_{t-9} + \theta\ (H)\ e_{t-10}$$

taking conditional expectations at time t,

$$Y_t\ (1) = Y_t\ (3)$$

$$= \varnothing\ Y_{t(2)} + \phi y_{t-9} - \varnothing\ \phi Y_{t-10} + 0 - \theta\ (0) - (H)\ (Y_{t-9} - Y_{t-10}) + \theta(H)\ (Y_{t-10} - Y_{t-11})$$

Because, $E(e_{t+1)} = 0, E(e_{t-1}) = Y_{t-1} - \hat{Y}_{t-1} = e_{t-1}$

i.e. $Y_t(3) = 0\, Y_t(2)$

The forecast $Y_t(2)$ can be obtained in a similar way in terms of $Y_t(1)$ from $E(Y_{t+2})$. Similarly $Y_t(1)$ can be obtained from $E(Y_{t+1})$.

In practice it is very easy to compute the forecast $Y_t(1)$, $Y_t(2)$, $Y_t(3)$ etc. recursively using the forecast function (3.19).

$E(Y_{t+1}) = E(Y_{t+1}\text{-}1 + Q_{t+1}\text{-}\, e_{t+1}\text{-}1) - \theta\, e_{t+1}\text{-}1 - (H)\, e_{t+1}\text{-}12 + \theta(H)\, e_{t+1}\text{-}13$ and using 3.18 and 3.19.

However, using these methods, Ex-post forecasts can also be calculated for comparing with the value actually realized.

The accuracy of forecasts for both Ex-ante and Ex-post were tested using the following tests (Markidakis and Hibbon, 1979).

1) Mean square error (MSE); the formula for computing MSE is

$$\text{MSE}=\frac{1}{\text{n}}\sum_{t=1}^{n}\sqrt{(X_t-\hat{X}_t)^2}$$

Where,

X_t = Actual values

$\hat{X}_t$ = Predicted values

2) Mean average percentage error (MAPE): The formula for this is

$$\text{MAPE} = \frac{1}{\text{n}}\sum_{t=1}^{n}\sqrt{\frac{(X_t-\hat{X}_t)^2}{X_t}}\times 100$$

Where,

X_t = Actual values

$\hat{X}_t$ = Predicted values

3.3.3: Exponential smoothing model

Exponential smoothing uses a weighted average of past time series values as the forecast it is special case of the weighted moving averages method in which we select only one weight –the weight for most recent observation. The weight for the other data values are computed automatically and become smaller as the observations move further into the past. The basic exponential smoothing model follows.

$$F_{t+1} = \alpha Y_t + (1-\alpha)F_t \text{.................(1)}$$

Where

F_{t+1}= forecast for the time period t+1

Y_t=actual value of the time series in period t

F_t=forecast of the time series for period t

α =smoothing constant ($0 \le \alpha \le 1$)

Shows that the forecast for period t+1 is weighted average of the actual value in period t and the forecast for period t; note in particular that the weight given to the actual value in period t is α And that weight given to the forecast in period t is $1-\alpha$ we can demonstrate that the exponential smoothing forecast for any period is also a weighted average of all the previous actual values for the time series with a time series n periods of data : Y_1 ,Y_2,Y_3......Y_n to start the calculation we let F_1 equal to the actual value of the time series in period 1; that is F_1= Y_1 hence the forecast for the period 2 is

$$F_2 = \alpha Y_1 + (1-\alpha)F_1$$

$$= \alpha Y_1 + (1-\alpha)Y_1$$

$$= Y_1$$

Thus the exponential smoothing forecast for period 2 is equal to the actual value for the time series in period 1.

The forecast for period 3 is

$$F_2 = \alpha Y_2 + (1-\alpha)F_2$$

$$= \alpha Y_2 + (1-\alpha)Y_1$$

…………………………

…………………………

$$F_n = \alpha Y_i + (1-\alpha)F_i$$

$$= \alpha Y_i + (1-\alpha)\lfloor \alpha Y_j + (1-\alpha)Y_k \rfloor$$

$$= \alpha Y_i + \alpha(1-\alpha)Y_j + (1-\alpha)^2 Y_k$$

Hence F_n is weighted average of the first three time series values. The sum of the coefficients, or weights, for Y_1 ,Y_2,$Y_{3......}Y_n$ equals one. A similar argument can be made to shows that in general, any forecast F_{t+1} is a weighted average of all the time previous time series values

Despite the fact that exponential smoothing provides a forecast that weighted average of all the fast observations, all the fast data dot need to be saved to compute the forecast for next period . In fact, once the smoothing constant α is selected, only two piece of information are needed to compute the forecast. equation (1) shows that with a given α we can compute the forecast for period t+1 simply by knowing the actual and forecast time series value for period t- that is Y_t and F_t.

3.3.4 Growth rate analysis

Estimation of growth rate helps in measuring the rate of change in area, production and yield of crop over years. Thus, the compound growth rates of area, production and yield were computed by the following functional form.

$$Y = a\, b^t e_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (3.1)$$

Where,

Y = Dependent variable for which growth rate is estimated

a = Intercept

b = Regression coefficient

t = Time variable

e = Error term

To make calculations easy we take natural logarithmic of the equation 3.1 and is given below.

$$\ln Y = \ln a + t \ln b \qquad (3.2)$$

Where In Y is natural logarithm of Y, ln a and ln b are similarly defined.

The compound growth rate 'r' was computed by using the relationship

$$r = \text{Antilog of } (\ln b) \times 100$$

Where, $$\ln b = \frac{\sum (t \ln Y) - (\sum t \sum \ln Y) / n}{\sum t^2 - (\sum t)^2 / n}$$

and n is number of time points

The significance of ln b was tested by t-statistic and is given below.

$$t = \frac{|\ln b|}{SE (\ln b)}$$

Where

$$SE (\ln b) = (SS_{\ln Y} (\ln Y)^2 SS_t) / ((n-2) SS_t)$$

Where,

$$SS_{\ln Y} = \sum (\ln Y)^2 - (\sum \ln Y)^2 / n$$

4. RESULTS

In view with the objectives of the study, the necessary data on arrivals and prices of chilli were collected from the Hubli and Byadagi markets. These collected data were subjected to various statistical analyses and interpreted. The results of such analysis were presented in this chapter under the following heads.

4.1 Behaviour of arrivals and prices of chilli.

4.2 Forecasting of arrivals and prices of chilli.

4.3 Growth pattern in Area, production, productivity of chilli.

4.1.1 Behaviour of arrivals and prices of chilli in both Hubli and Byadagi markets

4.1.1.1 Secular trend in arrivals of chilli in Hubli market

The trend was computed in order to ascertain long run movement of chilli arrivals in market and the results was adverted in Table 4.1

To determine the nature of trend movement in the arrivals of chilli in Hubli market, the data was fitted to up to 6^{th} degree polynomial equations and 6^{th} degree polynomial equation was selected as a good fitted equation because its co-efficient of determination i.e. R^2 value was 61 percent this R^2 value was more as compared to other degrees of polynomial equations. And it could be seen that the above adverted equation from the graph in Fig 4.1 In graph clearly it showed that the ups and downs in the arrivals of chilli from year to year. It was noticed that in the year 2005 highest arrivals (i.e. 10,50,35 qtls) and lowest in the year 2004 (i.e. 28,030 qtls).

4.1.1.2 Secular trend in prices of chilli in Hubli market

To ascertain the nature of trend movement in the prices of chilli in Hubli market, the data was fitted to up to 6^{th} degree polynomial equations and 6^{th} degree polynomial equation was selected as a good fit because its co-efficient of determination i.e. R^2 value was 70 percent this R^2 value was more than other degrees of polynomial equations and it was depicted in Table 4.2. And it could be seen that the above equation from the graph in Fig 4.2. In the graph ups and downs in the trend of chilli prices were observed from year to year. In the year 1994 price of chilli was low (i.e. is Rs 2564) then on words slightly increase in the trend prices of chilli and highest price was noticed in the year 2009 (i.e. Rs 5,263).

4.1.1.3 Secular trend in arrivals of chilli in Byadagi market.

The trend was computed in order to ascertain long run movement of chilli arrivals in market and the results was shown in Table 4.3.

To determine the nature of trend movement in the arrivals of chilli in Byadgi market, the data was fitted to up to 6^{th} degree polynomial equations and 6^{th} degree polynomial equation was selected as a good fitted equation because its co-efficient of determination i.e. R^2 value was 84.60 percent this R^2 value was more than other degrees of polynomial equations. It was presented in Table 4.5 and it could be seen the above equation graphically in Fig 4.3. The ups and downs in the arrivals of chilli from year to year were reported. And it was noticed that in 2006 highest arrivals (i.e. 7,37,002 qtls) and lowest (1,31,165 qtls) was noticed in 1995.

4.1.1.4 Secular trend in prices of chilli in Byadagi market.

The nature of trend movement in the prices of chilli in Byadagi market, the data was fitted to up to 6^{th} degree polynomial equations and 6^{th} degree polynomial equation was selected as a good fitted equation since its co-efficient of determination i.e. R^2 value was 63.10 percent this R^2 value was more than other degrees of polynomial equations and it was depicted in Table 4.4. The above equation shown in graph in Fig 4.4 In graph ups and downs were observed in the trend of chilli prices from year to year. In the year 1998 price of chilli is low (i.e. Rs 1518,) then on words slightly increase in the trend prices of chilli and highest price was noticed in the year 2009 (i.e. Rs 5,437).

Table 4.1 Different degrees of Polynomials for arrivals of Hubli market

Degrees	Equations	R-square
2nd	y = 2719-81.26x2 + 4290.x	0.332
3rd	$y = 31236+ 1806.x + 273.2x^2-13.90x^3$	0.340
4th	$y = - 8080 + 38248x- 8710.x^2+ 790.8x^3-23.66x^4$	0.436
5th	$y = 68085- 56275x + 25697x^2- 4344.x^3+ 310.3x^4-7.860x^5$	0.575
6th	$y =+ 13328-15659x+74704x^2-14925x^3+1431.x^4- 65.05x^5+1.121x^6$	0.619

Table 4.2 Different degrees of Polynomials for prices of Hubli market

Degrees	Equations	R-square
2nd	$y = 3217. + 90.57x-1.626x^2$	0.237
3rd	$y = 1866. + 921.0x - 120.1x^2+4.647x^3$	0.579
4th	$y = 2284+ 534.1x- 24.74x^2- 3.896x^3+0.251x^4$	0.594
5th	$y = 638.2+ 2576.x- 768.3x^2+ 107.0x^3- 6.968x^4+0.169x^5$	0.696
6th	$y = 31.06 + 3511.x- 1224.x^2+ 205.6x^3- 17.41x^4+ 0.702x^5-0.010x^6$	0.701

Table 4.3 Different degrees of Polynomials for arrivals of Byadagi market

Degrees	Equations	R-square
2nd	$y = 7123+72259x-2629.x^2$	0.616
3rd	$y =21413- 54994x+ 15529x^2-712.1x^3$	0.711
4th	$y =3066+ 14064x - 32700x^2+ 3607.x^3-127.0x^4$	0.757
5th	$y = 37289- 31832x + 13437x^2- 21327x^3+ 1495x^4-38.16x^5$	0.818
6th	$y = 77838-94221x+ 43914x^2 - 87131x^3+ 8469.x^4- 393.8x^5+6.974x^6$	0.846

Table 4.4 Different degrees of Polynomials for prices of Byadagi market

Degrees	Equations	R-square
2nd	$y = 2760- 131.6x +17.41x^2$	0.545
3rd	$y = 1901+ 396.4x - 57.95x^2+2.955x^3$	0.584
4th	$y = 1983+ 320.7x - 39.29x^2+ 1.284x^3+0.049x^4$	0.584
5th	$y = 346.2+ 2352.x- 778.7x^2+ 111.6x^3- 7.129x^4+0.168x^5$	0.613
6th	$y = - 1716. + 5525.x- 2329.x^2+ 446.3x^3- 42.60x^4+ 1.978x^5-0.035x^6$	0.631

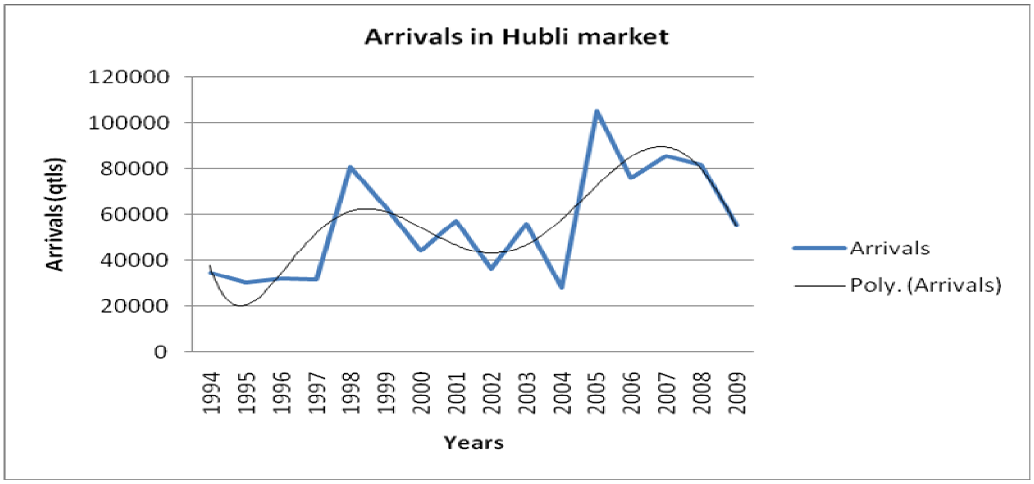


Fig 4.1: Trend component of arrivals of chilli in Hubli market

Fig 4.1 : Trend component of arrivals of chilli in Hubli market

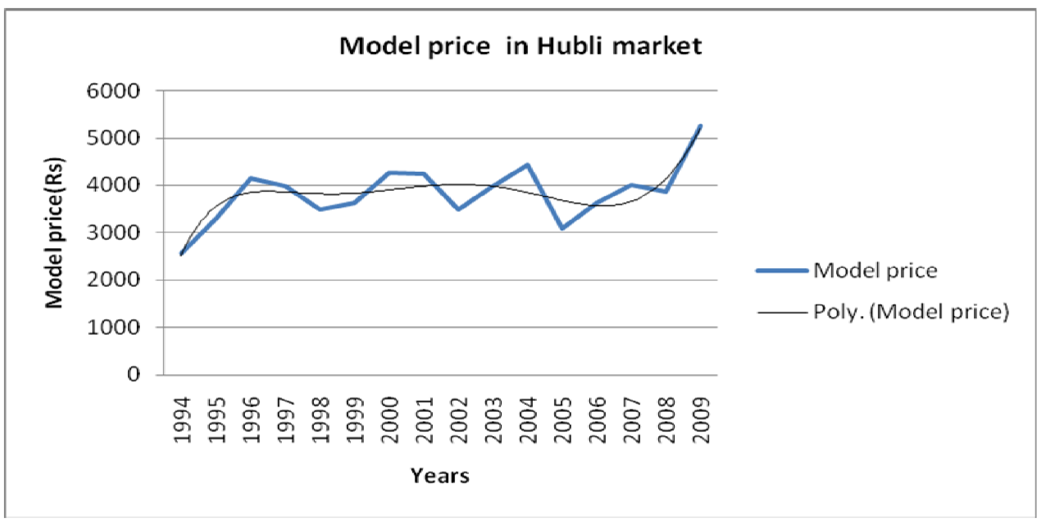


Fig 4.2: Trend component of prices of chilli market in Hubli market

Fig 4.2: Trend component of prices of chilli market in Hubli market

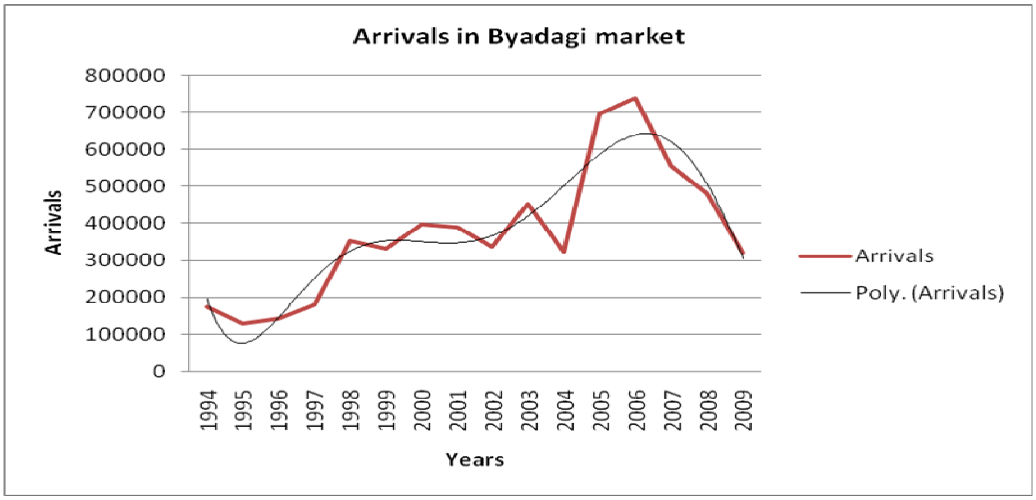


Fig 4.3: Trend component of arrivals of chilli in Byadagi market

Fig 4.3: Trend component ofarrivals of chilli in Byadagi market

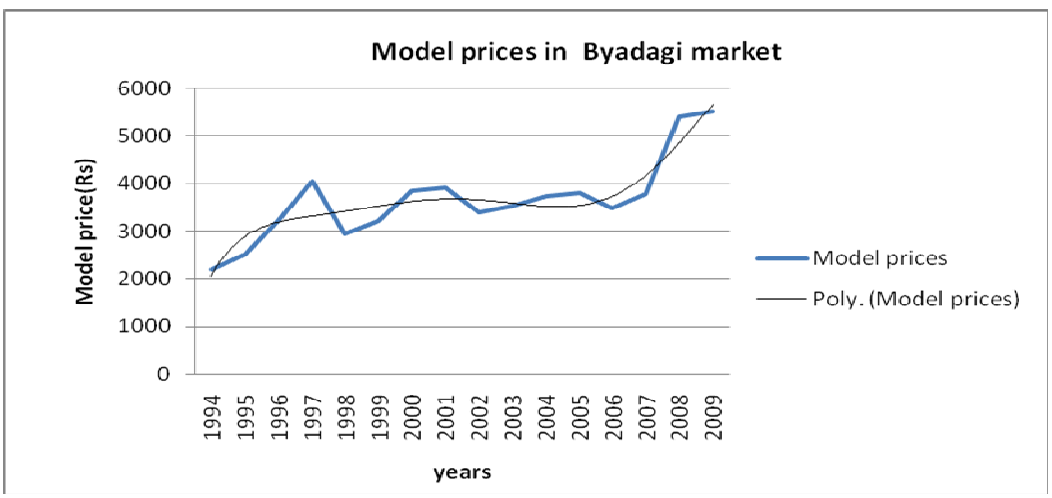


Fig 4.4: Trend component of prices of chilli market in Byadagi market

Fig 4.4: Trend component of prices of chilli market in Byadagi market

4.1.2 Seasonal indices of market arrivals and prices of chilli in Hubli and Byadagi markets

4.1.2.1 Seasonal indices of chilli arrivals and prices in Hubli market

The seasonal indices of arrivals and prices of chilli in Hubli market were presented in Table 4.5 and in Fig 4.5. The highest arrivals of indices were observed in the month of January (125.74) and February (287.4). The lowest arrivals were recorded in the month of August (6.6) and September (7.1). As far as the price indices of chilli were concerned, the highest price indices were noticed in the month of January (110.23) and February (107.9). The lowest indices were obtained in the months of September (88.8) and April (95.1) respectively.

4.1.2.2 Seasonal indices of chilli arrivals and prices in Byadagi market

The seasonal indices of arrivals and prices of chilli in Byadagi market were presented in Table 4.5 and Fig 4.6 The highest arrivals indices were observed in the month of February (211.7) and January (207.9). The lowest arrivals were recorded in the month of August and September (18.9). As far as the price indices of chilli were concerned, the highest price indices were noticed in the month of January (121.6) and March (114.3). The lowest price indices were obtained in the month of August (84.1) and April (86.6).

4.1.3 Cyclical variation in arrivals and prices of Chilli in Hubli and Byadagi Market

4.1.3.1Cyclical variation in arrivals of chilli in Hubli and Byadagi Market

Cyclical variation in arrivals was analyzed in order to known the variation in arrivals over the years. For this the multiplicative model was employed by dividing the original data by the seasonal factor and trend factor.

In both the selected market uneven cycles were being observed for arrivals. The number of cycles observed in Hubli market were two that of first cycle was occurred on an average of four years (1995-1999) and second was on an average of six years (2001-2009) In Byadagi market also we found same as in Hubli market (i.e. first cycle from 1995-2000 and second cycle was from 2001-2009).

4.1.3.1Cyclical variation in market prices of chilli in Hubli and Byadagi Market

Cyclical variation in prices was analyzed in order to know the variation in prices over the years. For this the multiplicative model was employed by dividing the original data by the seasonal factor and trend factor

In both the selected market uneven cycles were being observed for prices. In the Hubli market we observed that the little cyclical movement in the prices of chilli where the cycles on an average of two- three years (i.e.1997 to 2000) In Byadagi also we observed the small cyclical movement in the prices it might varies from two – three years.

4.2 Forecasting of arrivals and prices by using ARIMA and Exponential smoothing method

As Box-Jenkins model was preferred to the multiplicative time series model for forecasting purposes. It was used for the forecasting of arrivals and prices of chilli in the Hubli and Byadagi markets. The results were presented below.

4.2.1 Arrivals and prices of chilli in Hubli market

The detailed analysis of forecasting of arrivals and prices of chilli in Hubli market has been presented as under.

Table 4.5: Seasonal indices of monthly arrivals and prices of chilli in Hubli and Byadagi market

Month	Arrivals		Prices	
	Hubli	Byadagi	Hubli	Byadagi
Jan	307.4	207.9	110.6	121.6
Feb	287.4	211.7	107.9	112.7
Mar	184.8	217.3	103.9	114.3
Apr	109.6	124.5	95.1	107.4
May	37.5	66.4	100.3	98.3
Jun	23.6	26.9	93.4	96.8
Jul	8.3	19.2	94.7	87.6
Aug	6.6	18.9	100.8	84.1
Sep	7.1	18.9	88.8	86.6
Oct	7.1	24.0	96.4	98.0
Nov	25.7	82.5	101.5	91.2
Dec	194.9	181.7	106.6	101.3

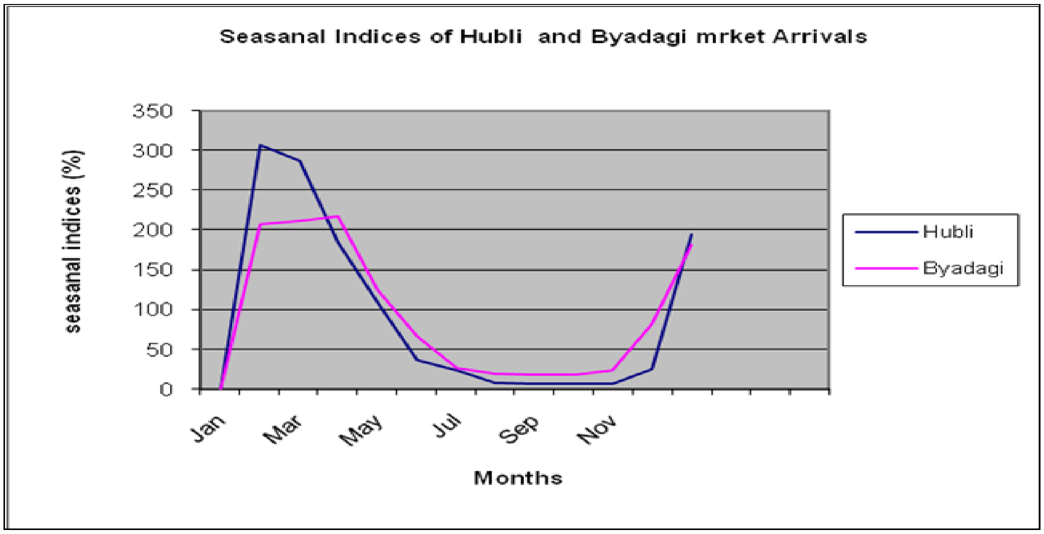


Fig 4.5 Seasonal indices for arrivals in Hubli and Byadagi market

Fig 4.5 Seasonal indices for arrivals in Hubli and Byadagi market

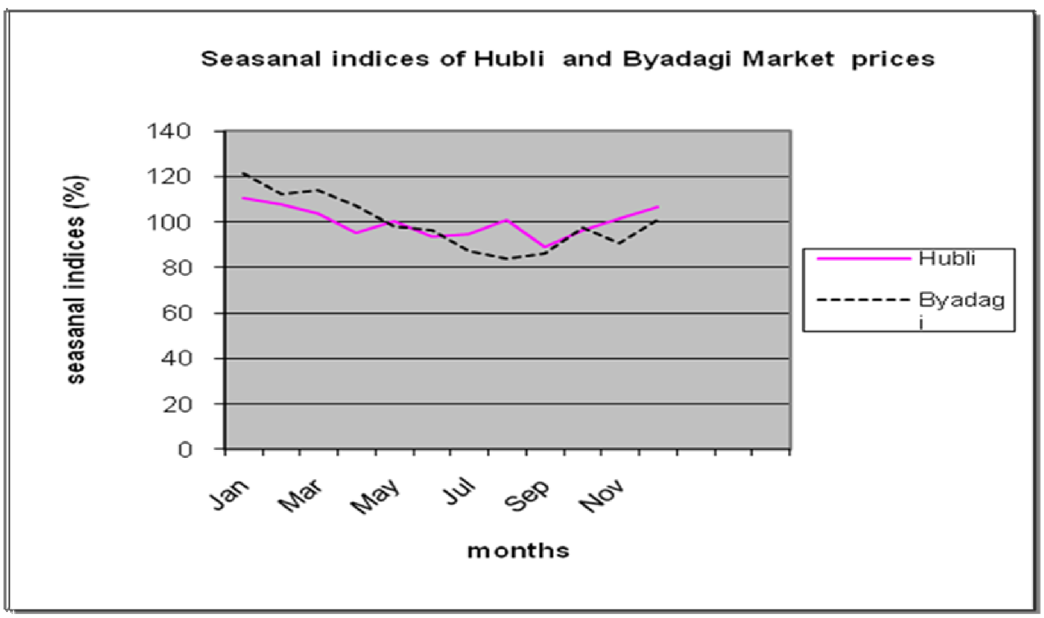


Fig 4.6 Seasonal indices for prices in Hubli and Byadagi market

Fig 4.6 Seasonal indices for prices in Hubli and Byadagi market

Table 4.6. Cyclical indices of arrivals and prices of chilli in Hubli and Byadagi market

Year	Hubli		Byadagi	
	Arrival	Prices	Arrivals	Prices
1995	185.99	298.02	253.59	331.60
1996	175.74	361.44	214.13	409.34
1997	257.30	367.28	239.76	471.15
1998	869.44	330.13	351.49	286.07
1999	606.37	321.98	372.90	193.72
2000	248.38	354.99	373.97	325.76
2001	242.47	360.40	356.55	334.81
2002	201.84	317.09	307.77	289.34
2003	209.69	320.11	321.36	285.71
2004	181.28	342.52	291.13	314.78
2005	325.47	285.72	404.46	317.41
2006	365.49	276.08	468.70	262.75
2007	488.53	301.98	379.37	282.64
2008	391.44	308.68	292.71	369.67
2009	220.41	335.53	197.67	385.66

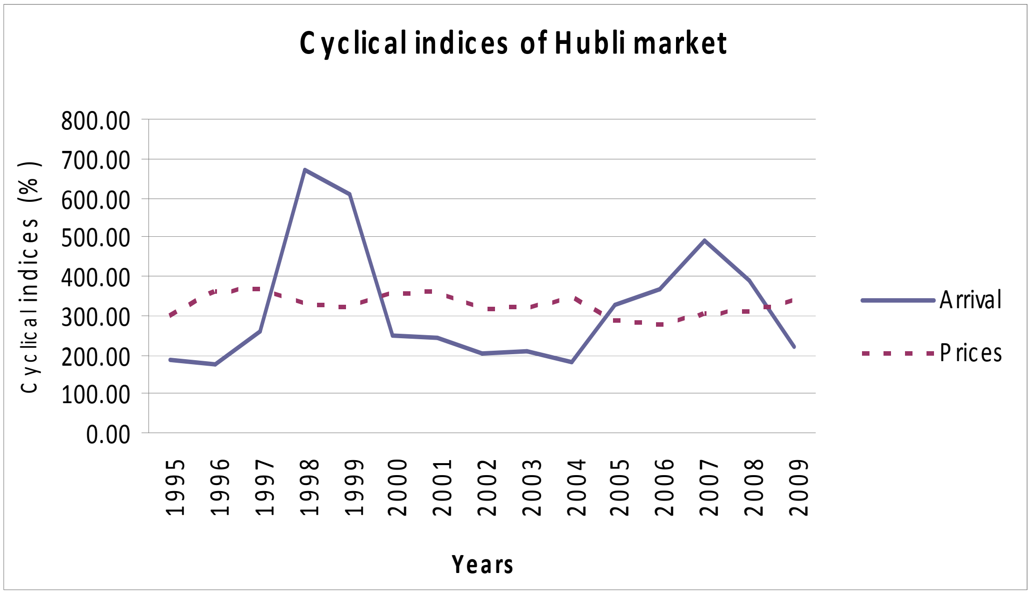


Fig 4.7 Cyclical movement for arrivals and prices of Hubli market

Fig 4.7 Cyclical movement for arrivals and prices of Hubli market

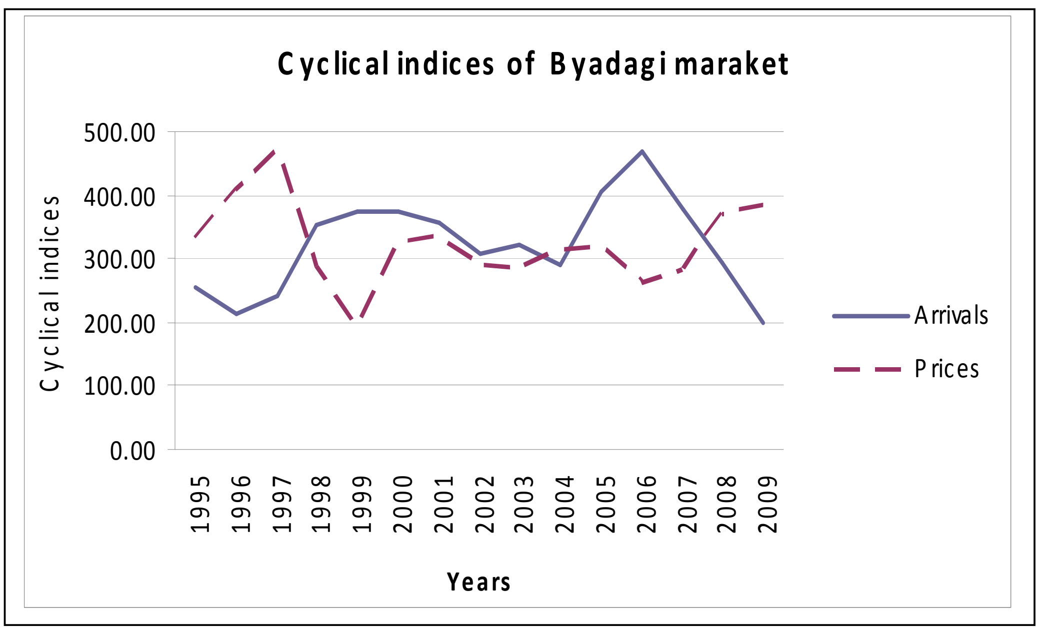


Fig 4.8 Cyclical movement for arrivals and prices of Byadagi market

Fig 4.8 Cyclical movement for arrivals and prices of Byadagi market

4.2.1.1 Identification of the model

The tentative models were first identified based on the Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) for the different series Y_t for Hubli markets. The computed value of ACF and PACF of Hubli market were adverted in Table 4.7 upto 30 lags. An examination of the ACF and PACF revealed seasonality. However, the series is found to be stationary, since the coefficient dropped to zero after the first or second lag. Each individual coefficient of ACF and PACF were tested for their significance using' test. Further, the absence of peak at first values clearly indicated suitability of the choice of non-seasonal difference d=1, to accomplish stationarity series. Hence, based on ACF and PACF many models were tried, finally model (3,1,1) (1,1,1) was identified for arrivals and model (1,1,1) (1,1,1) was identified for prices of chilli in Hubli market.

4.2.1.2 Estimation of parameters

After identifying the models tentatively the next step was to obtain the estimates by the method of Least Squares Estimates of the parameters ϕ and θ for both the markets. Such that the error sum of square was to be minimum.

i.e. $S(\phi .\theta) = et^2 (\phi .\theta)$

The parameters of the tentatively identified models were estimated by an iterative process and then the residual of each of the models was to be estimated.

4.2.1.3 Diagnostic checking

Residual analysis was carried out to check the adequacy of the models. The residuals of ACF and PACF were obtained from the tentatively identified model. The adequacy of the model was judged based on the values of Box-Pierce Q statistics and AIC (Beenstock and Bansali, (1981). The values of the statistics were given in Table 4.8. The model (3, 1, 1) (1, 1, 1) was found to be the best model for arrivals and for prices, the model (1,1,1) (1,1,1) was found to be the best as it had the lowest estimate for AIC and Q statistics.

4.2.1.4 Forecasting of arrivals and prices of chilli in Hubli market

The method of forecasting was explained in detail in chapter 3. Both Ex-ante and Ex-post forecast were done and it was compared with actual values of observations. The forecast was done up to December 2010. The results of Ex-ante and Ex-post forecast of arrivals and prices of chilli in Hubli market is shown in Table 4.9 and Table 4.10. The forecasts were also depicted in the Fig. 4.9 and Fig 4.11. The accuracy of forecasts for both Ex-ante and Ex-post are tested using MSE and MAPE tests. The values MSE and MAPE were presented in Table 4.11, which were found to be least. Forecasted values of arrivals showed an increasing trend and prices showed an increasing trend in Hubli market.

4.2.2 Arrivals and Prices of chilli in Byadagi market

The detailed analysis of forecasting of arrivals and prices of chilli in Byadagi market was presented as under.

4.2.2.1 Identification of the model

The tentative models were first identified based on the Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) for the different series Y_t for Byadagi market. The computed value of ACF and PACF of Byadagi market was given in Table 4.12 up to 30 lags. An examination of the ACF and PACF revealed seasonality. However, the series was found to be stationary, since the coefficient dropped to zero after the first or second lag. Each individual coefficient of ACF and PACF were tested for their significance using 't' test. Further, the absence of peak at first values clearly indicate suitability of the choice of non-seasonal difference d=1, to accomplish stationarity series. Hence, based on ACF and PACF many models were tried, finally model (1,1,1) (1,1,1) was identified for arrivals and (1,1,3) (1,1,2) models for prices in Byadagi market.

4.2.2.2 Estimation of parameters

After identifying the models tentatively the next step was to obtain the estimates by the method of Least Squares Estimates of the parameters ϕ and θ for both the markets. Such that the error sum of square was to be minimum.

i.e. $S(\phi . \theta) = et^2 (\phi . \theta)$

The parameters of the tentatively identified models were estimated by an iterative process and then the residual of each of the models was to be estimated.

4.2.2.3 Diagnostic checking

Residual analysis was carried out to check the adequacy of the models. The residuals of ACF and PACF were obtained from the tentatively identified model. The adequacy of the model was judged based on the values of Box-Pierce Q statistics and AIC. The values of the statistics were shown in Table 4.8. The model (1,1,3) (1,1,2) was found to be the best model for arrivals in Byadagi market and the model (1,1,1) (1,1,1) was found to be the best model for prices, since it had the least statistic for AIC and Q statistics.

4.2.2.4 Forecasting the arrivals and prices of chilli in Byadagi market

The methods of forecasting were explained in detail in chapter 3. Both Ex-ante and Ex-post forecast were done and it is compared with actual values of observations. The forecast is done up to March 2010. The results of Ex-ante and Ex-post forecast of arrivals and prices of chilli in Byadagi market was shown in Tables 4.13 to 4. 14. The forecasts were also depicted in the Fig. 4.13 and 4.15. The accuracy of forecasts for both Ex-ante and Ex-post are tested using MSE and MAPE tests. The values MSE and MAPE were presented in Table 4.11, which was found to be least. Forecasted values of arrivals showed an increasing trend and prices showed decreasing trend in Byadagi market.

4.2.3 Exponential smoothing method of forecasting

Under exponential smoothing, the weights (W) assigned in geometric progression. The techniques of Exponential smoothing method were taken to forecast the chilli arrivals and price of Hubli and Byadagi market.

In the present study exponential smoothing model was used for forecasting chilli price and arrivals of Hubli and Byadagi market. And the forecast was done up to January 2010. The results were presented as follows.

4.2.3.1 Hubli market

The different weight was given to all the observations; the weight was assigned by trial and error method. The weight (W) i.e., alpha (level) were found to be 0.4 for the prices with lowest MAPE (842.46) given in Table 4.19 and 0.6 for the arrivals with lowest MAPE (233.23) given in Table 4.19 The results of Ex-ante and Ex-post forecast were presented in Table 4.15 and Table 4.16 .

4.2.3.2 Byadagi market

The different weight was given to all the observations; the weight was assigned by trial and error method. The weight (W) i.e., alpha (level) were found to be 0.3 for the prices with lowest MAPE (923.26) given in Table 4.19 and 0.6 for the arrivals with lowest MAPE (456.28) given in Table 4.19 The results of Ex-ante and Ex-post forecast were presented in Table 4.17 and Table 4.18 .

4.3 Growth pattern in area production, productivity of chilli

The Compound growth rate (CGR) of area, production, and productivity of chilli was worked out for all districts of Northern Karnataka and North Karnataka as a whole and the results were presented in Table 4.20 and Table 4.21. According to the result, Area wise Belgaum (4.85) Gulbarga (0.81) Raichur (0.40) districts were significant at ten percent of level of significance but Haveri (0.65) districts was registered significance at five percent of level of significance. Production wise Belgaum (5.49) Bijapur (1.11) Haveri (0.79) districts significant at ten percent of level significance but Gadag (1.09) districts were significant at five percent of level of significance and rest of the other districts was non significant at both ten and five percent of level of significance. Productivity wise Bidar (1.74) and Raichur (0.21) districts were significant at ten percent of level of significance and rest of the districts were non-significant at both ten and five percent of level of level of significance.

Table 4.7: ACF and PACF of monthly arrivals and price of chilli in Hubli market

Lags	Arrival		Prices	
	ACF	PACF	ACF	PACF
1	-0.147	-0.147	-0.26	-0.26
2	-0.228	-0.255	-0.10	-0.17
3	-0.045	-0.136	-0.15	-0.24
4	-0.038	-0.147	0.12	-0.02
5	-0.046	-0.147	-0.07	-0.11
6	-0.001	-0.115	0.01	-0.06
7	0.037	-0.067	0.08	0.07
8	0.007	-0.063	-0.07	-0.07
9	0.002	-0.045	0.08	0.09
10	0.185	0.182	0.00	0.07
11	0.033	0.144	0.02	0.05
12	-0.534	-0.466	-0.23	-0.18
13	0.176	0.051	0.12	-0.01
14	0.053	-0.161	-0.01	-0.06
15	-0.019	-0.108	0.06	-0.01
16	0.028	-0.096	-0.11	-0.10
17	0.032	-0.098	0.10	0.02
18	-0.009	-0.1	0.05	0.08
19	-0.005	-0.057	-0.06	0.00
20	-0.027	-0.138	-0.02	-0.01
21	0.059	0.002	-0.06	-0.05
22	-0.139	-0.07	0.08	0.03
23	0.11	0.129	0.05	0.10
24	0.093	-0.267	-0.14	-0.21
25	-0.177	-0.099	-0.01	-0.06
26	0.112	-0.024	0.04	-0.04
27	0.057	-0.036	0.07	0.01
28	-0.019	-0.028	-0.03	-0.01
29	-0.029	-0.037	-0.07	-0.07
30	-0.008	-0.066	-0.09	-0.13

Table 4.8: Residual analysis of Hubli and Byadagi market

Market	Model	AIC	Box Pierce Q statistic
Hubli			
Arrivals	(3,1,1) (1,1,1)	39992.87	4015.2
prices	(1,1,1) (1,1,1)	2959.64	2990.25
Byadagi			
Arrivals	(1,1,3) (1,1,2)	4351.22	4377.28
Prices	(1,1,1,) (1,1,1)	956.28	2972.11

Table 4.9: Actual and forecasted value for arrivals of chilli in Hubli market (qtls)

Sl no	Years	Actual	Forecasted	Sl no	Years	Actual	Forecasted
1	Jan-94	10263	.	45	Sep-97	380	498.05
2	Feb-94	9583	.	46	Oct-97	368	493.06
3	Mar-94	3200	.	47	Nov-97	472	833.16
4	Apr-94	2223	.	48	Dec-97	2852	3465.39
5	May-94	622	.	49	Jan-98	14553	13897.88
6	Jun-94	589	.	50	Feb-98	17800	12759.32
7	Jul-94	366	.	51	Mar-98	18558	19966.34
8	Aug-94	162	.	52	Apr-98	9231	10908.27
9	Sep-94	363	.	53	May-98	4361	4225.30
10	Oct-94	384	.	54	Jun-98	2036	2394.33
11	Nov-94	766	.	55	Jul-98	565	214.86
12	Dec-94	6075	.	56	Aug-98	1579	993.47
13	Jan-95	8709	.	57	Sep-98	496	1612.91
14	Feb-95	7490	7952.39	58	Oct-98	179	452.53
15	Mar-95	1754	2857.40	59	Nov-98	196	107.01
16	Apr-95	624	877.21	60	Dec-98	11045	8799.10
17	May-95	519	910.82	61	Jan-99	12094	11348.99
18	Jun-95	249	188.96	62	Feb-99	11722	10215.06
19	Jul-95	150	237.07	63	Mar-99	8945	7598.00
20	Aug-95	82	121.99	64	Apr-99	10661	11606.00
21	Sep-95	289	372.27	65	May-99	4414	5006.98
22	Oct-95	73	212.16	66	Jun-99	2372	1924.91
23	Nov-95	601	484.81	67	Jul-99	439	359.38
24	Dec-95	9752	8893.13	68	Aug-99	299	539.27
25	Jan-96	6210	7884.95	69	Sep-99	72	156.99
26	Feb-96	4929	5497.48	70	Oct-99	98	362.18
27	Mar-96	2887	1674.51	71	Nov-99	2873	1411.93
28	Apr-96	112	649.15	72	Dec-99	9082	8638.60
29	May-96	57	16.55	73	Jan-00	12816	10749.90
30	Jun-96	57	322.06	74	Feb-00	11102	11945.77
31	Jul-96	78	626.86	75	Mar-00	5943	6233.34
32	Aug-96	30	60.73	76	Apr-00	4777	3216.94
33	Sep-96	65	79.60	77	May-00	1430	2957.00
34	Oct-96	73	682.36	78	Jun-00	668	833.19
35	Nov-96	4031	3172.59	79	Jul-00	431	383.48
36	Dec-96	13206	11010.42	80	Aug-00	182	431.11
37	Jan-97	10074	11502.94	81	Sep-00	163	292.67
38	Feb-97	8484	7618.08	82	Oct-00	750	542.43
39	Mar-97	4852	3808.52	83	Nov-00	1214	1894.56
40	Apr-97	1613	2925.14	84	Dec-00	4853	5704.50
41	May-97	1006	963.98	85	Jan-01	18501	17240.29
42	Jun-97	992	1062.22	86	Feb-01	13402	16864.75
43	Jul-97	216	313.66	87	Mar-01	7929	8601.54
44	Aug-97	165	402.83	88	Apr-01	8362	5390.60

Table 4.9: Contd…..

Sl no	Years	Actual	Forecasted	Sl no	Years	Actual	Forecasted
89	May-01	1740	1827.52	133	Jan-05	20284	18532.64
90	Jun-01	773	516.54	134	Feb-05	20316	19837.09
91	Jul-01	296	357.33	135	Mar-05	22790	20545.77
92	Aug-01	209	740.19	136	Apr-05	17611	15879.65
93	Sep-01	149	324.09	137	May-05	6777	8864.08
94	Oct-01	235	293.28	138	Jun-05	3404	3800.64
95	Nov-01	837	7630.85	139	Jul-05	1333	1852.23
96	Dec-01	4943	5009.15	140	Aug-05	1123	1011.19
97	Jan-02	6953	7859.82	141	Sep-05	1339	1005.71
98	Feb-02	4937	7712.08	142	Oct-05	1847	1171.49
99	Mar-02	3860	4174.05	143	Nov-05	1715	1809.61
100	Apr-02	3924	4301.39	144	Dec-05	6496	7220.67
101	May-02	2042	1594.14	145	Jan-06	25819	18073.30
102	Jun-02	1424	1543.08	146	Feb-06	25864	22136.01
103	Jul-02	669	831.11	147	Mar-06	6256	7030.62
104	Aug-02	673	785.67	148	Apr-06	5998	4708.28
105	Sep-02	681	644.30	149	May-06	1498	2541.30
106	Oct-02	783	868.10	150	Jun-06	477	689.30
107	Nov-02	144	474.96	151	Jul-06	310	323.99
108	Dec-02	10340	11616.45	152	Aug-06	154	352.74
109	Jan-03	24544	18698.23	153	Sep-06	102	291.78
110	Feb-03	14318	16752.13	154	Oct-06	213	399.45
111	Mar-03	5824	7779.63	155	Nov-06	804	792.23
112	Apr-03	2797	3737.39	156	Dec-06	8252	6732.32
113	May-03	1151	1214.87	157	Jan-07	24238	19914.46
114	Jun-03	301	198.93	158	Feb-07	24904	20037.60
115	Jul-03	262	170.80	159	Mar-07	20377	21512.35
116	Aug-03	81	148.02	160	Apr-07	4637	3150.62
117	Sep-03	187	206.96	161	May-07	765	577.37
118	Oct-03	14	58.39	162	Jun-07	338	941.64
119	Nov-03	388	301.00	163	Jul-07	322	345.36
120	Dec-03	6016	6145.63	164	Aug-07	70	63.42
121	Jan-04	4658	3183.79	165	Sep-07	238	480.81
122	Feb-04	5755	4008.65	166	Oct-07	51	179.25
123	Mar-04	5781	4834.93	167	Nov-07	697	684.92
124	Apr-04	1550	1493.70	168	Dec-07	8863	7634.70
125	May-04	700	460.02	169	Jan-08	25264	18874.80
126	Jun-04	776	1033.87	170	Feb-08	23699	21954.28
127	Jul-04	191	640.44	171	Mar-08	13826	14585.59
128	Aug-04	245	459.60	172	Apr-08	8882	8005.11
129	Sep-04	265	506.78	173	May-08	2167	3765.78
130	Oct-04	56	150.13	174	Jun-08	1197	938.00
131	Nov-04	266	572.57	175	Jul-08	234	477.71
132	Dec-04	7787	6475.33	176	Aug-08	199	402.89

Table 4.9: Contd…….

Sl no	Years	Actual	Forecasted
177	Sep-08	149	281.26
178	Oct-08	153	359.22
179	Nov-08	176	129.80
180	Dec-08	5681	6552.88
181	Jan-09	7308	8108.49
182	Feb-09	15540	10064.84
183	Mar-09	10664	12276.02
184	Apr-09	6325	5829.37
185	May-09	155	225.75
186	Jun-09	1704	1463.00
187	Jul-09	1704	1546.05
188	Aug-09	587	295.80
189	Sep-09	679	574.10
190	Oct-09	133	534.63
191	Nov-09	4039	3687.83
192	Dec-09	6532	8400.34
193	Jan-10	.	16942.78
194	Feb-10	.	17865.36
195	Mar-10	.	11891.42
196	Apr-10	.	5748.79
197	May-10	.	1094.21
198	Jun-10	.	1566.63
199	Jul-10	.	1101.46
200	Aug-10	.	468.60
201	Sep-10	.	310.48
202	Oct-10	.	850.86
203	Nov-10	.	1581.79
204	Dec-10	.	8814.21

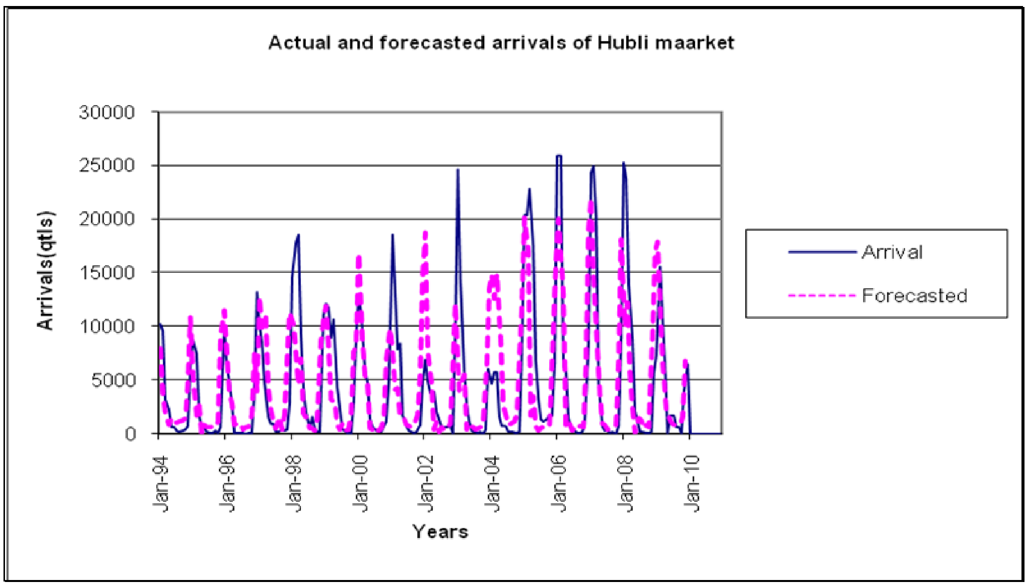
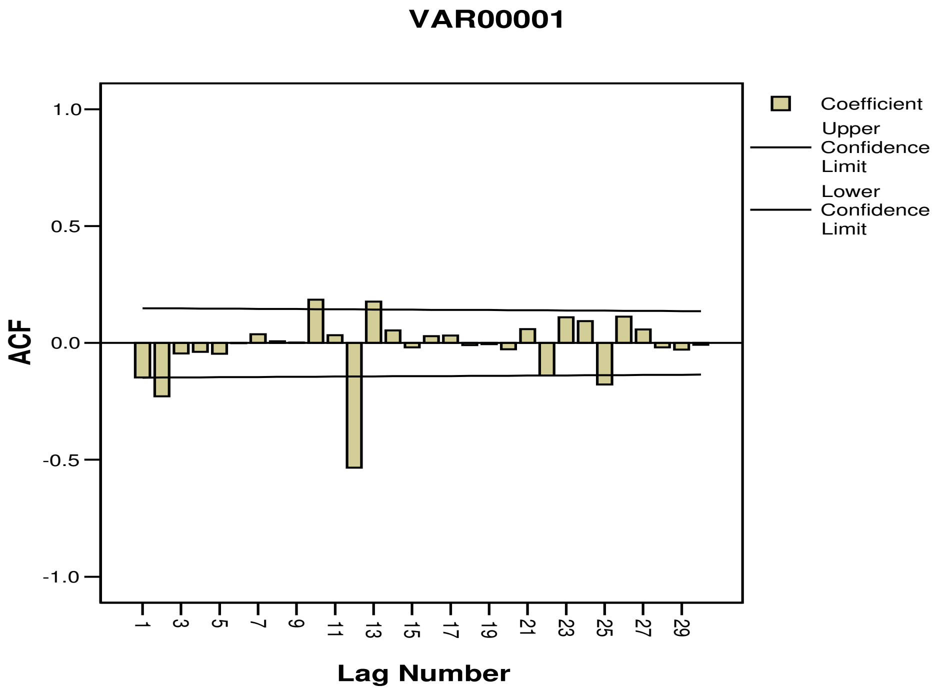


Fig 4.9: Actual and forecasted arrivals of chilli in Hubli markets

Fig 4.9: Actual and forecasted arrivals of chilli in Hubli markets



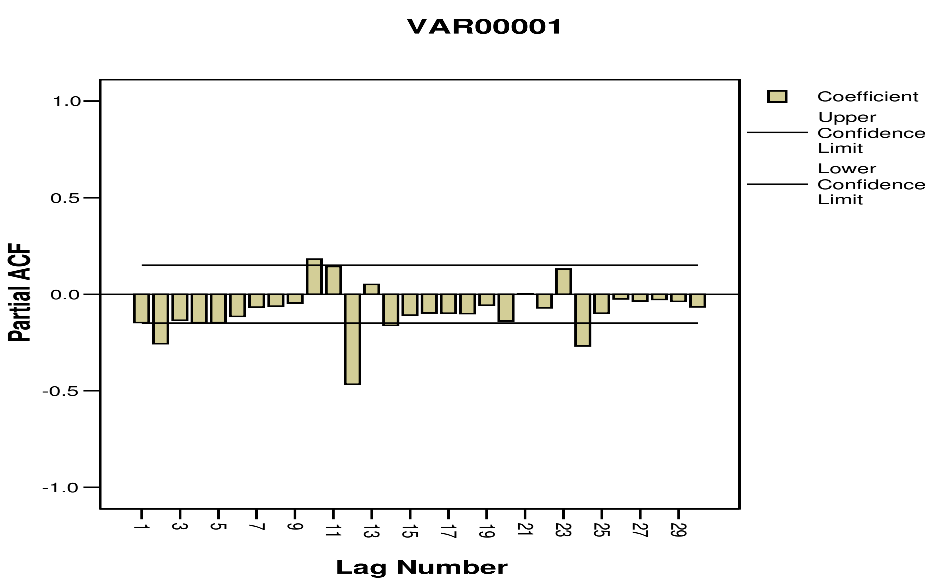


Fig 4.10: ACF and PACF of arrivals for Hubli market

Fig 4.10: ACF and PACF of arrivals for Hubli market

Table 4.10: Actual and forecasted values for prices in Hubli market

Sl no	Months	Actual	Forecast	Sl no	Months	Actual	Forecast
1	Jan-94	2300	.	44	Aug-97	3289	4243.03
2	Feb-94	2501	.	45	Sep-97	3509	1513.16
3	Mar-94	2000	.	46	Oct-97	3269	4535.48
4	Apr-94	2860	.	47	Nov-97	3890	4120.87
5	May-94	4850	.	48	Dec-97	3880	4320.36
6	Jun-94	2850	.	49	Jan-98	3800	4105.48
7	Jul-94	2015	.	50	Feb-98	3510	3898.09
8	Aug-94	2450	.	51	Mar-98	3650	3701.73
9	Sep-94	1730	.	52	Apr-98	3250	4117.20
10	Oct-94	2209	.	53	May-98	2250	4075.41
11	Nov-94	1660	.	54	Jun-98	2850	2758.54
12	Dec-94	3353	.	55	Jul-98	3550	2805.88
13	Jan-95	2850	.	56	Aug-98	3800	3609.54
14	Feb-95	2626	3053.99	57	Sep-98	3180	2374.51
15	Mar-95	2689	2251.42	58	Oct-98	3800	3637.06
16	Apr-95	2420	3446.45	59	Nov-98	3800	4101.84
17	May-95	2819	4766.26	60	Dec-98	4500	4038.33
18	Jun-95	3240	1744.64	61	Jan-99	3889	4181.88
19	Jul-95	4269	2137.43	62	Feb-99	5856	3728.12
20	Aug-95	3800	3695.39	63	Mar-99	3680	4966.03
21	Sep-95	1270	2649.03	64	Apr-99	3407	3973.80
22	Oct-95	3750	2180.70	65	May-99	3009	3775.13
23	Nov-95	5210	2678.10	66	Jun-99	3549	3388.62
24	Dec-95	4567	5590.77	67	Jul-99	3885	3735.50
25	Jan-96	4569	3990.33	68	Aug-99	3258	4131.03
26	Feb-96	3670	4295.46	69	Sep-99	3259	2364.28
27	Mar-96	4130	3667.67	70	Oct-99	3219	3970.71
28	Apr-96	4240	4211.60	71	Nov-99	3125	3796.93
29	May-96	4160	5253.32	72	Dec-99	3290	3914.79
30	Jun-96	4725	4012.44	73	Jan-00	3800	3420.28
31	Jul-96	4539	4831.73	74	Feb-00	3849	4271.61
32	Aug-96	5430	4531.29	75	Mar-00	4169	3351.38
33	Sep-96	1820	3301.81	76	Apr-00	4102	3923.38
34	Oct-96	3750	3968.29	77	May-00	4200	3974.38
35	Nov-96	4470	4650.45	78	Jun-00	3356	4033.13
36	Dec-96	4196	4990.69	79	Jul-00	4209	3654.90
37	Jan-97	4496	4365.79	80	Aug-00	5009	4049.59
38	Feb-97	4575	4193.56	81	Sep-00	5869	3552.93
39	Mar-97	4419	4527.84	82	Oct-00	5389	5363.46
40	Apr-97	4869	4660.34	83	Nov-00	3818	5174.69
41	May-97	4540	5437.74	84	Dec-00	3569	4522.41
42	Jun-97	4019	4671.38	85	Jan-01	4600	4164.36
43	Jul-97	3097	4375.72	86	Feb-01	3800	4754.47

Table 4.10 Contd……

Sl no	Months	Actual	Forecast	Sl no	Months	Actual	Forecast
87	Mar-01	4541	4075.01	130	Oct-04	4109	4769.43
88	Apr-01	4281	4564.34	131	Nov-04	4839	4335.58
89	May-01	4769	4537.22	132	Dec-04	4519	5188.84
90	Jun-01	3606	4387.21	133	Jan-05	4300	4706.68
91	Jul-01	4300	4183.98	134	Feb-05	4229	4612.45
92	Aug-01	4309	4701.22	135	Mar-05	3669	4255.33
93	Sep-01	4569	3923.98	136	Apr-05	2860	3673.65
94	Oct-01	4719	4838.94	137	May-05	2860	3885.55
95	Nov-01	4299	4477.50	138	Jun-05	2497	3263.59
96	Dec-01	3239	4517.86	139	Jul-05	1811	3198.21
97	Jan-02	4060	4062.51	140	Aug-05	2109	2781.71
98	Feb-02	4276	4170.86	141	Sep-05	2129	2240.27
99	Mar-02	4389	4335.09	142	Oct-05	1986	2765.66
100	Apr-02	3640	4377.80	143	Nov-05	4663	2655.26
101	May-02	3466	4213.27	144	Dec-05	4019	4124.31
102	Jun-02	3009	3451.07	145	Jan-06	4399	3745.24
103	Jul-02	2839	3665.23	146	Feb-06	3566	4027.83
104	Aug-02	2897	3517.52	147	Mar-06	3566	3385.46
105	Sep-02	2999	2791.87	148	Apr-06	3299	3204.97
106	Oct-02	2711	3625.80	149	May-06	3269	3475.15
107	Nov-02	3039	3090.41	150	Jun-06	3069	3098.25
108	Dec-02	4449	3110.55	151	Jul-06	3319	3024.69
109	Jan-03	3669	4195.26	152	Aug-06	3631	3426.07
110	Feb-03	3261	3783.76	153	Sep-06	4689	3024.87
111	Mar-03	3266	3439.67	154	Oct-06	3909	4236.00
112	Apr-03	3229	3280.20	155	Nov-06	3376	4470.50
113	May-03	3534	3421.85	156	Dec-06	3376	3861.23
114	Jun-03	4719	3161.51	157	Jan-07	4666	3836.95
115	Jul-03	4109	4129.48	158	Feb-07	4399	4269.09
116	Aug-03	4669	4019.92	159	Mar-07	4299	4122.90
117	Sep-03	3397	3758.99	160	Apr-07	4219	3951.14
118	Oct-03	4226	3793.47	161	May-07	4209	4266.41
119	Nov-03	4169	4139.30	162	Jun-07	3911	3962.27
120	Dec-03	5459	4513.59	163	Jul-07	3689	4008.02
121	Jan-04	5089	4917.50	164	Aug-07	3839	4067.33
122	Feb-04	5219	4780.97	165	Sep-07	4050	3803.88
123	Mar-04	4469	4858.15	166	Oct-07	4299	4156.04
124	Apr-04	3079	4498.46	167	Nov-07	3369	4347.44
125	May-04	4669	3931.59	168	Dec-07	3029	3928.93
126	Jun-04	4229	4642.39	169	Jan-08	4399	3899.77
127	Jul-04	4409	4353.60	170	Feb-08	4399	4297.89
128	Aug-04	4219	4730.30	171	Mar-08	4629	4206.59
129	Sep-04	4411	3652.36	172	Apr-08	3239	4249.26

Table 4.10 Contd….

Sl no	Months	Actual	Forecast
173	May-08	3066	3813.83
174	Jun-08	3539	3312.33
175	Jul-08	3369	3616.80
176	Aug-08	4399	3715.42
180	Dec-08	4199	3935.84
181	Jan-09	4099	4509.03
182	Feb-09	4398	4201.49
183	Mar-09	3888	4300.79
184	Apr-09	4609	3603.47
185	May-09	8066	4387.50
186	Jun-09	4099	6233.06
187	Jul-09	4099	4359.91
188	Aug-09	4299	4715.16
189	Sep-09	4021	4121.10
190	Oct-09	3699	4420.42
191	Nov-09	8218	4244.75
192	Dec-09	9632	6810.63
193	Jan-10	.	7910.94
194	Feb-10	.	7224.57
195	Mar-10	.	6745.15
196	Apr-10	.	6587.33
197	May-10	.	7475.94
198	Jun-10	.	6473.49
199	Jul-10	.	6492.92
200	Aug-10	.	6751.59
201	Sep-10	.	6375.68
202	Oct-10	.	6553.64
203	Nov-10	.	7678.28
204	Dec-10	.	8123.54

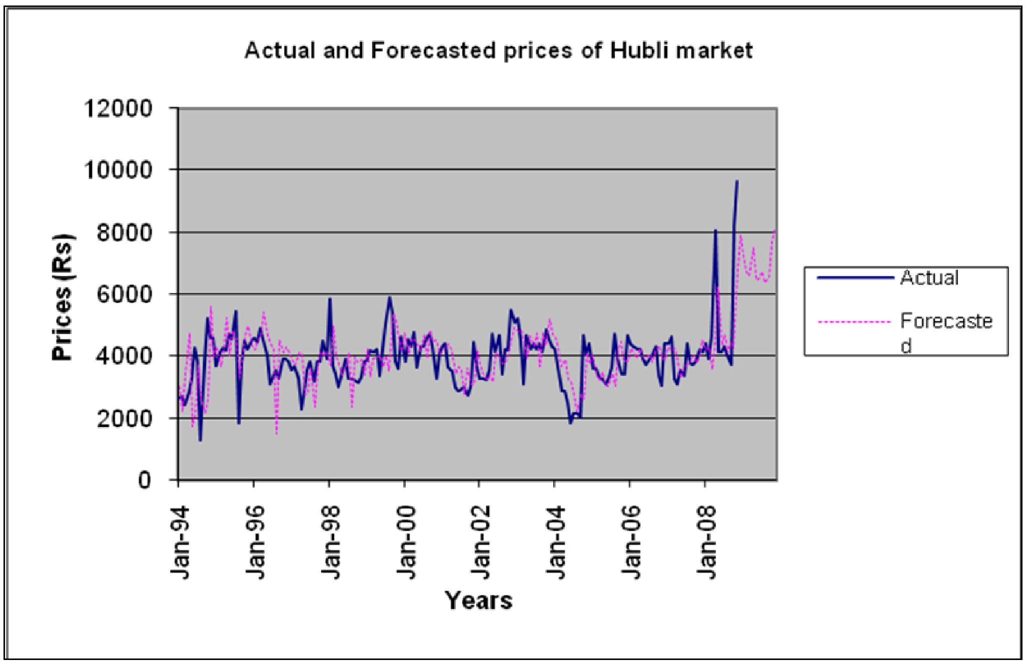
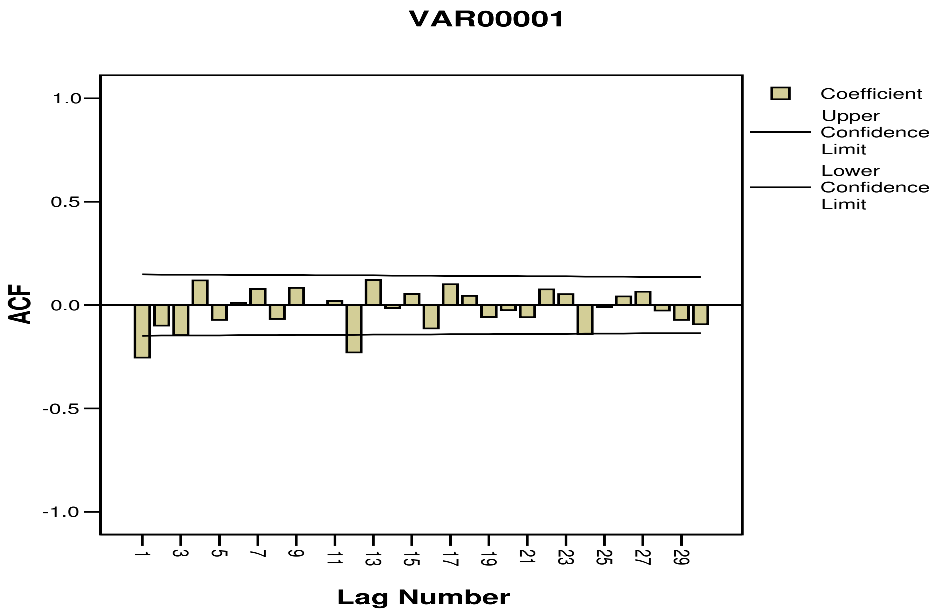


Fig 4.11 Actual and forecasted price of Hubli markets

Fig 4.11 Actual and forecasted price of Hubli markets



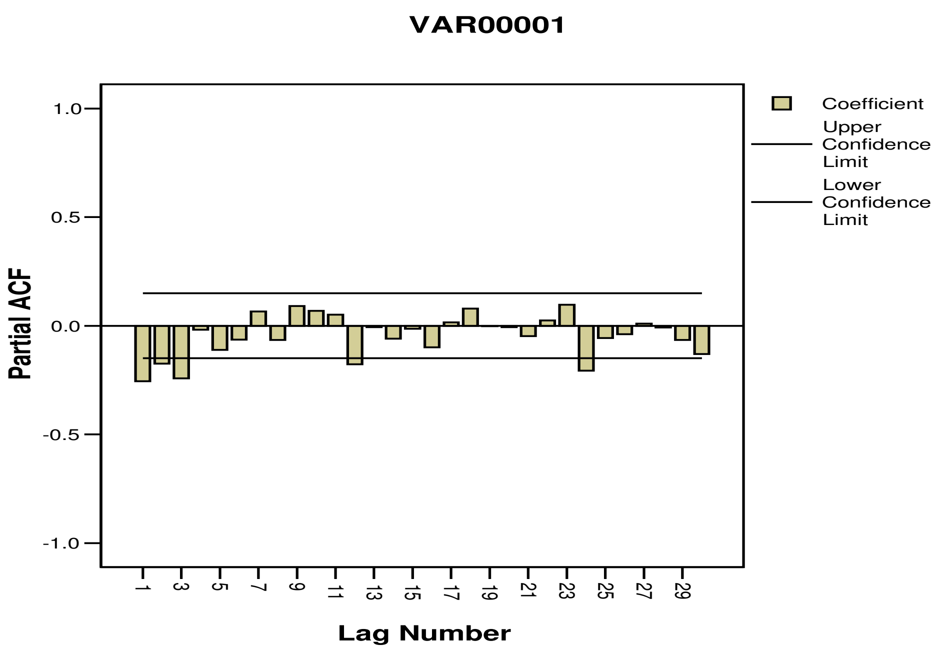


Fig 4.12 ACF and PACF price for Hubli market

Fig 4.12 ACF and PACF price for Hubli market

Table 4.11: Selected measure of predictive performance of Box-Jenkins model

	HUBLI		BYADAGI	
	Arrivals	Prices	Arrivals	Prices
MSE	843.33	233.42	1023.5	466.33
MAPE	671.22	150.23	756.23	256.33

Table 4.12: ACF and PACF of monthly arrivals and price of chilli in Byadagi market

Sl no	Arrivals		Prices	
	ACF	PACF	ACF	PACF
1	-0.40	-0.40	-0.35	-0.35
2	0.05	-0.14	-0.01	-0.16
3	-0.26	-0.36	-0.05	-0.14
4	0.10	-0.23	0.01	-0.08
5	0.08	-0.05	-0.06	-0.12
6	-0.01	-0.09	0.09	0.01
7	-0.05	-0.12	-0.01	0.01
8	-0.08	-0.16	-0.11	-0.13
9	0.06	-0.11	0.17	0.10
10	0.01	-0.11	-0.08	-0.00
11	0.35	0.42	0.15	0.17
12	-0.62	-0.43	-0.32	-0.25
13	0.28	-0.09	0.14	-0.04
14	-0.16	-0.09	0.02	0.04
15	0.29	-0.11	-0.08	-0.14
16	-0.08	-0.02	-0.05	-0.16
17	-0.07	-0.05	0.11	0.00
18	0.00	-0.05	-0.04	0.00
19	0.00	-0.04	-0.01	-0.02
20	0.01	-0.17	0.12	0.01
21	0.06	-0.06	-0.14	0.01
22	0.05	0.10	0.09	0.06
23	-0.18	0.24	0.03	0.12
24	0.11	-0.34	-0.25	-0.38
25	-0.09	0.02	0.00	-0.20
26	0.21	0.06	0.05	-0.09
27	-0.17	-0.02	0.04	-0.10
28	0.00	-0.03	0.10	0.01
29	0.01	-0.01	-0.05	-0.01
30	0.03	0.01	-0.13	-0.10

Table 4.13 Actual and forecasted values for arrivals of Byadagi market

Sl no	Years	Actual	Forecast	Sl no	Years	Actual	Forecast
1	Jan-94	41793	.	44	Aug-97	1005	15570.17
2	Feb-94	18078	.	45	Sep-97	789	873.69
3	Mar-94	6735	.	46	Oct-97	2349	3361.19
4	Apr-94	5850	.	47	Nov-97	35132	31273.57
5	May-94	2916	.	48	Dec-97	46230	43765.54
6	Jun-94	3530	.	49	Jan-98	92869	74331.00
7	Jul-94	2618	.	50	Feb-98	63198	57718.48
8	Aug-94	3452	.	51	Mar-98	51812	48789.87
9	Sep-94	3224	.	52	Apr-98	12739	13472.75
10	Oct-94	9487	.	53	May-98	15904	18205.16
11	Nov-94	36862	.	54	Jun-98	10046	11220.63
12	Dec-94	40690	.	55	Jul-98	7026	8856.34
13	Jan-95	21631	.	56	Aug-98	7493	6219.59
14	Feb-95	17611	16484.93	57	Sep-98	12490	10014.86
15	Mar-95	14134	13233.17	58	Oct-98	13577	13119.42
16	Apr-95	4542	3561.98	59	Nov-98	20039	22856.53
17	May-95	3586	3400.17	60	Dec-98	45265	46201.20
18	Jun-95	2208	2313.07	61	Jan-99	42391	40596.00
19	Jul-95	2270	1905.27	62	Feb-99	34726	33321.46
20	Aug-95	2270	2042.53	63	Mar-99	56749	47220.19
21	Sep-95	2866	2896.13	64	Apr-99	31701	31097.57
22	Oct-95	2854	3604.05	65	May-99	15678	13455.19
23	Nov-95	20753	22884.19	66	Jun-99	7652	5790.09
24	Dec-95	36440	34059.73	67	Jul-99	5229	6520.82
25	Jan-96	22338	23083.58	68	Aug-99	5615	6621.89
26	Feb-96	23403	20122.82	69	Sep-99	2742	3820.06
27	Mar-96	24801	24609.67	70	Oct-99	9133	9707.13
28	Apr-96	8349	71201.79	71	Nov-99	44991	39811.44
29	May-96	4654	4150.69	72	Dec-99	75596	63194.57
30	Jun-96	3054	3888.32	73	Jan-00	65400	75912.61
31	Jul-96	3075	4723.12	74	Feb-00	59780	48935.70
32	Aug-96	1668	2271.83	75	Mar-00	43610	42312.71
33	Sep-96	1929	1532.77	76	Apr-00	66210	55141.07
34	Oct-96	1952	2007.52	77	May-00	35438	39360.19
35	Nov-96	9382	3262.72	78	Jun-00	13250	17196.09
36	Dec-96	40248	3555.37	79	Jul-00	7189	5586.10
37	Jan-97	39196	4106.65	80	Aug-00	3842	4269.50
38	Feb-97	21432	22560.59	81	Sep-00	4393	1988.69
39	Mar-97	19768	16075.58	82	Oct-00	4762	3043.51
40	Apr-97	7706	8965.71	83	Nov-00	30699	28192.96
41	May-97	4286	3108.12	84	Dec-00	64100	58203.84
42	Jun-97	1829	1545.51	85	Jan-01	54739	66416.34
43	Jul-97	678	438.12	86	Feb-01	95608	62471.88

Table 4.13 Contd…..

Sl no	Years	Actual	Forecast	sl no	Years	Actual	Forecast
87	Mar-01	96768	81394.23	130	Oct-04	2277	3438.33
88	Apr-01	30138	46050.19	131	Nov-04	3923	6583.55
89	May-01	16778	11121.68	132	Dec-04	22519	24940.93
90	Jun-01	5279	4584.25	133	Jan-05	154929	140029.89
91	Jul-01	4949	5776.50	134	Feb-05	119873	119109.32
92	Aug-01	5623	6604.55	135	Mar-05	157321	117173.20
93	Sep-01	4175	5194.11	136	Apr-05	56754	67103.20
94	Oct-01	4404	3155.15	137	May-05	18302	20717.58
95	Nov-01	24436	27673.35	138	Jun-05	11116	11235.00
96	Dec-01	46989	48943.38	139	Jul-05	5657	9192.38
97	Jan-02	49406	50942.34	140	Aug-05	4949	8593.43
98	Feb-02	55359	50117.24	141	Sep-05	7136	5915.39
99	Mar-02	66393	58976.05	142	Oct-05	4265	5011.41
100	Apr-02	43060	42463.40	143	Nov-05	21195	17895.42
101	May-02	26210	26816.87	144	Dec-05	133504	17399.69
102	Jun-02	7600	10651.93	145	Jan-06	98357	110875.27
103	Jul-02	9992	9681.76	146	Feb-06	120190	98993.69
104	Aug-02	8811	9903.03	147	Mar-06	101818	99320.05
105	Sep-02	4459	957.11	148	Apr-06	153185	135575.90
106	Oct-02	4998	5920.51	149	May-06	91086	88059.55
107	Nov-02	14007	17694.90	150	Jun-06	41444	56972.75
108	Dec-02	46121	46019.65	151	Jul-06	22992	24342.01
109	Jan-03	76957	64025.43	152	Aug-06	14789	15799.68
110	Feb-03	61482	52734.18	153	Sep-06	18101	19739.20
111	Mar-03	80757	74992.10	154	Oct-06	10278	9402.64
112	Apr-03	56333	51374.76	155	Nov-06	18412	15146.43
113	May-03	41962	40294.33	156	Dec-06	46350	48771.27
114	Jun-03	13147	11314.03	157	Jan-07	99548	88502.47
115	Jul-03	9584	7453.88	158	Feb-07	127991	91319.40
116	Aug-03	11763	9589.26	159	Mar-07	141579	127990.52
117	Sep-03	14953	11734.02	160	Apr-07	59970	77500.65
118	Oct-03	9977	11239.21	161	May-07	18117	16570.99
119	Nov-03	13500	15721.65	162	Jun-07	7468	5465.83
120	Dec-03	61097	50529.14	163	Jul-07	4878	50349.24
121	Jan-04	43374	54955.24	164	Aug-07	6329	8567.82
122	Feb-04	86876	62225.47	165	Sep-07	5558	8952.72
123	Mar-04	100827	74011.55	166	Oct-07	7718	7458.88
124	Apr-04	29494	36995.15	167	Nov-07	14837	15923.61
125	May-04	19991	17329.93	168	Dec-07	59469	67401.72
126	Jun-04	5969	786.19	169	Jan-08	126382	96888.58
127	Jul-04	3676	7666.08	170	Feb-08	131651	116624.85
128	Aug-04	2816	3250.80	171	Mar-08	93818	117287.34
129	Sep-04	2533	1776.81	172	Apr-08	55713	70279.94

Table 4.13 Contd…….

Sl no	Years	Actual	Forecast
173	May-08	8939	7837.17
174	Jun-08	6435	5793.58
175	Jul-08	3246	4148.86
176	Aug-08	7423	9371.25
177	Sep-08	3525	2577.04
178	Oct-08	9754	6441.50
179	Nov-08	4907	7806.73
180	Dec-08	30183	45885.66
181	Jan-09	34385	40559.68
182	Feb-09	67747	71786.03
183	Mar-09	58706	54768.20
184	Apr-09	71997	67194.75
185	May-09	35141	34240.90
186	Jun-09	7605	7046.51
187	Jul-09	11027	14497.10
188	Aug-09	7714	8523.27
189	Sep-09	6318	6564.26
190	Oct-09	5798	6706.61
191	Nov-09	5089	3945.49
192	Dec-09	10797	15726.87
193	Jan-10		42280.68
194	Feb-10		84001.06
195	Mar-10		75600.87
196	Apr-10		60252.03
197	May-10		24930.33
198	Jun-10		4808.57
199	Jul-10		6307.46
200	Aug-10		8740.45
201	Sep-10		1589.26
202	Oct-10		3409.96
203	Nov-10		4209.23
204	Dec-10		25042.34

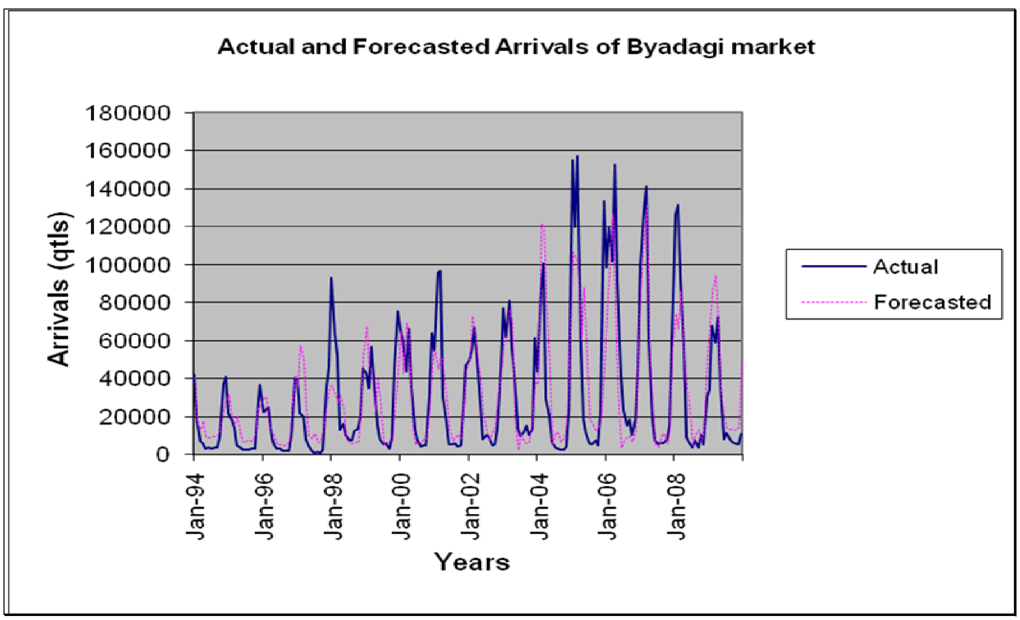
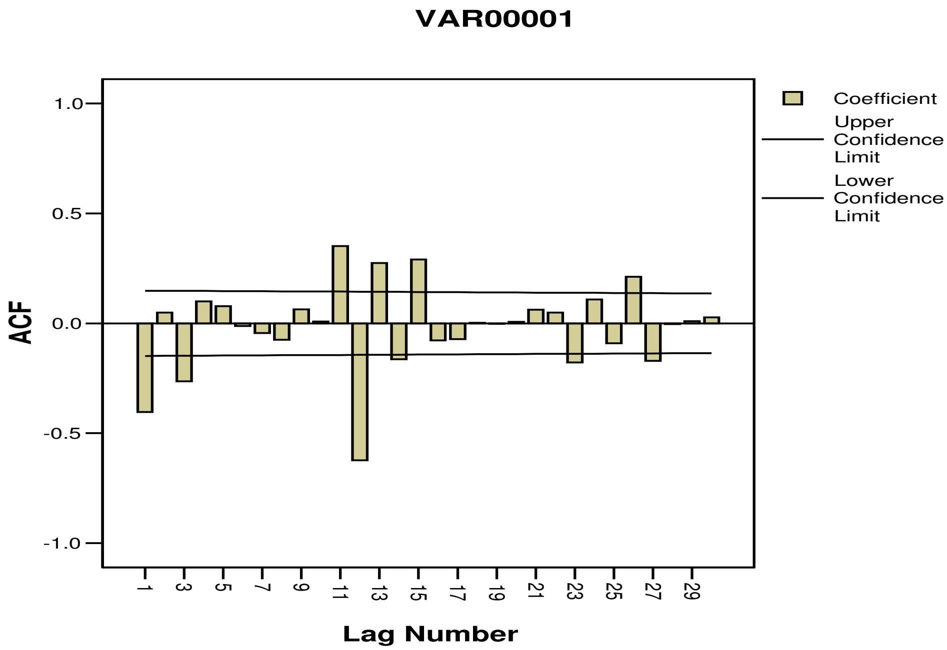


Fig 4.13 Actual and forecasted vales for arrivals in Byadagi markets



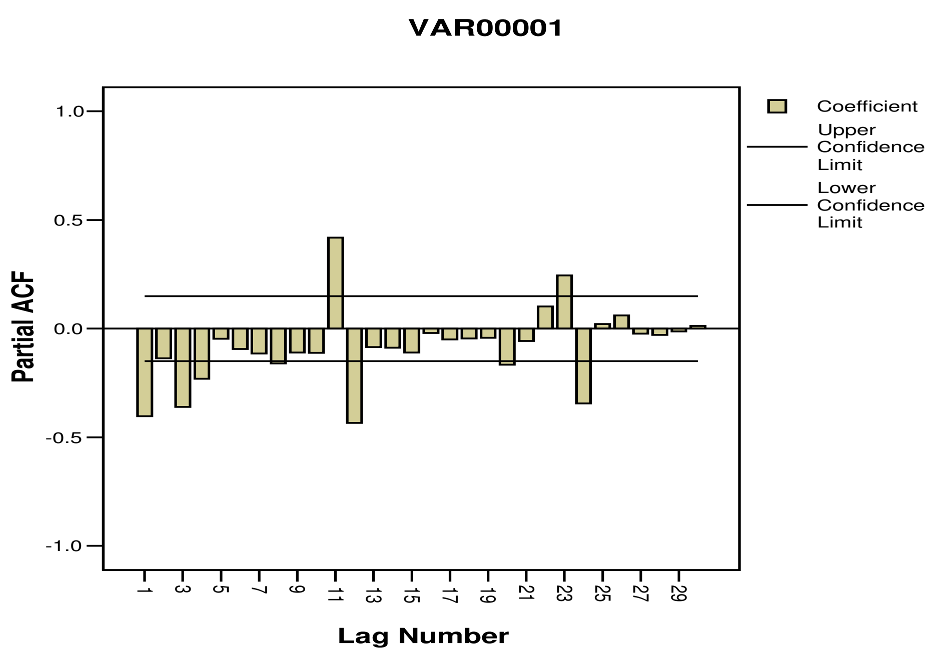


Fig 4.14: ACF and PACF for arrivals of chilli in Byadagi markets

Fig 4.14: ACF and PACF for arrivals of chilli in Byadagi markets

Table 4.14: Actual and forecasted value for the prices in Byadagi market.

Sl no	Years	Actual	Forecasted	Sl no	Years	Actual	Forecasted
1	Jan-94	1650	.	44	Aug-97	3855	4258.47
2	Feb-94	1782	.	45	Sep-97	3889	3601.57
3	Mar-94	1784	.	46	Oct-97	4369	4311.61
4	Apr-94	2825	.	47	Nov-97	4174	3934.09
5	May-94	2689	.	48	Dec-97	3590	4278.34
6	Jun-94	2544	.	49	Jan-98	1380	4626.76
7	Jul-94	2335	.	50	Feb-98	1250	2545.96
8	Aug-94	1761	.	51	Mar-98	1400	2759.39
9	Sep-94	2089	.	52	Apr-98	2969	1437.67
10	Oct-94	2340	.	53	May-98	2500	2902.58
11	Nov-94	1888	.	54	Jun-98	1500	2492.98
12	Dec-94	2308	.	55	Jul-98	1200	2053.40
13	Jan-95	2618	.	56	Aug-98	1061	1553.03
14	Feb-95	2501	2751.40	57	Sep-98	1160	1351.03
15	Mar-95	2481	2578.45	58	Oct-98	1050	1786.26
16	Apr-95	1999	3581.44	59	Nov-98	1500	1143.08
17	May-95	1979	2487.48	60	Dec-98	1250	1334.34
18	Jun-95	1745	2234.35	61	Jan-99	1380	538.39
19	Jul-95	1733	1861.02	62	Feb-99	1250	951.71
20	Aug-95	1800	1314.71	63	Mar-99	1400	1238.33
21	Sep-95	1785	1978.81	64	Apr-99	2969	1732.24
22	Oct-95	2089	2064.85	65	May-99	2500	2315.23
23	Nov-95	2069	1624.22	66	Jun-99	1500	1781.09
24	Dec-95	2432	2262.98	67	Jul-99	1200	1444.85
25	Jan-96	3289	2472.81	68	Aug-99	1061	1200.95
26	Feb-96	3350	2931.35	69	Sep-99	1160	1135.87
27	Mar-96	3339	3068.31	70	Oct-99	1050	1361.68
28	Apr-96	2324	3221.39	71	Nov-99	1500	1215.23
29	May-96	2819	2566.39	72	Dec-99	1250	1360.85
30	Jun-96	3119	2612.38	73	Jan-00	5860	1313.97
31	Jul-96	3468	2826.90	74	Feb-00	4369	3927.37
32	Aug-96	3984	2972.36	75	Mar-00	3969	3813.49
33	Sep-96	3014	3575.89	76	Apr-00	2869	4304.10
34	Oct-96	3679	3363.44	77	May-00	2619	3202.43
35	Nov-96	3189	3385.11	78	Jun-00	2860	2465.33
36	Dec-96	3288	3592.80	79	Jul-00	3860	2701.24
37	Jan-97	4417	3999.37	80	Aug-00	2960	3258.20
38	Feb-97	3958	4343.35	81	Sep-00	3760	2928.55
39	Mar-97	5107	4068.15	82	Oct-00	4069	3545.90
40	Apr-97	3419	4362.85	83	Nov-00	3969	3837.32
41	May-97	3918	3909.90	84	Dec-00	4010	3713.63
42	Jun-97	3829	4076.64	85	Jan-01	4456	5753.98
43	Jul-97	4074	4087.28	86	Feb-01	4336	4279.38

Table 4.14 Contd……

Sl no	Years	Actual	Forecast	Sl no	Years	Actual	Forecasted
87	Mar-01	4336	4441.93	130	Oct-04	3484	3787.04
88	Apr-01	2533	4117.79	131	Nov-04	3582	3519.50
89	May-01	2233	3098.12	132	Dec-04	4111	4060.79
90	Jun-01	3167	2690.78	133	Jan-05	4752	4628.18
91	Jul-01	2200	3527.76	134	Feb-05	3469	4467.67
92	Aug-01	2690	2319.13	135	Mar-05	3102	3771.64
93	Sep-01	2876	3005.10	136	Apr-05	3307	3897.99
94	Oct-01	1833	3208.01	137	May-05	3857	3128.01
95	Nov-01	1533	2340.02	138	Jun-05	3551	3861.39
96	Dec-01	3876	2048.45	139	Jul-05	3871	3146.30
97	Jan-02	2550	3900.68	140	Aug-05	3456	3642.92
98	Feb-02	4200	2694.82	141	Sep-05	3736	3387.30
99	Mar-02	4733	3788.23	142	Oct-05	3899	3782.99
100	Apr-02	3729	3517.00	143	Nov-05	3837	3763.41
101	May-02	3440	3321.88	144	Dec-05	4882	4185.00
102	Jun-02	4533	3508.75	145	Jan-06	4376	5166.69
103	Jul-02	1403	3762.69	146	Feb-06	4299	4104.01
104	Aug-02	2100	2284.32	147	Mar-06	3446	4187.11
105	Sep-02	2000	2557.58	148	Apr-06	2132	3787.95
106	Oct-02	2350	2091.60	149	May-06	1856	2948.76
107	Nov-02	1767	2195.53	150	Jun-06	1629	2472.19
108	Dec-02	2050	2840.74	151	Jul-06	2067	2056.78
109	Jan-03	3653	2347.40	152	Aug-06	1770	2090.04
110	Feb-03	3876	3696.63	153	Sep-06	1723	2042.15
111	Mar-03	3183	3951.61	154	Oct-06	3619	2118.83
112	Apr-03	3467	2939.39	155	Nov-06	3286	2978.42
113	May-03	3132	3171.25	156	Dec-06	3719	3585.50
114	Jun-03	2790	3446.56	157	Jan-07	3740	3755.85
115	Jul-03	2567	1858.00	158	Feb-07	2569	3556.00
116	Aug-03	2483	2544.00	159	Mar-07	5436	2665.96
117	Sep-03	1733	2463.57	160	Apr-07	3367	3947.59
118	Oct-03	2917	2211.77	161	May-07	3130	3080.50
119	Nov-03	3014	2441.86	162	Jun-07	3617	3014.11
120	Dec-03	3816	2999.78	163	Jul-07	3217	3296.56
121	Jan-04	4287	4263.69	164	Aug-07	2733	3033.94
122	Feb-04	3677	4197.57	165	Sep-07	4819	2828.76
123	Mar-04	3277	3701.28	166	Oct-07	6064	4844.02
124	Apr-04	4767	3432.00	167	Nov-07	2849	5137.89
125	May-04	3467	4103.22	168	Dec-07	3783	3978.43
126	Jun-04	4000	3470.07	169	Jan-08	5069	4401.75
127	Jul-04	3326	3494.89	170	Feb-08	5946	4377.16
128	Aug-04	3514	3289.34	171	Mar-08	5442	6191.80
129	Sep-04	3372	3196.94	172	Apr-08	6199	4725.05

Table 4.14 Contd….

Sl no	Years	Actual	Forecast
173	May-08	4969	5426.02
174	Jun-08	5236	5138.97
175	Jul-08	5376	4890.95
176	Aug-08	5609	4955.31
177	Sep-08	5349	5996.45
178	Oct-08	5486	6180.46
179	Nov-08	5849	4638.69
180	Dec-08	4269	6060.38
181	Jan-09	6519	5612.18
182	Feb-09	5902	6477.34
183	Mar-09	5245	6023.76
184	Apr-09	4269	5688.97
185	May-09	3636	4435.09
186	Jun-09	4969	4303.33
187	Jul-09	5736	4742.36
188	Aug-09	6092	5312.39
189	Sep-09	5812	5659.09
190	Oct-09	5979	5941.56
191	Nov-09	5772	5782.23
192	Dec-09	5313	5518.85
193	Jan-10	.	6493.34
194	Feb-10	.	6203.72
195	Mar-10	.	6069.84
196	Apr-10	.	5604.18
197	May-10	.	5220.50
198	Jun-10	.	5710.40
199	Jul-10	.	5815.73
200	Aug-10	.	5890.31
201	Sep-10	.	5890.11
202	Oct-10	.	6224.65
203	Nov-10	.	5952.63
204	Dec-10	.	6002.48

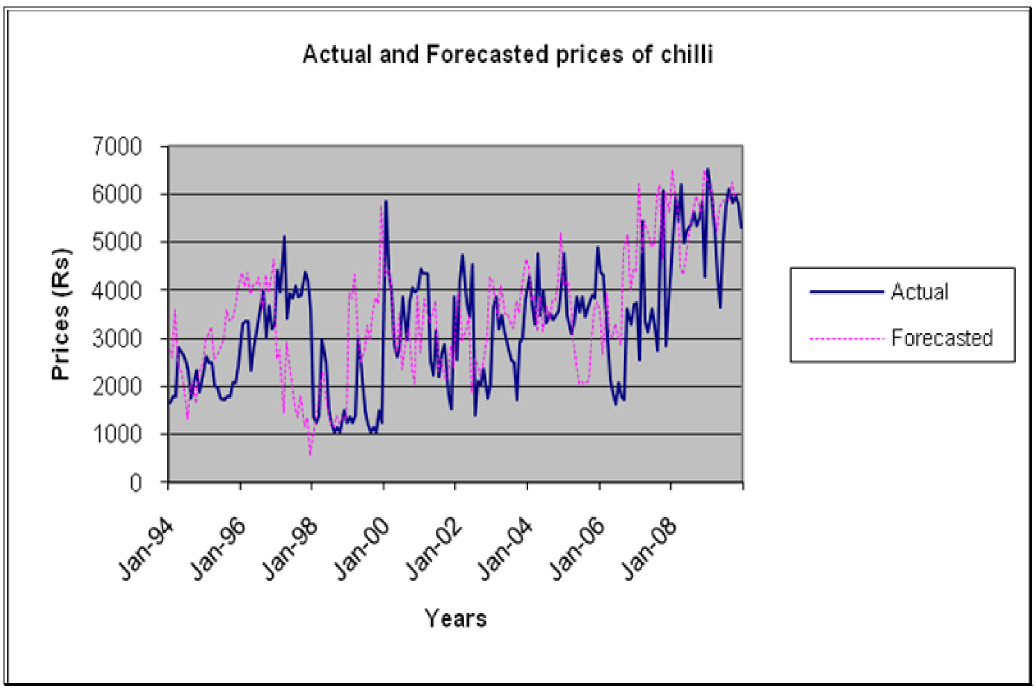
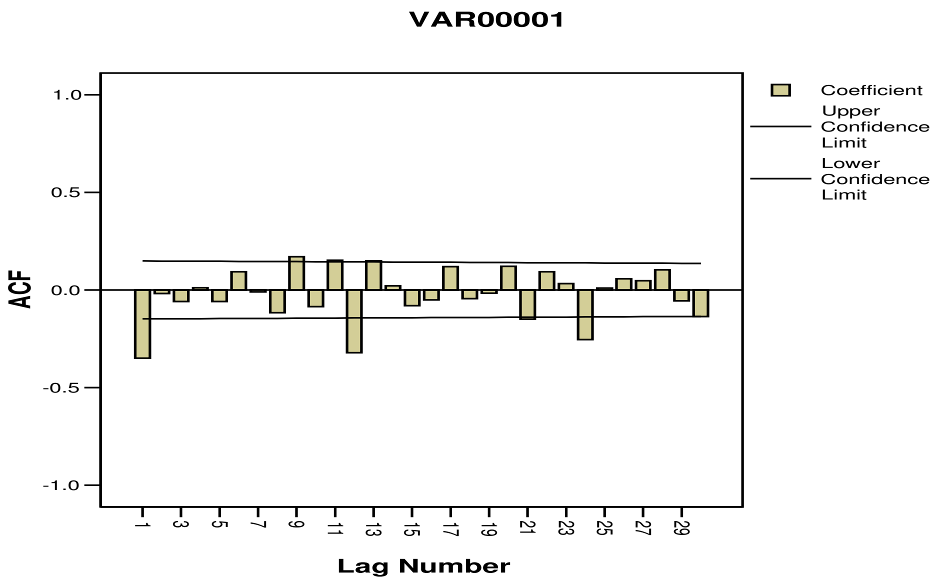


Fig 4.15 Actual and forecasted prices of Byadagi market

Fig 4.15 Actual and forecasted prices of Byadagi market



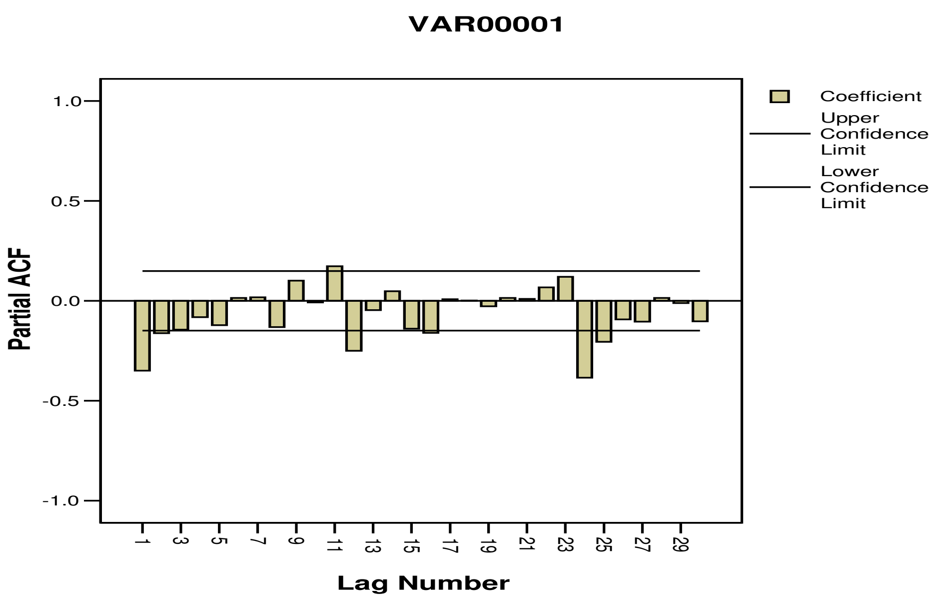


Fig 4.16: ACF and PACF for prices of Byadagi market

Fig 4.16: ACF and PACF for prices of Byadagi market

Table 4.15 Actual and Forecasted arrivals of chilli in Hubli markets by exponential smoothing method

Sl no	Actual	Forecasted	Sl no	Actual	Forecasted
1	10263		44	165	502.67
2	9583	10263.00	45	380	266.30
3	3200	9787.00	46	368	345.89
4	2223	5176.10	47	472	361.37
5	622	3108.93	48	2852	438.81
6	589	1368.08	49	14553	2128.04
7	366	822.72	50	17800	10825.51
8	162	503.02	51	18558	15707.65
9	363	264.31	52	9231	17702.90
10	384	333.39	53	4361	11772.57
11	766	368.82	54	2036	6584.47
12	6075	646.85	55	565	3400.54
13	8709	4446.55	56	1579	1415.66
14	7490	7430.27	57	496	1530.00
15	1754	7472.08	58	179	806.20
16	624	3469.42	59	196	367.16
17	519	1477.63	60	11045	247.35
18	249	806.59	61	12094	7805.70
19	150	416.28	62	11722	10807.51
20	82	229.88	63	8945	11447.65
21	289	126.36	64	10661	9695.80
22	73	240.21	65	4414	10371.44
23	601	123.16	66	2372	6201.23
24	9752	457.65	67	439	3520.77
25	6210	6963.69	68	299	1363.53
26	4929	6436.11	69	72	618.36
27	2887	5381.13	70	98	235.91
28	112	3635.24	71	2873	139.37
29	57	1168.97	72	9082	2052.91
30	57	390.59	73	12816	6973.27
31	78	157.08	74	11102	11063.18
32	30	101.72	75	5943	11090.35
33	65	51.52	76	4777	7487.21
34	73	60.96	77	1430	5590.06
35	4031	69.39	78	668	2678.02
36	13206	2842.52	79	431	1271.01
37	10074	10096.95	80	182	683.00
38	8484	10080.89	81	163	332.30
39	4852	8963.07	82	750	213.79
40	1613	6085.32	83	1214	589.14
41	1006	2954.70	84	4853	1026.54
42	992	1590.61	85	18501	3705.06
43	216	1171.58	86	13402	14062.22

Table 4.15 Contd….

Sl no	Actual	Forecasted	Sl no	Actual	Forecasted
87	7929	13600.07	130	56	274.38
88	8362	9630.32	131	266	121.51
89	1740	8742.50	132	7787	222.65
90	773	3840.75	133	20284	5517.64
91	296	1693.32	134	20316	15854.10
92	209	715.20	135	22790	18977.43
93	149	360.86	136	17611	21646.23
94	235	212.56	137	6777	18821.56
95	837	228.27	138	3404	10390.37
96	4943	654.38	139	1333	5499.91
97	6953	3656.41	140	1123	2583.07
98	4937	5964.02	141	1339	1561.02
99	3860	5245.11	142	1847	1405.60
100	3924	4275.53	143	1715	1714.58
101	2042	4029.46	144	6496	1714.87
102	1424	2638.24	145	25819	5061.66
103	669	1788.27	146	25864	19591.7
104	673	1004.78	147	6256	23982.3
105	681	772.53	148	5998	11573.90
106	783	708.46	149	1498	7670.77
107	144	760.64	150	477	3349.83
108	10340	328.99	151	310	1338.84
109	24544	7336.70	152	154	618.65
110	14318	19381.81	153	102	293.39
111	5824	15837.14	154	213	159.41
112	2797	8827.94	155	804	196.92
113	1151	4606.28	156	8252	621.87
114	301	2187.58	157	24238	5962.93
115	262	866.98	158	24904	18755.48
116	81	443.49	159	20377	23059.44
117	187	189.75	160	4637	21181.73
118	14	187.82	161	765	9600.42
119	388	66.15	162	338	3415.62
120	6016	291.44	163	322	1261.28
121	4658	4298.63	164	70	603.78
122	5755	4550.19	165	238	230.13
123	5781	5393.56	166	51	235.64
124	1550	5664.77	167	697	106.39
125	700	2784.43	168	8863	519.81
126	776	1325.33	169	25264	6360.03
127	191	940.80	170	23699	19592.81
128	245	415.94	171	13826	22467.14
129	265	296.28	172	8882	16418.34

Table 4.15 Contd….

Sl no	Actual	Forecasted
173	2167	11142.90
174	1197	4859.77
175	234	2295.83
176	199	852.54
177	149	395.06
178	153	222.81
179	176	173.94
180	5681	175.38
181	7308	4029.31
182	15540	6324.39
183	10664	12775.39
184	6325	11297.39
185	155	7816.71
186	1704	2453.51
187	1704	1928.85
188	587	1771.45
189	679	942.336
190	133	758.001
191	4039	320.500
192	6532	2923.45
193		5449.43

Table: 4.16 Actual and forecasted prices of chilli in Hubli market by exponential smoothing method

Sl No	Model Price	Forecasted	Sl No	Model Price	Forecasted
1	2300		44	3289	3425.98
2	2501	2300	45	3509	3330.09
3	2000	2440.7	46	3269	3455.32
4	2860	2132.21	47	3890	3324.89
5	4850	2641.66	48	3880	3720.46
6	2850	4187.49	49	3800	3832.14
7	2015	3251.24	50	3510	3809.64
8	2450	2385.87	51	3650	3599.89
9	1730	2430.76	52	3250	3634.96
10	2209	1940.22	53	2250	3365.49
11	1660	2128.36	54	2850	2584.64
12	3353	1800.51	55	3550	2770.39
13	2850	2887.25	56	3800	3316.11
14	2626	2861.17	57	3180	3654.83
15	2689	2696.55	58	3800	3322.45
16	2420	2691.26	59	3800	3656.73
17	2819	2501.37	60	4500	3757.02
18	3240	2723.71	61	3889	4277.10
19	4269	3085.11	62	5856	4005.43
20	3800	3913.83	63	3680	5300.82
21	1270	3834.15	64	3407	4166.24
22	3750	2039.24	65	3009	3634.77
23	5210	3236.77	66	3549	3196.73
24	4567	4618.03	67	3885	3443.31
25	4569	4582.30	68	3258	3752.49
26	3670	4572.99	69	3259	3406.34
27	4130	3940.89	70	3219	3303.20
28	4240	4073.26	71	3125	3244.26
29	4160	4189.98	72	3290	3160.77
30	4725	4168.99	73	3800	3251.23
31	4539	4558.19	74	3849	3635.37
32	5430	4544.75	75	4169	3784.91
33	1820	5164.42	76	4102	4053.77
34	3750	2823.32	77	4200	4087.53
35	4470	3471.99	78	3356	4166.25
36	4196	4170.59	79	4209	3599.07
37	4496	4188.37	80	5009	4026.02
38	4575	4403.71	81	5869	4714.10
39	4419	4523.61	82	5389	5522.53
40	4869	4450.38	83	3818	5429.05
41	4540	4743.41	84	3569	4301.31
42	4019	4601.02	85	4600	3788.69
43	3097	4193.60	86	3800	4356.60

Table 4.16 Contd…..

Sl No	Model Price	Forecasted	Sl No	Model Price	Forecasted
87	4541	3966.98	130	4109	4366.51
88	4281	4368.79	131	4839	4186.25
89	4769	4307.34	132	4519	4643.18
90	3606	4630.50	133	4300	4556.25
91	4300	3913.35	134	4229	4376.88
92	4309	4184.01	135	3669	4273.36
93	4569	4271.50	136	2860	3850.31
94	4719	4479.75	137	2860	3157.09
95	4299	4647.23	138	2497	2949.13
96	3239	4403.47	139	1811	2632.64
97	4060	3588.34	140	2109	2057.49
98	4276	3918.50	141	2129	2093.55
99	4389	4168.75	142	1986	2118.36
100	3640	4322.93	143	4663	2025.71
101	3466	3844.88	144	4019	3871.81
102	3009	3579.66	145	4399	3974.84
103	2839	3180.20	146	3566	4271.75
104	2897	2941.36	147	3566	3777.73
105	2999	2910.31	148	3299	3629.52
106	2711	2972.39	149	3269	3398.16
107	3039	2789.42	150	3069	3307.75
108	4449	2964.13	151	3319	3140.62
109	3669	4003.54	152	3631	3265.49
110	3261	3769.36	153	4689	3521.35
111	3266	3413.51	154	3909	4338.70
112	3229	3310.25	155	3376	4037.91
113	3534	3253.38	156	3376	3574.57
114	4719	3449.81	157	4666	3435.57
115	4109	4338.24	158	4399	4296.87
116	4669	4177.77	159	4299	4368.36
117	3397	4521.63	160	4219	4319.81
118	4226	3734.39	161	4209	4249.24
119	4169	4078.52	162	3911	4221.07
120	5459	4141.86	163	3689	4004.02
121	5089	5063.86	164	3839	3783.51
122	5219	5081.46	165	4050	3822.35
123	4469	5177.74	166	4299	3981.71
124	3079	4681.62	167	3369	4203.81
125	4669	3559.79	168	3029	3619.44
126	4229	4336.24	169	4399	3206.13
127	4409	4261.17	170	4399	4041.14
128	4219	4364.65	171	4629	4291.64
129	4411	4262.70	172	3239	4527.79

Table 4.16 Contd…..

Sl No	Model Price	Forecasted
173	3066	3625.64
174	3539	3233.89
175	3369	3447.47
176	4399	3392.54
177	3749	4097.06
178	3689	3853.42
179	3811	3738.33
180	4199	3789.20
181	4099	4076.06
182	4398	4092.12
183	3888	4306.24
184	4609	4013.47
185	8066	4430.34
186	4099	6975.30
187	4099	4961.89
188	4299	4357.87
189	4021	4316.66
190	3699	4109.70
191	8218	3822.21
192	9632	6899.26
193		8812.18

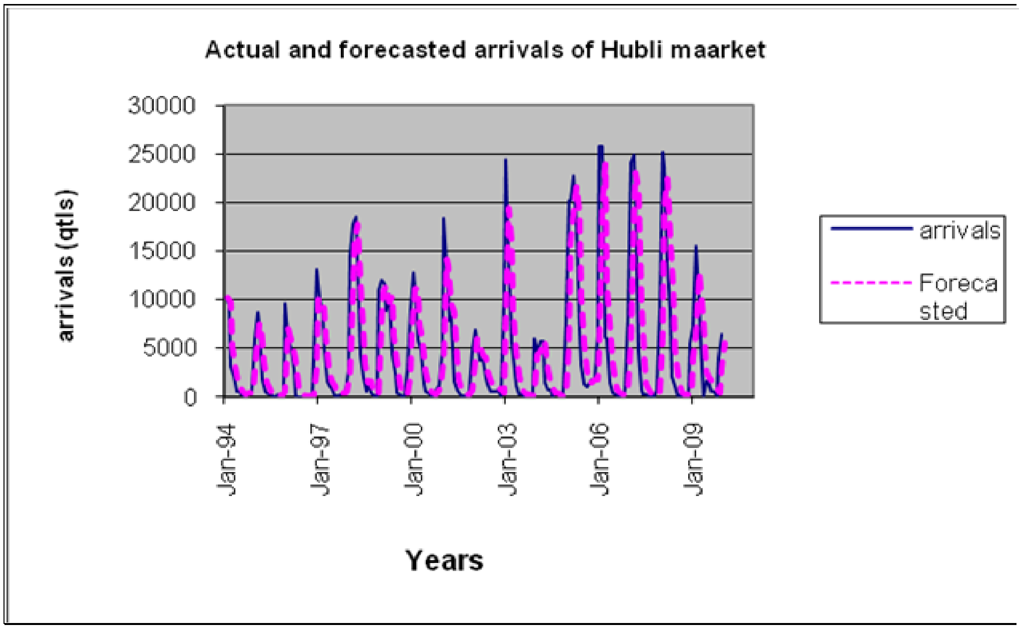


Fig 4.17: Actual and forecasted value for arrivals in Hubli market by exponential smoothing method

Fig 4.17: Actual and forecasted value for arrivals in Hubli market by exponential smoothing method

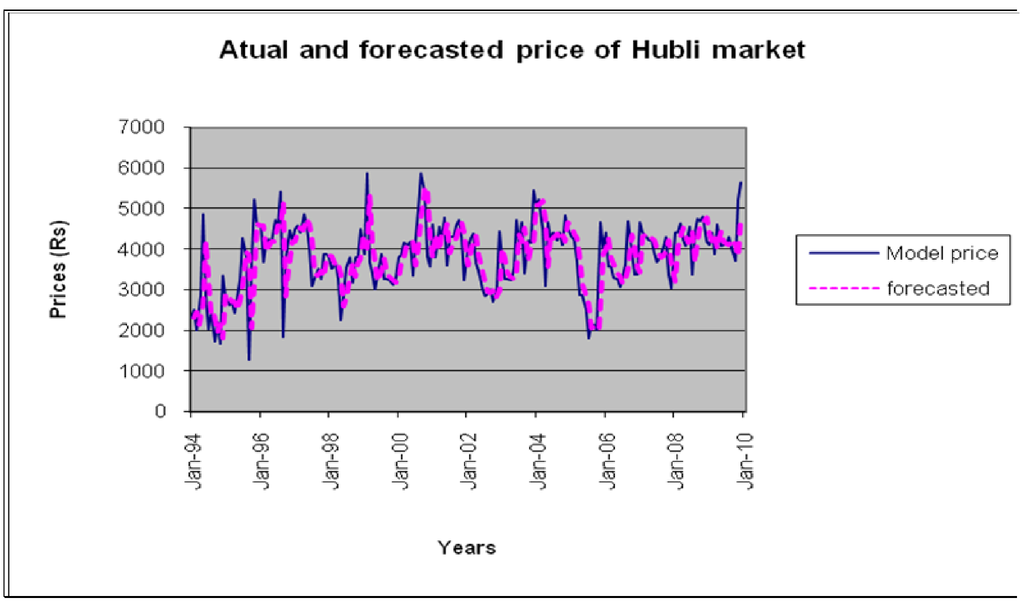


Fig 4.18: Actual and forecasted value for Prices in Hubli market by exponential smoothing method

Fig 4.18: Actual and forecasted value for Prices in Hubli market by exponential smoothing method

Table 4.17 Actual and forecasted values arrivals in Byadagi market by exponential smoothing method

Sl No	Actual	Forecasted	Sl No	Actual	Forecasted
1	41793		44	1005	4958.54
2	18078	41793.00	45	789	3377.13
3	6735	32307.00	46	2349	2341.88
4	5850	22078.20	47	35132	2344.73
5	2916	15586.92	48	46230	15459.64
6	3530	10518.55	49	92869	27767.78
7	2618	7723.13	50	63198	53808.27
8	3452	5681.08	51	51812	57564.16
9	3224	4789.45	52	12739	55263.30
10	9487	4163.27	53	15904	38253.58
11	36862	6292.76	54	10046	29313.75
12	40690	18520.46	55	7026	21606.65
13	21631	27388.27	56	7493	15774.39
14	17611	25085.36	57	12490	12461.83
15	14134	22095.62	58	13577	12473.10
16	4542	18910.97	59	20039	12914.66
17	3586	13163.38	60	45265	15764.40
18	2208	9332.43	61	42391	27564.64
19	2270	6482.66	62	34726	33495.18
20	2270	4797.59	63	56749	33987.51
21	2866	3786.56	64	31701	43092.11
22	2854	3418.33	65	15678	38535.66
23	20753	3192.60	66	7652	29392.60
24	36440	10216.76	67	5229	20696.36
25	22338	20706.06	68	5615	14509.42
26	23403	21358.83	69	2742	10951.65
27	24801	22176.50	70	9133	7667.79
28	8349	23226.30	71	44991	8253.87
29	4654	17275.38	72	75596	22948.72
30	3054	12226.83	73	65400	44007.63
31	3075	8557.70	74	59780	52564.58
32	1668	6364.62	75	43610	55450.75
33	1929	4485.97	76	66210	50714.45
34	1952	3463.18	77	35438	56912.67
35	9382	2858.71	78	13250	48322.80
36	40248	5468.03	79	7189	34293.68
37	39196	19380.02	80	3842	23451.81
38	21432	27306.41	81	4393	15607.89
39	19768	24956.65	82	4762	11121.93
40	7706	22881.19	83	30699	8577.96
41	4286	16811.11	84	64100	17426.38
42	1829	11801.07	85	54739	36095.83
43	678	7812.24	86	95608	43553.10

Table: 4.17 Contd….

Sl No	Actual	Forecasted	Sl No	Actual	Forecasted
87	96768	64375.06	130	2277	8166.75
88	30138	77332.23	131	3923	5810.85
89	16778	58454.54	132	22519	5055.71
90	5279	41783.92	133	154929	12041.03
91	4949	27181.95	134	119873	69196.22
92	5623	18288.77	135	157321	89466.93
93	4175	13222.46	136	56754	116608.56
94	4404	9603.48	137	18302	92666.73
95	24436	7523.69	138	11116	62920.84
96	46989	14288.61	139	5657	42198.90
97	49406	27368.77	140	4949	27582.14
98	55359	36183.66	141	7136	18528.89
99	66393	43853.80	142	4265	13971.73
100	43060	52869.48	143	21195	10089.04
101	26210	48945.69	144	133504	14531.42
102	7600	39851.41	145	98357	62120.45
103	9992	26950.85	146	120190	76615.07
104	8811	20167.31	147	101818	94045.04
105	4459	15624.78	148	153185	97154.23
106	4998	11158.47	149	91086	119566.54
107	14007	8694.28	150	41444	108174.32
108	46121	10819.37	151	22992	81482.19
109	76957	24940.02	152	14789	58086.12
110	61482	45746.81	153	18101	40767.27
111	80757	52040.89	154	10278	31700.76
112	56333	63527.33	155	18412	23131.66
113	41962	60649.60	156	46350	21243.79
114	13147	53174.56	157	99548	31286.28
115	9584	37163.54	158	127991	58590.97
116	11763	26131.72	159	141579	86350.98
117	14953	20384.23	160	59970	108442.19
118	9977	18211.74	161	18117	89053.31
119	13500	14917.84	162	7468	60678.79
120	61097	14350.71	163	4878	39394.47
121	43374	33049.22	164	6329	25587.88
122	86876	37179.13	165	5558	17884.33
123	100827	57057.88	166	7718	12953.80
124	29494	74565.53	167	14837	10859.48
125	19991	56536.92	168	59469	12450.49
126	5969	41918.55	169	126382	31257.89
127	3676	27538.73	170	131651	69307.54
128	2816	17993.64	171	93818	94244.92
129	2533	11922.58	172	55713	94074.15

Table 4.17 Contd….

Sl No	Actual	Forecasted
173	8939	78729.69
174	6435	50813.41
175	3246	33062.05
176	7423	21135.63
177	3525	15650.58
178	9754	10800.35
179	4907	10381.81
180	30183	8191.88
181	34385	16988.33
182	67747	23947.00
183	58706	41467.00
184	71997	48362.60
185	35141	57816.36
186	7605	48746.22
187	11027	32289.73
188	7714	23784.64
189	6318	17356.38
190	5798	12941.03
191	5089	10083.82
192	10797	8085.89
	….	9170.33

Table 4.18 Actual and forecasted value for prices of Byadagi market by exponential smoothing method

Sl No	Actual	Forecasted	Sl No	Actual	Forecasted
1	1650		44	3855	4005.97
2	1782	1650	45	3889	3900.29
3	1784	1742.4	46	4369	3892.38
4	2825	1771.52	47	4174	4226.01
5	2689	2508.95	48	3590	4189.60
6	2544	2634.63	49	1380	3769.53
7	2335	2571.19	50	1250	2096.85
8	1761	2405.50	51	1400	1504.05
9	2089	1954.35	52	2969	1431.21
10	2340	2048.60	53	2500	2507.66
11	1888	2252.58	54	1500	2502.29
12	2308	1997.37	55	1200	1800.68
13	2618	2214.46	56	1061	1380.20
14	2501	2496.58	57	1160	1156.76
15	2481	2499.32	58	1050	1159.02
16	1999	2486.14	59	1500	1082.70
17	1979	2145.14	60	1250	1374.81
18	1745	2028.84	61	1380	1287.44
19	1733	1829.80	62	1250	1352.23
20	1800	1762.04	63	1400	1280.66
21	1785	1788.61	64	2969	1364.20
22	2089	1785.73	65	2500	2487.56
23	2069	1998.02	66	1500	2496.26
24	2432	2047.70	67	1200	1798.88
25	3289	2316.71	68	1061	1379.66
26	3350	2997.31	69	1160	1156.59
27	3339	3244.19	70	1050	1158.97
28	2324	3310.55	71	1500	1082.69
29	2819	2619.96	72	1250	1374.80
30	3119	2759.29	73	5860	1287.44
31	3468	3011.08	74	4369	4488.23
32	3984	3330.57	75	3969	4404.76
33	3014	3787.62	76	2869	4099.73
34	3679	3246.08	77	2619	3238.21
35	3189	3549.12	78	2860	2804.76
36	3288	3297.03	79	3860	2843.42
37	4417	3290.36	80	2960	3555.02
38	3958	4079.00	81	3760	3138.50
39	5107	3993.95	82	4069	3573.55
40	3419	4773.08	83	3969	3920.36
41	3918	3825.22	84	4010	3954.40
42	3829	3889.81	85	4456	3993.32
43	4074	3847.24	86	4336	4316.96

Table 4.18 Contd…..

Sl No	Actual	Forecasted	Sl No	Actual	Forecasted
87	4336	4330.05	130	3484	3414.02
88	2533	4333.98	131	3582	3463.00
89	2233	3073.52	132	4111	3546.53
90	3167	2485.39	133	4752	3941.42
91	2200	2962.28	134	3469	4509.06
92	2690	2428.68	135	3102	3781.01
93	2876	2611.60	136	3307	3305.93
94	1833	2796.68	137	3857	3306.91
95	1533	2122.33	138	3551	3692.20
96	3876	1710.03	139	3871	3593.12
97	2550	3225.97	140	3456	3787.40
98	4200	2752.79	141	3736	3555.18
99	4733	3765.83	142	3899	3681.52
100	3729	4443.08	143	3837	3833.75
101	3440	3943.45	144	4882	3835.79
102	4533	3590.80	145	4376	4568.37
103	1403	4250.57	146	4299	4433.47
104	2100	2257.50	147	3446	4339.34
105	2000	2147.25	148	2132	3713.76
106	2350	2044.17	149	1856	2606.76
107	1767	2258.25	150	1629	2080.99
108	2050	1914.14	151	2067	1764.59
109	3653	2009.24	152	1770	1976.04
110	3876	3159.87	153	1723	1831.58
111	3183	3660.92	154	3619	1755.57
112	3467	3326.61	155	3286	3059.97
113	3132	3424.65	156	3719	3217.95
114	2790	3220.02	157	3740	3568.68
115	2567	2918.77	158	2569	3688.37
116	2483	2672.29	159	5436	2904.81
117	1733	2540.02	160	3367	4676.41
118	2917	1975.34	161	3130	3759.58
119	3014	2634.26	162	3617	3318.64
120	3816	2900.08	163	3217	3527.25
121	4287	3540.99	164	2733	3309.84
122	3677	4063.43	165	4819	2906.28
123	3277	3793.16	166	6064	4245.18
124	4767	3432.08	167	2849	5518.58
125	3467	4366.29	168	3783	3649.87
126	4000	3736.55	169	5069	3743.29
127	3326	3920.96	170	5946	4671.28
128	3514	3504.25	171	5442	5563.35
129	3372	3511.31	172	6199	5478.63

Table 4.18 Contd……

Sl No	Actual	Forecasted
173	4969	5982.89
174	5236	5273.16
175	5376	5246.91
176	5609	5337.04
177	5349	5527.41
178	5486	5402.52
179	5849	5460.72
180	4269	5732.51
181	6519	4708.05
182	5902	5975.71
183	5245	5924.34
184	4269	5448.57
185	3636	4622.87
186	4969	3931.82
187	5736	4657.84
188	6092	5412.32
189	5812	5888.32
190	5979	5835.13
191	5772	5935.83
192	5313	5821.38
193		5465.51

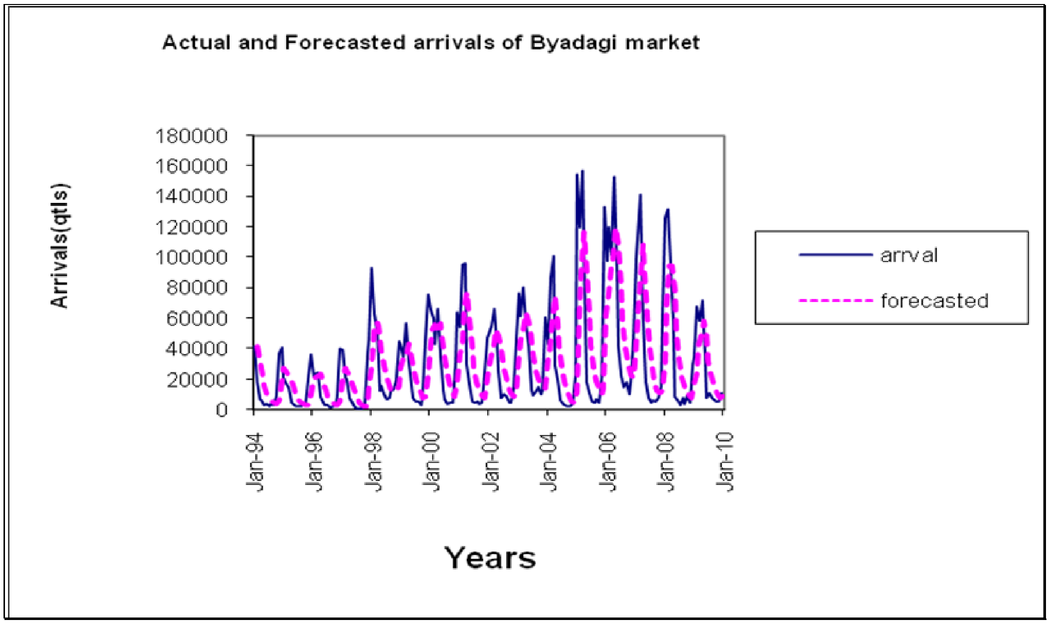


Fig 4.19 Actual and forecasted values of arrivals for Byadaagi market by exponential smoothing method

Fig 4.19 Actual and forecasted values of arrivals for Byadaagi market by exponential smoothing method

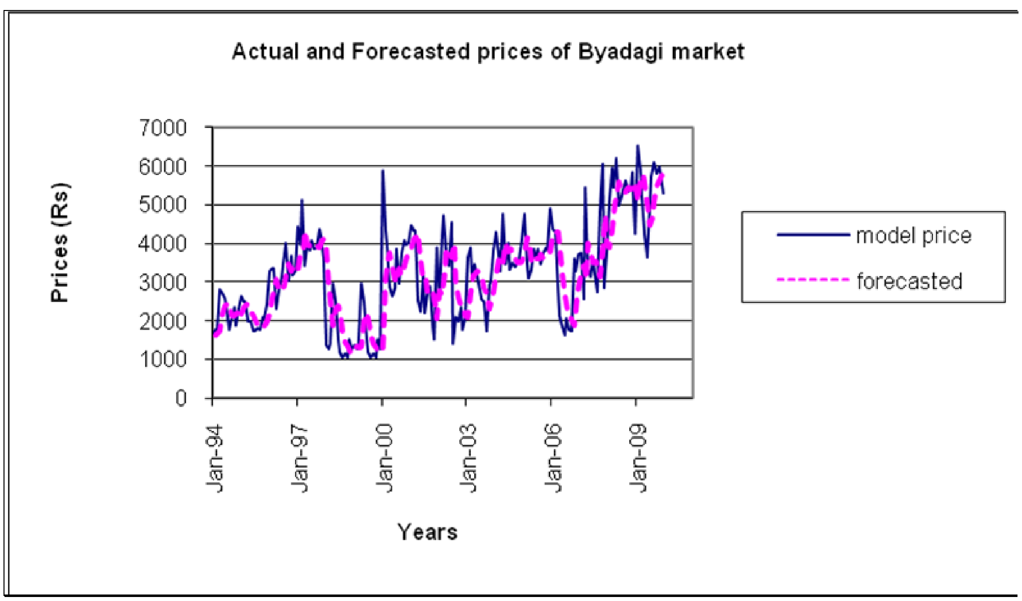


Fig 4.20. Actual and forecasted values of prices for Byadagi market by exponential smoothing method

Fig 4.20. Actual and forecasted values of prices for Byadagi market by exponential smoothing method

Table 4.19: Selected measure of predictive performance of Exponential smoothing technique

	Hubli		Byadagi	
	Arrivals	Prices	Arrivals	Prices
MSE	1042.12	332.33	1236.56	563.23
MAPE	842.46	233.23	923.26	456.28

Table 4.20: Compound growth rates of area, production and productivity of chilli In North Karnataka (In percentages)

	AREA	PRODUCTION	PRODUCTIVITY
CGR	13.76	13.88	12.20

Note: all value are non significant at 10 and 5 percent of level of significance

Table 4.21: Compound growth rates of area, production and productivity of Chilli in different districts of North Karnataka (In percentages)

Districts	CGR Area	CGR Production	CGR Productivity
Bagalkot	9.09	10.51	11.36
Belgaum	4.85***	5.49***	4.96
Bellary	3.11	3.38	3.09
Bidar	1.59	1.88	1.74***
Bijapur	0.89	1.11***	1.23
Dharwad	1.08	1.17	0.80
Gadag	0.91	1.09**	0.66
Gulbarga	0.81***	0.97	0.49
Haveri	0.65**	0.79***	0.37
Koppal	0.46	0.61	0.31
Raichur	0.40***	0.49	0.21***
U kannada	0.19	0.27	0.16

Note: ***, **, Indicates significant' at 10 and 5 percent levels of significance

Northern Karnataka as a whole registered positive compound growth rate for area (13.76) production (13.88), productivity (12.20). These registered values were non significant at both at ten and five percent level of significance.

5. DISCUSSION

The results of the study which was presented in the previous chapter were briefly discussed in this chapter and it was presented under the following broad heads.

5.1 Behaviour of arrivals and prices of chilli

5.2 Box-Jenkins model

5.3 Exponential Smoothing Technique

5.4 Growth pattern in area, production, productivity of chilli

5.1 Behaviour of arrivals and prices

5.1.1 Secular trend in arrivals and prices of Chilli in Hubli and Byadagi markets

Trend was a long term movement in time series value of a variable over a fairly long period of time. This method was more suitable for the present study because of absence of a prior knowledge regarding the exact mathematical form of the trend function.

The change in trend occurs as a result of general tendency of the data to increase or decrease as a result of some identifiable influences. The Trend component in arrivals and prices of chilli were presented in Table 4.1, to 4.4. And it was depicted in Fig 4.1 to 4.4.

The arrivals of chilli in both markets were very slowly and gradually increasing, but sudden increase in arrivals of chilli in Byadagi market during the year 2006 then onwards decreasing trend in the arrivals of chilli but the quantum of increase in arrivals varied from Hubli market to Byadagi market. During the year 2005, Hubli market was recorded highest quantity of arrivals but after that the trend was changed. Market arrivals were highly varied from year to year because majority of the crop was grown in the rainfed area, we can say that more than 65-70 percent of Hubli and Byadagi catchment area of the markets depends on rainfall, because of timely non occurrence of rain fall (Monsoon) production was varied, so intern market arrivals were also varied.

The trend show decrease in arrivals during the year 2009 in both Hubli (55,370 qtls) and Byadagi (3, 22,324 qtls) market. The reason was the occurrence of sever flood due to heavy rainfall before harvesting time of the crop and in some of the areas entire crop was washed out, During this period, slight fetched in the price of chilli in both Hubli (Rs 5263) and Byadagi (Rs 5437) markets.

In both Hubli and Byadagi markets, the price was fixed mainly based on quality apart from quantity of arrival of chilli. Though the arrivals increased, the prices did not show the corresponding decline, this might be due to the fact that the chilli may be in continuous demand in the locality.

A critical analysis of trend shows slowly an increasing trend in arrivals in both the study markets but the price of chilli shows trend equation with mild ups and downs in both the markets.

5.1.2 Seasonal movements in market arrivals and prices of chilli in Hubli and Byadagi Markets

5.1.2.1 Seasonal indices of market arrivals of chilli in Hubli and Byadagi markets

To analyze the arrivals of chilli during the different months of year, seasonal indices were computed by adopting 12 months moving averages. Seasonal variation was observed in arrivals of chilli in both Hubli and Byadagi markets. The seasonal indices exhibited that, there was a vast variation in the seasonal pattern of both markets. In both the markets, the quantity of arrivals was found to be almost high during December, January, February, and March latter on the arrivals tapering during September to November months. This pattern of variation in market arrivals could be attributable to seasonality nature of chilli production.

Chilli is a four month crop usually planted in the month of June - July every year; hence those months have registered high arrivals. Inadequacy of cold storage facilities in many parts of growing regions was another bottleneck which hinders the farmers phase their market arrivals. Hence the farmers need to plan the production, store the produce during the peak season and sell them during the off season to get remunerative price of chilli produce.

5.1.2.1 Seasonal indices of market prices of chilli in Hubli and Byadagi markets

To ascertain the pattern of price variation in chilli during different months of the year, seasonal indices were computed by adopting 12 months moving averages. The results of seasonal indices of prices were presented in Table 4.5.

Table 4.5 reveals the seasonal indices of prices of chilli in Hubli and Byadagi markets. It could be seen that there was seasonal variation in prices of chilli in both the markets. There was no fluctuation observed in the prices of chilli. This may be due to the nature of arrivals to the market. The higher price of seasonal indices were observed during December to April months, during which the arrivals were also high, even though price was more in those months. Where as in rest of the other months i.e. May to November price indices found low even though arrivals were low.The comparative study of seasonal variation of arrivals and prices showed the existence of higher price in the month of Dec, Jan, Feb, and March then onwords almost steady state in the prices of markets but in case of arrivals higher in the months of Dec-April and in rest of the months arrivals goes on decreasing up to December.

5.1.3 Cyclical variations in arrivals and prices of chilli in Hubli and Byadagi markets

5.1.3.1 Cyclical variation in arrivals of chilli in Hubli and Byadagi markets

To ascertain the cyclical variation in arrivals of chilli in Hubli and Byadagi markets was presented in the table 4.6.

In both the markets uneven cycles were observed. The number of cycles were being observed in Hubli market is two, that of first cycle was occurred on an average of four years (i.e. 1995-1999) and second was on an average of six years (i.e. 2001-2009). In Byadagi market also, we found same as in Hubli market(i.e. first cycle from 1995-200 and second cycle was from 2002-2009) The variation in the arrivals of chilli across the year could be attributable to weather or climatic conditions, pest and disease situations, market impact factors and such other parameters which vary at regular intervals, market infrastructure could be geared up to even out such cyclical variation well in advance, so that the shocks at spurt are not transferred to producers or consumers. There was a need to evolve some mechanism, which would stabilize the market situation every year.

5.1.3.2 Cyclical variation in prices of chilli in Hubli and Byadagi markets

Cyclical variation in prices of chilli in both Byadagi and Hubli markets were presented in table 4.6.

It could be observed that there existed uneven cycles in the prices of chilli in both the markets. In Hubli market, little cyclical movement in the prices of chilli was observed on an average of two to three years (i.e.1997-2000). In Byadagi market also, we observed that small cyclical movement in the prices, it might varies from two to three years. Perfect cycles with regard to variation in prices could be observed if the time series data is for the larger period, i.e. for the period of 35-40 years. Non availability of data for such a long period has posed another demerit in getting the proper cyclical pattern with respect to prices. Hence maintenance of the records of the past events is crucial to evolve policy guidelines for orderly marketing of the produce and to evolve better pricing strategies.

5.2 Box-Jenkins model

As explained earlier (Chapter III), fitting Box-Jenkins models, the other name of ARIMA model, involves a four stage procedure. The discussion part was presented in the same order.

The trend of forecast is not precise for owing to non-stationarity of data, it is not always reliable. So Box-Jenkins method is applied for precise forecast.

Since ARIMA models were intensively used to study market fluctuations particularly of commodities singular advantage of this class of model lies in ability to quantify random variation present in many economic time series .Hence, the monthly data on prices and arrivals of chilli of Hubli and Byadagi market were subject to the ARIMA analysis to quantify the variation.

The pre-requisite for ARIMA model is the stationarity of time series considered for the analysis. Therefore the first step in running ARIMA to check whether the time series are stationarity, if not make them stationary by differencing the time series. The Auto-correlation and Partial Auto-correlation co-efficient (Table 4.7 and Table 4.12) of working was computed and conformed the absence of trend component in the series. A perusal of such tables reveals that this can be justified by the Auto-correlation function (ACF) of the series dropping to zero in the first lag.

5.2.1 Identification of the model

Identification of the model was the first step which involves a greater deal of skill. It was done based on conjunction of the sample Auto Correlation Function with the Partial Auto Correlation Function (PACF). ACF and PACF for both markets are presented in Table 4.7 and 4.12. Since the method of identification does not lay down any hard and fast principles, several possible models are tentatively identified and the following yielded the best results.

5.2.2 Estimation

Having tentatively identified the model, next parameters which minimize the sum of squares of errors are estimated. The estimated models for arrivals and prices of chilli are presented below.

1. Monthly arrivals of chilli in Hubli market : (3,1,1) (1,1,1)
2. Monthly prices of chilli in Hubli market : (1,1,1,) (1,1,1)
3. Monthly arrivals of chilli in Byadagi market : (1,1,3) (1,1,2)
4. Monthly prices of chilli in Byadagi market: (1,1,1) (1,1,1)

5.2.3 Diagnostic checking

The residuals of estimated models were examined for testing the randomness of series and analyzed to determine the adequacy of the estimated models.

For all the series of chilli arrivals and prices in Hubli and Byadagi market, Box-Pierce Q statistic yielded non- significant and AIC is minimum. Seasonality is found and forecast consideration was the best. Hence these models were chosen for the study.

5.2.4 Forecasting

Ex-ante and Ex-post obtained by the Box-Jenkins methods were presented in Table 4.9, 4.10 and Table 4.13, 4.14. The forecasts from the various models were checked for their efficacy by comparing them with the actual values

The similar model (Box-Jenkins) was used by Achoth (1985) analyzed the supply, price and trade of Indian tea by fitting ARIMA model to data on prices and production. The forecasts yielded reasonably good results as estimated from the tests of their efficiency. The forecasts of prices were superior when compared to the forecasts of quantities, which is attributed to the highly structured pattern of price behavior. And Punith (2007) lead out to attempt to fit ARIMA model to forecast the values of prices of maize and Groundnut for Davanageri market and Hubli market. The forecasts afforded reasonably effective solutions as estimated from the tests of their efficiency. The forecasts of prices were superior when compared to the forecasts of arrivals, which was attributed to the highly structured pattern of price behavior.

5.3 Exponential Smoothing Technique.

In this method for updating the forecast in light of changing parameters of a regression model was expressed. There are several ways to update the parameters: One is to re-estimate them every time a new data point is obtained another was to use of moving average technique on the series before attempting to compute the parameters. The most common and efficient way of handling the problem was to use Exponential Smoothing technique. In this we discuss the methods of obtaining the correct weighting factors and building a prediction for the updated forecast. An Exponential Smoothing model is preferred to the multiplicative time series model for forecasting purposes. The Exponential smoothing is best model for short term forecasting than regression and moving average. Exponential smoothing technique was carried out for the monthly arrivals and prices of chilli in Hubli and Byadagi market data using MINITAB SOFTWARE and MS Excel package.

In Exponential Smoothing method in order to smooth a set of data correctly, we must first obtain the proper weighting factor. In theory this weighting factor alpha can range from 0.01 to 1, but it has been used that any estimated value of alpha that was greater than 0.3 indicates that the error terms are not random. However, recent research was shown that the values greater than 0.3 are also acceptable (Gander, 1985)

Once it has established that the time series variable was stationary, and then it was possible to apply the exponential smoothing method. The different weights were given to all the observations of the arrivals and price of chilli in Hubli and Byadagi markets data; the weights were assigned by trial and error method. The weight (W) i.e., the alpha (level) was found to be 0.6, 0.4 for the Hubli market arrivals and prices, and 0.6, 0.4 for the Byadagi market arrivals and prices which was obtained by trial and error methods. The accuracy measures considered are MSE and MAPE tests. The values of MSE and MAPE are presented in Table 4.19, which were found to be least and stable. Table 4.15, Table 4.16, Table 4.17 and Table 4.18 shows the actual and forecasted values of the model using exponential smoothing constant.

Similar research work was carried out by Vasanth Kumar in 2002 on Statistical Evaluation of price variation in tropical timbers. Exponential Smoothing was used for forecasting the price of timber in different depots.

5.4 Growth pattern in Area, production, productivity of chilli

Agriculture was inherently unstable and more so in a state like Karnataka, where hardly about 20 percent of the net sown area was irrigated and remaining area depends on the monsoon. Better prices, higher income with improved varieties, production technology and export opportunities along with low interest rate credit facilities in recent years might have encouraged the growth in production of chilli increased over the years.

The compound growth rate (CGR) of area, production and productivity of chilli was worked out for all the districts of North Karnataka and North Karnataka as a whole and results were given in Table 4.20 and 4.21. The results revealed that in North Karnataka compound growth rate in area (13.76), production (13.88) and productivity (12.20). These results were non significant at both ten and five percent level of significance. District wise analysis of CGR was observed that, Belgaum (4.85), Gadag (0.81) and Raichur (0.40) were significant at ten percent level of significance but Haveri (0.65) district has registered significance at five percent of level of significance. In case of production, Belgaum (5.49), Bijapur (1.11) and Haveri (0.79) districts were significant at ten percent level of significance but Gadag (1.09) district has registered significant at five percent level of significance and rest of the other districts were non significant at both ten and five percent level of significance. In case of productivity, Bidar (1.74) and Raichur (0.21) districts were significant at ten percent level of significance. The findings of the study were on par with the results obtained by the Veena (1996) and Vinaya (2007).

6. SUMMARY AND CONCLUSION

It was well known fact that the Indian agriculture was characterized by wide variation in output of major crops which subsequently leads to wider fluctuation in market arrivals. The extent of fluctuations in market arrivals largely contributed to the price instability of agricultural commodity. In order to device, the appropriate ways and means for not only reducing the degree of fluctuations in the prices of agricultural commodities, but also increasing the quality of market arrivals, there is need to have a perfect understanding about the behavior of prices and market arrivals of different products and responsiveness of market arrivals to price movements over a period of time.

The present study indicate modest attempt in this direction. It tries to identify some of the causes responsible for the wide marketing margins witnessed in the rate of chilli in the selected markets. The markets are located in the major chilli producing tract of Dharwad and Haveri districts.

The information on area, production, and productivity data were collected from Directorate of Economics and Statistics, Bangalore and monthly and yearly data of price and arrivals of data were collected from the respective agriculture produce market committees.

A multiplicative model of time series was used on arrivals and prices data for each of the markets. The Box-Jenkins model was also applied to those markets. At 12 months centered moving average was calculated for the purpose of estimating final stabilized seasonal indices.

The trend cycle components were obtained by dividing the original observation by seasonal index of corresponding years and months. The chart of trend-cycle component was examined to the presented cycles. Whenever the presence of cycle was detected the periodicity of cycle was found out. The moving average of length equal to span of the periodicity of cycle was computed.

Then the trend cycle was computed and divide by corresponding months,years of cyclical index. This resulted in a pure component were re-examined, the charts exhibit the similar pattern, it was indication of no cyclical pattern, then trend cycle component was treated as pure trend component. This component was used to fit the polynomial equations. The order of polynomial regression was determined based on the highest R^2 values.

The Box-Jenkins model was fitted to the market arrivals and prices of chilli in Hubli and Byadagi markets. If the seasonality in the data, then seasonal ARIMA model was used. Before going to the application of Box-Jenkins analysis, more the data should be stationary series. If, the series was non stationary, it could be removed by differencing. The differenced series does not distort the feature of the series.

Making use of differenced series (which was stationary), the ACF and PACF was computed because, it helps in tentitatively identified the models. Then the parameters of all tentitatively identified the models. Were estimated by iterative process. These estimated models are subjected to diagnostic checking in order to determine the adequacy. The residues of estimated models are examined for testing the randomly of series and for its significance. The ACF and PACF of residual's were tested using Box-Jenkins Q statistic. Both ex-ante and ex-post forecast was done for among the best models.

MAJOR DETERMINATIONS OF THE STUDY

Secular trend:

The pattern of trend in arrivals and prices of chilli were almost similar in study markets.

For both the markets, the 6^{th} degree polynomial regression equation was fitted and it was found to be highest R^2 value. It shows an increasing trend in arrivals and prices, of chilli though it was fluctuating with ups and downs.

Seasonal indices

Seasonal indices of arrivals and prices of chilli in Hubli market revealed that the highest arrival index was noticed in the month of January (307.4) and the lowest arrival was noticed in the month of September and October (7.1). The highest price index was noticed in the month of January (110.6).

Seasonal indices of arrivals and prices of chilli in Byadagi market recorded that the highest arrival index was noticed in the month of March (217.3) and the lowest arrival was noticed in the month of August and September (18.9). The highest price index was noticed in the month of January (121.6).

Cyclical trend

The cycles in the selected market for both arrivals and prices was found to be uneven. There by it implied that there was large fluctuation in arrivals and prices of chilli in selected markets. The cyclical trend in selected markets showed that there were no constant period between cycles in both arrivals and prices.

ARIMA: Auto-Regressive Integrated Moving Average

ARIMA (Box-Jenkins model) employed to predict the future prices and arrivals of chilli in Hubli and Byadagi markets. For all the time series of chilli the estimated models for prices of and arrivals was presented below.

Monthly arrivals of chilli in Hubli market	(3, 1, 1) (1, 1, 1)
Monthly prices of chilli in Hubli market	(1, 1, 1) (1, 1, 1)
Monthly arrivals of chilli in Byadagi market	(1, 1, 3) (1, 1, 2)
Monthly prices of chilli in Byadagi market	(1, 1, 1) (1, 1, 1)

Exponential smoothing technique

Exponential Smoothing methods were fitted to the monthly arrivals and prices. Trial and error method was used in identifying the smoothing constants. The equal weight was given to all the observations. In Exponential smoothing, the weight (W) i.e., the alpha (level) was noticed for Hubli market arrivals (0.6), prices (0.4) and for Byadagi market arrivals (0.6), prices (0.3) The accuracy measures were tested using MSE and MAPE tests

Selection of best forecasting model based on MAPE and MSE

In selecting the best model to forecast the trend for monthly Arrivals and prices of chilli, the accuracy measures MAPE and MSE are considered. Among all the models tried, the Box-Jenkins ARIMA model was best fit with least MAPE and MSE values i.e. (Hubli arrivals 843.33, 671.22 respectively, for prices 233.42, 150.23 respectively and for Byadagi arrivals 1023.5, 756.23 respectively, for prices 466.33, 256.33). And the forecasted values from the ARIMA model were much nearer to the Actual values.

Growth in area, production and productivity of chilli in Northern Karnataka

In North Karnataka, positive compound growth rate (CGR) was noticed in area (13.70), production (13.88) and productivity (12.20) but these values were non- significant at ten and five percent level of significance

Districts wise analysis in case of area showed that highest compound growth rate was noticed in Belgaum (4.85) district at ten percent level of significance and Haveri (0.65) district at five percent level of significance respectively. In case of production, highest compound growth rate was noticed in Belgaum (5.41) district at ten percent level of significance and Gadag (1.09) district at five percent level of significance respectively. In case of productivity highest compound growth rate was noticed in Bidar (1.74) and Raichur (0.21) districts at ten percent level of significance respectively.

6.2 POLICY IMPLICATIONS

1. The growth rates of area, production and productivity of chilli was found to be positive but it is inconsistent over the years, hence the chilli area, production, and productivity can be increased by providing easy credit facilities, incentives to farmers, policy measures should be brought out to have good minimum support price for chilli
2. Cyclical fluctuation in market arrivals and prices were found to be uneven in the market. Hence there is a need to have a constant watch on prices and arrivals of the crop so that the farmers can know the variation occurring in the arrivals and prices

during certain period in the market and bring the produce at the right time to avoid the price crash in chilli. The regulated market should take necessary step to see that the dissemination of the market information regarding the arrivals and prices reach the farmers of the remote places.

3. With the help of ARIMA, model prices were forecasted. The forecasted prices showed an increasing trend, with due consideration to seasonality and cycles. In this regard farmers may be advised to plan the production process and decide when to sell the produce. So that they would get a higher price for their produce. In this regard APMC, should provide the basic infrastructural facilities to the farmers.
4. Since dry chilli was mainly used in 'powder' which was processed product and apart from these one in many industries like cosmetics, oleoresin extraction, and in many pharmaceutical industries etc. so the establishment of processing units may provide a value addition to chilli as indicated lower number of processing industries. This would help farmer to get better income, reduce the price fluctuation, and alternatively trigger the interest of the farmer to produce the good quality of the product.

Future line of work

The present study was limited to only few models. Therefore, it was suggested as mentioned below.

- In the present study comparison ARIMA and exponential smoothing technique was did we have scope to compare other forecasting models like ANN, ARCH and GARCH models
- If the data has higher variation in that case go for ARCH and GARCH models for forecasting purpose

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STATISTICAL INVESTIGATION OF PRICE BEHAVIOUR IN CHILLI

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ABSTRACT

The present study was conducted to know the statistical investigation of price behaviour of chilli (*Capsicum annum* L.) in North Karnataka. Chilli is one of the most important commercial spice crops of India. The information on price and arrival of chilli in Byadagi and Hubli market was collected for the period 1993-94 to 2008-09.

The highest arrivals of seasonal indices in Hubli market were observed in February (287.4) and the lowest, in August (6.6). With regard to price indices of chilli, the highest price was recorded in January (110.23). In case Byadagi market, the highest arrivals of seasonal indices were observed in February (211.7) and the least arrivals in August and September (18.9). Whereas, the highest price indices were noticed in January (121.6) and lowest price indices in August (84.1). The critical analysis showed a gradual increasing trend in arrivals in both markets but the price of chilli in both markets exhibited mild up and down trend equation.

The CGR in North Karnataka showed a positive growth rate with respect to area (13.70), production (13.88) and productivity (12.20) but, these values were non- significant at five percent level of significance.

Districts wise analysis of area showed that the highest CGR was noticed in Belgaum (4.85) at ten percent level of significance and Haveri (0.65) at five percent level of significance. In case of production, the highest CGR was noticed in Belgaum (5.41). In case of productivity, the highest compound growth rate was noticed in Bidar (1.74) and Raichur (0.21) districts.

The accuracy measures like MAPE and MSE are considered as the best models to forecast monthly arrivals and prices. Among all the models, ARIMA model was best with least MAPE and MSE values (for Hubli, arrivals 843.33, 671.22 respectively, for prices 233.42, 150.23 respectively and for Byadagi, arrivals 1023.5, 756.23 respectively, for prices 466.33, 256.33). The forecasted values from the ARIMA model were much nearer to the Actual values.